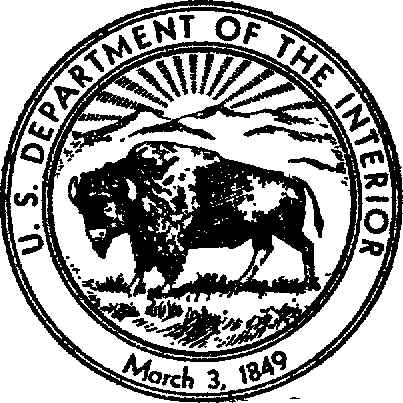
Geology, Hydrology, and Chemical Character of Ground Waters in the Torrance-Santa Monica Area, California

**By J. F. POLAND, A. A. GARRETT, *and* ALLEN SINNOTT**



**GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1461**

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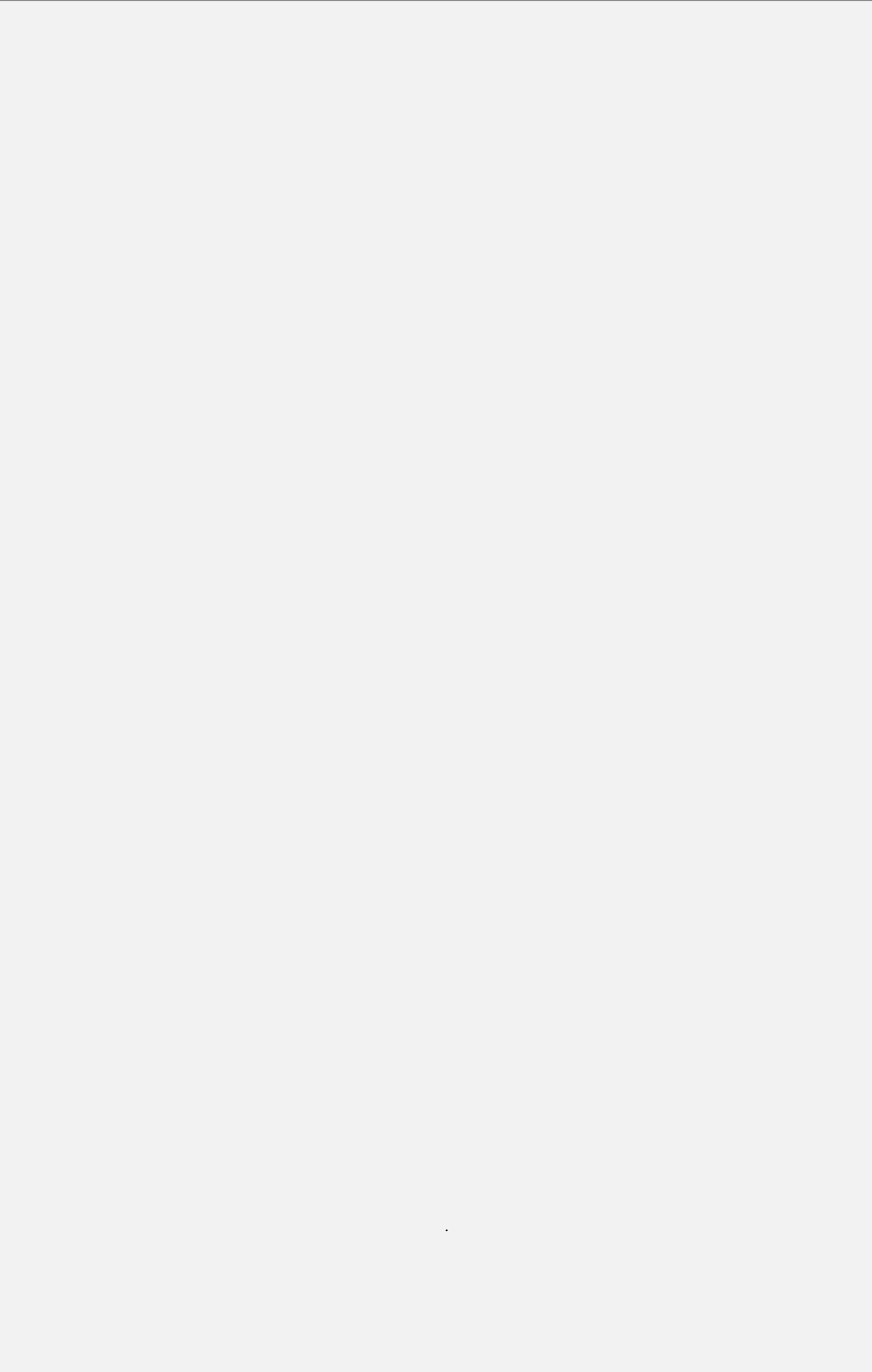
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**GEOLOGY, HYDROLOGY, AND CHEMICAL CHARACTER OF GROUND WATERS IN THE TORRANCE-SANTA**

**MONICA AREA, CALIFORNIA**

By J. F. POLAND, A. A. GARRETT, and ALLEN SINNOTT

**ABSTRACT**

The coastal plain in Los Angeles County, southern California, is divided into two distinct ground-water basins by the Newport-Inglewood uplift. On the northeast or inland side is the main coastal basin; on the southwest, bordering the Pacific Ocean and extending from Long Beach to Santa Monica, is the so-called west basin. The Torrance-Santa Monica area, as identified here, embraces the western part of the coastal plain and spans the entire west basin.

The west basin, which includes about 180 square miles, is an area of expanding population and of rapid industrial growth. Its water supply for domestic, indus­ trial, and irrigation uses is obtained chiefly from wells. In the part of the west basin south of the Ballona escarpment-the Torrance-Inglewood subarea of this report-the draft on ground water has been excessive for many years; and local water levels, which were drawn down to about sea level by 1930, now are as much as 70 feet below sea level. Saline contamination has developed extensively along the coast, and the ground-water supply is threatened with ultimate deterioraw tion if the present draft is maintained.

This investigation, which covers the period from 1943 to 1947, was for the purpose of appraising the geologic conditions controlling the occurrence and circulation of ground water, the replenishment to the west basin, and the extent and sources of saline contamination and methods for its control.

The dominant geologic formations of the area are of Tertiary and Quaternary age. The Tertiary rocks, of Miocene and Pliocene age, are formed almost entirely of marine deposits and consist chiefly of shale, siltstone, and sandstone. Except in their uppermost part, they contain connate saline waters. The lower part of upper division of the Pico formation (the youngest rocks of Pliocene age) has several relatively permeable sand members which collectively average at least 200 feet in thickness. These sand members have not been tapped by water wells; however, they contain essentially fresh water and constitute a reserve supply. It would be expensive to develop this supply because the wells would have to be at least 1,500 feet deep and would require special construction to hold back the sand.

The Quaternary rocks, chiefly of Pleistocene age, contain almost all of the aquifers now tapped by water wells. Deposits of Recent age in the west basin occur only within the Dominguez and Ballona Gaps. The Pleistocene deposits, which underlie most of the Torrance-Santa Monica area, comprise three units which, in downward succession, are: (1) a capping terrace deposit and the Palos Verdes sand, which is composed of sand, silt, and gravel, commonly not more than **30** feet thick and, for the most part, above the water table; (2) the unnamed upper

**1**

Pleistocene deposits consisting of silt, clay, sand, and gravel, which are as much as 400 feet thick and are of fluvial and marine origin; and (3) the San Pedro formation (composed of about half sand and gravel and half silt and clay) which is as much as 1,000 feet thick and mostly of marine origin within the west basin. The Silverado water-bearing zone and correlative aquifers in the San Pedro formation yield about 90 percent of the ground water pumped from the west basin. The thickness of this principal aquifer ranges from 50 to 700 feet; its extent within the west basin is about 120 square miles. From pumping tests its permeability has been determined as ranging from 1,000 to 2,000 gallons per day per square foot (gpd per sq ft).

The deposits of Recent age are the latest contributions to the alluvial fans of the Los Angeles and San Gabriel Rivers. They underlie the Downey plain and extend across the west· basin as two tongues in Dominguez and Ballona Gaps. The upper division is fine sand and silt, but the lower division is highly permeable coarse sand and gravel, as much as 75 feet thick in Dominguez Gap.

The Newport-Inglewood uplift-a regional anticlinal fold-is ruptured by a series of faults, which form a discontinuous but substantial barrier to underflow from the main coastal basin to the west basin. These faults cut all rocks except those of Recent age.

Three distinct bodies of ground water occur in the area. In downward succes­ sion these are: (1) a body of shallow unconfined and semiperched water of inferior quality under natural conditions, which extends to a few tens of feet below the land surface; (2) the principal body of fresh ground water, which occupies almost all the deposits of Recent and Pleistocene age and the upper part of the underlying Pliocene rocks (extending to depths as much as 2,500 feet below land surface in the west basin and 8,000 feet in the main coastal basin), which contains water of good quality; and (3) a body of saline connate water underlying the principal fresh-water body.

The principal body of fresh ground water underlies most of the Torrance­ Santa Monica area and occurs beneath the greater part of the west basin. Except near Redondo Beach and north of El Segundo, where a water table exists, the aquifers of the principal water body are confined and separated from each other **by** substantial thicknesses of relatively impermeable silt or clay.

In the Torrance-Inglewood subarea (the part of the west basin south of the Ballona escarpment), withdrawals of ground water increased from nearly **10,000** acre-feet in 1904 to about 48,000 acre-feet per year in the thirties, and then rose to about 78,000 acre-feet in 1945, because of accelerated demands in the war years. In 1945 about half the withdrawal was used for industrial. purposes.

As a result of this increase in draft, water levels noticeably declined in the early twenties and were drawn down to or below sea level throughout the subarea by 1930. A slow, irregular decline continued through 1941, when the decline was accelerated by the increased water demands of the war years. In 1946, local pressure levels in the Silverado water-bearing zone were as much as 70 feet below sea level near the inland boundary of the basin. Because of the impermeable confining beds and disproportionate draft, water levels in the several aquifers have been drawn down unequally. For example, in the Gardena area in 1946, the pressure level in the Silverado water-bearing zone was 50 feet below the semiperched water table, 20 feet below the pressure level of the "200-foot sand" and about 9 feet below that of the "400-foot gravel."

Under the early conditions of ground-water development, replenishment to the west basin occurred (1) by underflow across the Newport-Inglewood uplift,

(2) by direct infiltration of rainfall and return water from irrigation on the land surface; (3) by infiltration of local runoff, and (4) by seepage from the channel

**ABSTRACT** 3

of the Los Angeles River to the south and from Ballona Creek and its tributaries to the north. With the drawdown in water levels to and below sea level, water has been added to the basin in substantial quantity by landward encroachment of saline waters from the ocean and from the subsea extensions of the aquifers. Water also has been withdrawn from storage in the water-table reaches by com­ paction of the water-bearing system in the confined reaches.

The replenishment to the Torrance-Inglewood subarea under native conditions is estimated to have been within the range of 30,000 to 40,000 acre-feet per year. From 1933 to 1941 the draft averaged 48,000 acre-feet per year. It is estimated that about 2,000 acre-feet per year was withdrawn from storage, about 12,000 acre-feet per year was contributed from the subsea extension of the aquifers **or** from the ocean, and nearly 34,000 acre-feet per year was contributed by net fresh-water replenishment from all sources.

The underflow across the Newport-lnglewood uplift varies with the differential in pressure head across the barrier faults. For the reach from the Baldwin Hills to Long Beach, the average differential is estimated to have decreased from about 40 feet in 1904 to 28 feet in 1941 and to have increased to about 36 feet in 1945 with the accelerated drawdown in the west basin. The underflow into the Torrance-Inglewood subarea in 1945 is estimated as from approximately 15,000 to 20,000 acre-feet, or about 85 percent as much as the underflow during 1904. By 1945 the underflow is believed to have constituted nearly one-half the fresh­ water replenishment, and the probable excess of draft over net replenishment was at least 40,000 acre-feet in that year. A major part of this excess draft was replaced by invasion of ocean water.

In the west basin the native waters of good quality in the principal water body range in character from calcium bicarbonate to sodium bicarbonate, and their chloride content ranges from 25 to 90 ppm. For native inferior waters-those in which dissolved solids are in excess of 600 ppm-the chloride content is as great as 500 ppm.

The potential contaminants of the ground water in the west basin are ocean water, oil-field brines, and industrial wastes. The ocean water contains dissolved solids of about 34,000 ppm and chloride content of about 19,000 ppm. The oil-field brines are connate waters from the Tertiary rocks and range in dissolved solids about from 10,000 to 39,000 ppm. The ocean waters are in contact with the subsea extensions of the aquifers; the oil-field and industrial wastes have been discharged at the land surface and in stream channels.

In the twenties and early thirties, in response to the drawdown of the water level in the west basin, certain wells tapping the principal water body along the west coast between Santa Monica and Redondo Beach began to yield saline water. Contamination also developed near the Baldwin Hills and in Dominguez Gap about that time.

In general, the contaminated waters are not simple mixtures of the contaminant and native waters but have been so greatly modified that the nature of the con­ taminant is very obscure. Such modification is caused chiefly by base exchange-­ substitution of calcium and magnesium for sodium-and by sulfate reduction.

In the coastal part of Ballona Gap contamination started in the twenties and by 1931 extended beneath nearly 5,100 acres; by 1946 this contamination ex­ tended to about 7,300 acres. Inland for about 1.6 miles (near Lincoln Boulevard) the contaminated waters contain more than 500 ppm of chloride. The con­ taminant at this point is almost wholly ocean water. Contaminated waters extend about 3 miles inland in the Ballona Gap and range in chloride content from 100 to 500 ppm. The source of the contaminant is not definitely known, but the high sulfate content indicates that the shallow unconfined waters are a

principal source. Adjacent to the west and north flanks of the Baldwin Hills, oiMield wastes have contaminated two areas. The contamination on the west flank is increasing but on the north flank it has receded since the thirties.

Along the 11-mile coastal reach, from the Ballona escarpment (Playa del Rey) to the Palos Verdes Hills, salt water has invaded the main water-bearing zones. Contamination was first noted at Hermosa Beach about 1915 and at El Segundo in 1921. By 1931 the coastal area underlain by contaminated waters amounted to almost 5,000 acres, and the greatest inland extent was about 1.3 miles, at El Segundo. By 1946 the contaminated area had increased by about 1,700 acres. In the last 14 years the greatest advance of the front was between El Segundo and Manhattan Beach and was as much as 0.5 mile. In the reach from the Palos Verdes Hills to Hermosa Beach the average rate of advance of the front was about 90 feet per year from 1931 to 1941, and it had increased to about 140 feet per year by 1946. From Hermosa Beach to El Segundo the average rate of ad­ vance in the thirties was about 115 feet a year, but it was as much as 300 to 400 feet per year by 1946. The chief source of contamination along the west coast is ocean water. Near El Segundo, part of the early contamination seems to have developed from locally discharged high-sulfate waters.

In Dominguez Gap the Gaspur water-bearing zone, of Recent age, is extensively contaminated in two principal areas. Along the coast and inland, as far as the Pacific Coast Highway (State Street), this zone is highly contaminated with ocean water. Inland from this highway to Carson Street, about 3 miles, the Gaspur zone is contaminated by waste brines from the Long Beach oil field. The Silverado water-bearing zone, which underlies the Gaspur zone but is sepa­ rated from it by relatively impervious deposits several hundred feet thick, is uncontaminated as of 1947; however, it can become contaminated by downward movement of saline water through abandoned wells unless these wells are properly sealed. The contamination in the Gaspur water-bearing zone is not moving inland; it is moving slowly westward into the upper Pleistocene deposits, and ulti­ mately wilJ reach the Silverado water-bearing zone if the present water-level differentials of as much as 70 feet are maintained.

The continued inland advance of ocean water into the west basin, especially from the west coast, would result in ultimate destruction of the supply of fresh water. The water rights in the Torrance-Inglewood subarea now are being adjudicated because it is recognized that the water supply is being excessively depleted and is being replaced by salt water. In most ground-water basins bordering on the ocean, the most effective long-term program for restraining or driving back saline waters depends upon raising water levels throughout the basin to such a height that fresh-water levels at the saline front will displace salt water seaward. Such raising of water levels ordinarily does not greatly affect replenishment procedures.

However, in the Torrance-Inglewood subarea almost half the current replenish­ ment is derived by underflow across the barrier features. If the restraint of ocean water should be achieved by raising water levels above sea level throughout the basin, and if water levels inland should remain at sea level, underflow across the Newport-Inglewood barrier would cease and half of the replenishment would be lost. Therefore, it seems that the amount of the natural fresh-water yield from the basin will remain substantial only if the salt water can be restrained by local control near the coast and water levels immediately coastward from the barrier can be held low enough to induce continued underflow across the barrier.

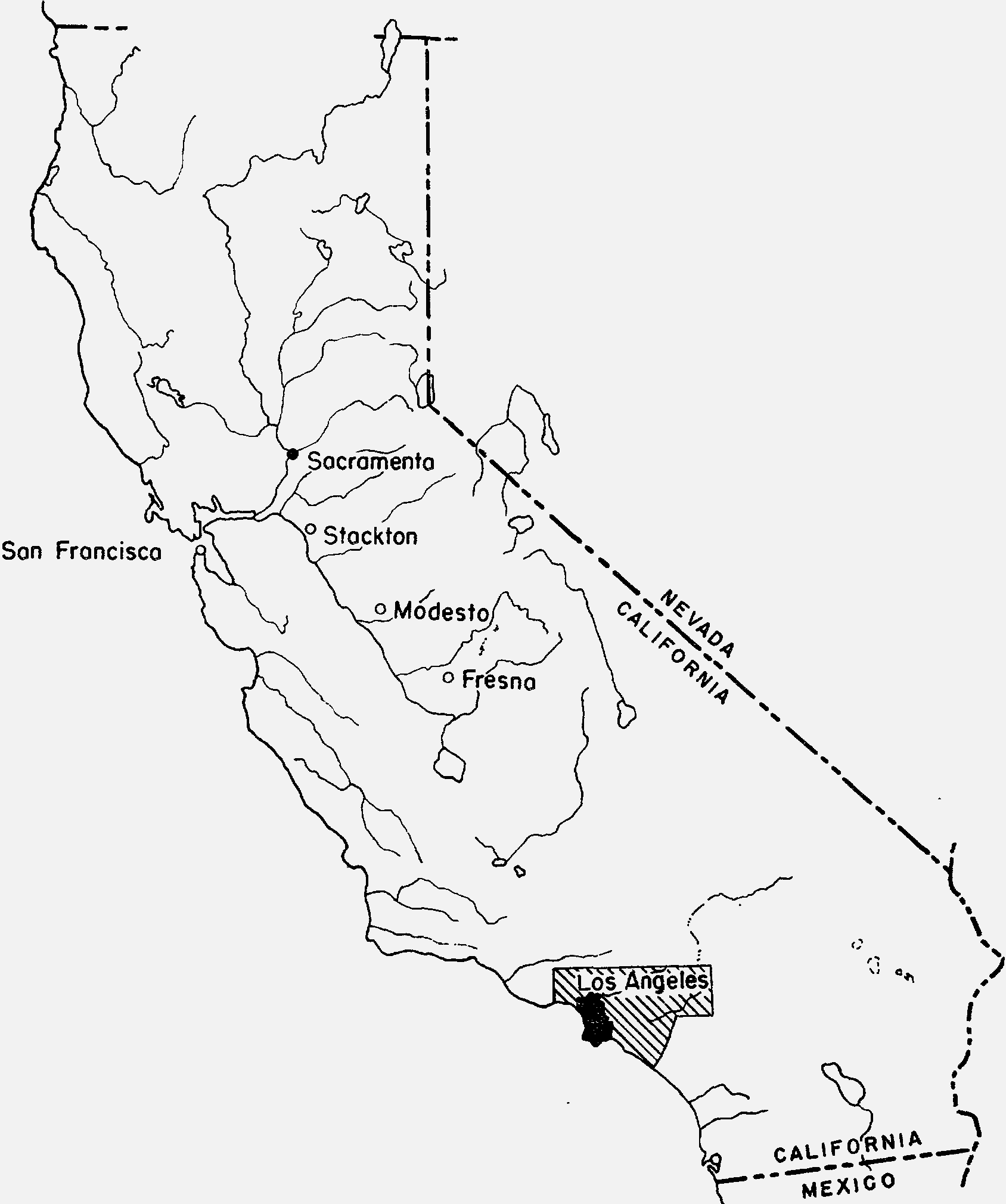
Only three physical possibilities seem capable of such local control of saline waters: (1) the construction of artificial subsurface dikes or cut-off walls; (2) the development, by pumping, of a water-level trough coastward from the saline

front; and (3) the maintenance of fresh-water head above sea level at and immedi­ ately inland from the saline front. Only the maintenance of fresh-water head is considered to be an economic possibility. The fresh-water head required along the west coast would range from 3 to 13 feet above sea level. It could be attained only by artificial recharge through wells, trenches, or pits.

**INTRODUCTION**

**LOCATION AND GENERAL FEATURES OF THE AREA**

The Torrance-Santa Monica area, as identified in this report, embraces the western part of the coastal plain in Los Angeles County, in southern California. Its location is shown by figure 1 and some



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**OREGON**

ALIFORNIA

50

0

100 Miles

FIGURE 1.-Map of California showing area covered by this report and that covered by plate 1.

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1. **GEOLOGY, HYDROLOGY, TORRANCE-SA.i. TA MONICA AREA**

of its general features are shown by plate 1. It is bounded on the north by the Santa Monica Mountains, on the south by the Palos Verdes Hills, and on the west by the Pacific Ocean. It encompasses about 280 square miles, spans the entire west basin of Eckis (1934,

p. 198) and extends inland beyond the axis of the Newport-Inglewood uplift. This uplift, which extends about 40 miles southeastward from Beverly Hills to Newport Beach (pl. 1), divides the coastal plain of Los Angeles County into two distinct ground-water basins. On the northeast or inland side is the main or "central" coastal basin, which includes about 500 square miles in Los Angeles and Orange Counties. As of 1948 about one-third of a million acre-feet of ground water is pumped annually to supply municipalities, diversified industries, and extensive agricultural developments from the central basin.

The ground-water basin on the southwest or coastal side of the uplift extends from Santa Monica to Long Beach and is flanked on the southwest by the Palos Verdes Hills and the Pacific Ocean. It was designated the west basin by Eckis, but in recent references by the California Division of Water Resources it has been called the west coast basin. The shorter term by Eckis is used in this report. The approximate dimensions of the west basin are 25 miles long,

1. miles wide, and 180 square miles in area. It is an area of expand­ ing population and of rapid industrial growth. Two-fifths of the 180 square miles consists of a residential development with a popu­ lation of at least 300,000. Irrigated farmland covers about one-fifth of the area. The city of Santa Monica is supplied with water from the Metropolitan Water District, but the water supply for domestic, industrial, and irrigation uses is obtained almost entirely from wells. In the part of the west basin south of the Ballona escarpment the draft on ground water has been excessive for many years, and local water levels, which nearly reached sea level by 1930, now (1948) are as low as 70 feet below sea level. As a result, saline contamination has developed in three areas along the coast and the ground-water supply of most of the basin is threatened with ultimate deterioration if the present draft is maintained or increased.

**SCOPE OF THE INVESTIGATION AND OF THIS REPORT**

Because of the critical ground-water situation in the west basin, in July 1943 an agreement for a cooperative ground-water investi­ gation was made between the U. S. Geological Survey and the Los Angeles County Flood Control District. In addition to its own interest, the District also represented the joint interests of nine cities intimately concerned with the preservation of the ground-water sup­ plies-the cities of Inglewood, Redondo Beach, Manhattan Beach, **El** Segundo, Hawthorne, Culver City, Gardena, Hermosa Beach, and

Palos Verdes Estates. All these communities obtain water wholly or partly from well fields in the west basin; several of these well fields have been affected or are threatened by saline encroachment-espe­ cially the wells that supply Redondo Beach, Hermosa Beach, Man­ hattan Beach, and El Segundo.

The cooperative investigation of the west basin area was under­ taken to appraise: (1) the geologic conditions which control the occurrence and circulation of ground water; (2) the replenishment to the west basin; and (3) the chemical character of the ground water with special reference to saline contamination.

The investigation, which began in October 1943, was under the general direction of 0. E. Meinzer, chief geologist. Upon his retire­ ment, A. N. Sayre served in that capacity. Until mid-1946 the proj­ ect was under the supervision of district geologist A. M. Piper. A. A. Garrett and Allen Sinnott, of the field office at Long Beach, did most of the field operations under the supervision of J. F. Poland, district geologist. Garrett made the partial chemical analyses of well waters. This report is under the combined authorship of Poland, Garrett and Sinnott; the section treating the geology is largely the work of Sinnott and the section on chemical character is chiefly the work of Garrett. The hydrologic interpretations and text were prepared by Poland.

The Geological Survey has made an intensive study of ground-water features in the coastal zone of 240 square miles that extends from Long Beach to Santa Monica, spans all the west basin, and extends inland for about 3 miles beyond the axis of the Newport-Inglewood uplift. The Survey also made a general study of selected ground­ water features in a contiguous inland zone of 40 square miles that extends to the western boundary of the Long Beach-Santa Ana area. These two zones comprise the Torrance-Santa Monica area; the boundaries of this area and those of the Long Beach-Santa Ana area are shown on plate 1. It will be noted on plate 1 that the area imme­ diately west of Long Beach (50 square miles comprising Dominguez Gap and vicinity) is common to both areas. Although the ground­ water features of Dominguez Gap and vicinity were studied in the earlier investigation, the area lies within the scope of this report and is the area of the most intensive ground-water draft within the west basin.

The Geological Survey has released two reports on its work in the Torrance-Santa Monica area. A progress report (Poland, Garrett, and Sinnott, 1944) was prepared after the first year of work to outline the general ground-water conditions and to indicate the current extent of saline contamination in the critical area from Redondo Beach to El Segundo. In 1946 a factual well index was issued (Sinnott and Garrett, 1946), which for the canvassed extent of the coastal zone pre-

sents brief tabulated descriptions of nearly all of the active or poten­ tially active water wells and of those abandoned wells for which data are available (incorporated in this report as table 26). This index also summarizes the sources and scope of the available well records, chemi­ cal analyses of water from wells, measurements of depth to water, and logs of wells. Wells were not canvassed *by* the Geological Survey in. 62 square miles of the Torrance-Santa 1-fonica area; however, a brief tabulated record of pertinent well data was prepared from records supplied by the California Division of Water Resources, the Los Angeles County Flood Control District, the Los Angeles Department of Water and Power, and other agencies (table 27).

The present report gives the findings and conclusions relating to the geology, hydrology, and chemical character of the ground waters in and adjacent to the west basin. Because ground-water conditions are most critical in the part of the west basin that is south of the Ballona Gap, the report treats that area in greater detail. This report was first released to the public in 1948, in duplicated form. Publication has been delayed in part by the decision to wait until the revised topographic sheets of the area became available for the base map. The last of these was supplied in 1953.

From 1940 to 1946 the Geological Survey made an intensive investi­ gation of ground-water conditions within the southern part of the coastal plain-from Dominguez Hill southeast to Newport Beach­ with special reference to saline contamination and the effectiveness of the barrier features of the Newport-Inglewood uplift to restrain inland movement of ocean water. The are1 of study embraced almost all the coastal plain east of Vermont Avenue and was called the Long Beach-Santa Ana area. From that investigation four interpretive reports had been released to the public in duplicated form by 1946.1 These reports are being published in three water-supply papers (Piper, Garrett, and others, 1953; Poland, Piper, and others, 1956; Poland, 1959). Because the Long Beach-Santa Ana area is adjacent to and, in T. 4 S., R. 13 W., overlaps the Torrance-Santa Monica area, they have many features in common. Thus, in this report, frequent reference is made to matters treated in the reports on the Long Beach­ Santa Ana area.

1 Poland, J. F., Piper, A. M., and others, 1945, Geologic features in the coastal zone of the Long Beach­ Santa Ana area, California, with particular respect to ground-water conditions: U. S. Geol. Survey dupli­ cated report, 527 p. Poland, J. F., Sinnott, Allen, and others, 1945, Withdrawals of ground water from the Long Beach-Santa Ana area, California, 1932-41: U.S. Geol. Survey duplicated report, 112 p. Piper, A. M., Garrett, A. A., and others, 1946, Chemical character of native and contaminated ground waters in the Long Beach-Santa Ana area, California: U.S. Geol. Survey duplicated report, 356 p. Poland, J. F., and others, 1946, Hydrology of the Long Beach-Santa Ana area, California, with special reference to the water­ tightness of the Newport-Inglewood structural zone: U. S. Geol. Survey duplicated report, 198 p.

**OTHER INVESTIGATIONS**

The first investigation of the ground waters within the western part of the coastal plain was made by Mendenhall (1905a, 1905b) in 1903-4. At that time about 2,500 active wells within the extent of the Torrance­ Santa Monica area were visited, and readings were made of depth to water, and of chemical quality as measured by electrical resistance.

From 1904 to 1926 the Geological Survey continued periodic measurements of depth to water on a few selected wells. Of these, 26 were within the Torrance-Santa Monica area, but measurements for all but 3 wells were discontinued prior to 1926. Their records through 1920 have been published by the Geological Survey (Ebert, 1921, p. 13-29).

From the middle twenties to 1941 the Los Angeles Department of Water and Power made periodic measurements of depth to water in many wells within the part of the coastal plain in Los Angeles County. Of these, several hundred were within the Torrance-Santa Monica area. No interpretive reports have been published by that agency as a result of this program but the measurements have been made available for use in the preparation of this report.

Since 1929 the Los Angeles County Flood Control District has been collecting a large mass of basic data, chiefly in the form of water-level measurements, chemical analyses from wells and streams, and well logs. In its series of annual reports, that agency has published semi­ annual water-level contour maps and selected hydrographs. Also, it has prepared brief reports or summary statements treating the problems of saline contamination along the coast of Los Angeles County within the west basin. The earliest of these reports is believed to be one prepared by Donald Seal (1931), in which the author pointed out the presence of saline contamination along the coast and the danger of its expansion inland. The saline encroach­ ment was treated more fully by Dockweiler (1932) in a report on the so-called Nigger Slough project for flood control and conservation. The report included a plan for artificial recharge of the ground water by injection through wells. In 1935 the Flood Control District began a study of saline contamination in Ballona Gap, in connection with the construction of the new Ballona Creek flood control channel. The results of the study were issued in several progress reports and summarized in a final report by Koch (1940).

Since the late twenties the California Division of Water Resources has acted as a collecting agency and its Los Angeles office has been a depository for factual information relating to ground-water supplies, especially measurements of depth to water, chemical analyses, and well logs. Some of the measurements and chemical analyses have been made by its· own staff but most of the work was done by other

agencies, although the data were assembled by the Division. For many years the Division has been investigating the water supplies available to the ground-water basins of the Los Angeles area and it has issued several factual and interpretive reports relating in part to the west basin area (Gleason, 1932; Scofield, 1933; Eckis, 1934). In 1944 the California Division of Water Resources issued a brief state­ ment on ground-water conditions in the west basin.

Since 1929, the water department of the city of Long Beach has made periodic measurements of depth to water in about a dozen wells in Dominguez Gap. Also in 1932 the water department began making periodic determinations of the chloride content of water samples usually taken once a month from 40 to 50 wells in Dominguez Gap. The measurements and analyses have been continued to date.

In connection with an appraisal of water supply and use of ground water in southern California, the Metropolitan Water District has prepared two reports concerned with ground water conditions in the southern part of the west basin (Vail, 1932; 1942).

After the cooperative investigation in the west basin was started by the Geological Survey, and partly as a result of the :findings in the Survey's progress report of 1944, water users in the part of the west basin south of Ballona Gap organized a "West Basin Ground Water Conservation Group" to investigate and report on the problems con­ fronting water producers and users in the area. A Ways and Means Committee of that group, appointed in March 1945, published its

:findings in September 1945 (Anon., September 1945).

The :findings and conclusions of the Ways and Means Committee report led to the organization of the West Basin Water Association late in 1945, a nonprofit organization comprised of many of the water users in the parent group. The Water Association has released a report by Harold Conkling (1946), which appraised the possibilities of the importation of water.

Knowledge concerning the saline encroachment and the increasing overdraft upon the ground-water supplies had been widely dissem­ inated by mid-1945, and in October of that year legal action was brought by three water users in the west basin for the purpose of seeking adjudication of the rights of each producer of ground water in the part of the basin south of Ballona Gap. In July 1946 the California Division of Water Resources was appointed as referee to investigate and report on physical facts pertinent to the action (Gleason, 1946). (Seep. 262.)

**ACKNOWLEDGMENTS**

The U. S. Geological Survey has made extensive use of the data and reports summarized in the preceding section of this report.· The

basic data collected by the Los Angeles County Flood Control Dis­ trict, the California Division of Water Resources, and the Los Angeles Department of Water and Power have been of immeasurable value in this investigation. Acknowledgment also is made of valuable data supplied by the cities of El Segundo, Hawthorne, Inglewood, Long Beach, and Manhattan Beach; by the Southern California Water Co., the California Water Service Co., and the Dominguez Water Corp.; by the many industrial plants that produce water from the west basin, especially the Standard Oil Co. at El Segundo for the many chemical analyses and the results of its test-pumping operations on a well tapping the upper division of the Pico formation; and the Union Oil Co. for its cooperation in making a pumping test to determine ground­ water conditions in the vicinity of Bixby Slough; also, by many other agencies and individuals that cooperated fully in making their data available.

Substantial contributions on geological data appearing in this report have been made by several oil companies, especially the Stand­ ard Oil Co. of California for making available an unpublished map of the surface geology of the Baldwin Hills, by G. B. Moody. With reference to stratigraphic problems, special acknowledgment for microfaunal information is due S. G. Wissler of the Union Oil Co. and M. L. Natland of the Richfield Oil Corp. Sample suites from water wells were obtained through the cooperation of the Roscoe Moss Co. by Paul Karnes and Mr. Bromwell, drillers; and also through the city of Long Beach. Cores from several wells were received from the Kalco Drilling Co. through C. C. Killingsworth;

M. R. Peck furnished several logs.

Electric logs of oil wells, supplied through the courtesy of many oil companies, were utilized in correlating the deeper fresh-water zones and in determining the depth to the body of saline connate water that underlies the fresh-water body throughout the area.

**NUMBERS APPLIED TO WELLS BY THE GEOLOGICAL SURVEY**

In its cooperative programs on the coastal plain and elsewhere in California, the Geological Survey has designated wells by numbers that indicate the respective locations according to rectangular land surveys. For example, for well 3/14-36M3, the first part of the Geological Survey number indicates the township and range (T. 3 S.,

1. 14 W., San Bernardino base line and meridian), the two digits following the hyphen indicate the section (sec. 36), and the letter indicates the 40-acre subdivision of the section as shown on the accompanying diagram.

|  |  |  |  |
| --- | --- | --- | --- |
| D | C | B | A |
| E | F | G | H |
| **M** | L | K | J |
| N | p | Q | R |

Within each 40-acre tract the wells are numbered serially as indi­ cated by the final digit or digits of the number. Thus, well 36M3 is in the NW} SW} sec. 36 and is the third well in that tract to be listed. In the parts of the area that once were public land, the official Federal land survey is followed. Elsewhere the net is projected, but most of the land has been subdivided according to extensions of the

Federal Survey so that the system can be applied readily.

This system of numbers has also been used as a convenient means of locating a feature described in the text. Thus, an area or feature within the NW} NW7 sec. 7, T. 3 S., R. 14 W. (projected land lines), may be identified as 3/14-,D.

**SUBDIVISIONS OF THE WEST BASIN WITH RESPECT TO GROUND WATER**

For purposes of this report, the west basin is divided into two parts. The area extending from the Ballona escarpment (pl. 8) southeast to the Los Angeles River flood-control channel west of Long Beach forms a hydrologic unit that is believed to be essentially un­ broken by barrier faults except those which bound the basin. This area, which includes some 135 square miles, or about three-quarters of the west basin, is identified in this report as the Torrance-Inglewood subarea. It is the area of the most intensive regional lowering of water level and, as late as 1945, it yielded more than 80 percent of the water withdrawn from the west basin. Also, this is the area involved in the pending suit for adjudication of water rights.

The area extending from the Ballona escarpment north to the Santa Monica Mountains, and including the Ballona Gap, is traversed by several faults which interrupt hydraulic continuity in the Pleistocene water-bearing deposits and produce conditions of localized ground­ water movement. This area, about 45 square miles in extent, is identified in this report as the Culver City subarea.

**CLIMATE**

The climate of the Torrance-Santa Monica area is mild and is charact.erized by a wet and a dry season. The average annual rainfall is 12 to 16 inches throughout the area. About 95 percent of the rain­ fall occurs in the 7 months from October through April, principally from storms originating in the north Pacific area and moving inland from the ocean; at times, however, rain develops from storms moving northwestward from the Caribbean area and across Mexico.

The prevailing winds are from the west and northwest and carry moisture over the land from the Pacific Ocean. These winds quickly lose much of their moisture as they pass eastward across the land. Within the west basin, however, their moisture content is sufficient to substantially reduce the requirements for irrigated crops below those of the interior valleys.

The mean annual temperature at Santa Monica, on the coast, is about 60°F; the temperature ranges from 53° in January to 66° in August. The hottest and driest periods occur when infrequent winds sweep coastward from the interior deserts. Table 1 gives monthly and yearly averages of temperature and precipitation for Long Beach and Santa Monica at opposite ends of the area, and for Los Angeles, at the inland margin. In a recent publication, Gleason (1947, pl. 21) has included a map showing lines of equal precipitation (mean for the 53-year period) for the entire south coastal basin. The distribution and magnitude of average yearly rainfall in the west basin and the increase in rainfall inland to the San Gabriel Mountains are well shown on that map.

TABLE *1.-Monthly and yearly averages of temperature and precipitation at three climatological stations in or adjacent to the Torrance-Santa Monica area in the period ending 1946*

[From publications of U.S. Weather Bureau]

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Long Beach | | Los .Angeles | | Santa Monica | |
| Tempera- ture (OF) 1926-46 | Precipita- tion (inches) 192G--46 | Tempera- ture (OF) 1876-1946 | Precipita- tion (iriches) 1876-1946 | Tempera- ture (OF) 1889-1922 | Precipita- tion (inches) 1884-1922 |
| January February March  April.  May June.  July.-------------------------  August.\_---------------------  September October  November December  Annual | *53.* 7 lili.4 57.6  59. 9  63.1  65.9  70.2  70.6  68.5  64.4  60.2  56.1  62.1 | 2.18  2.90  1.51  .88  .31  .08  .04  .30  .lili   * 71   2. 74  12.20 | *54.6*  /iii.Ii 57.li 59.4  62.2  66.4  70.2  71.1  69.0  65.3  60.9  56.6  62.4 | 3.10  *8.07*  2. 78  1.04  .45  .08  .01  .02  .17  .68  1.20  2.63  15.23 | 52.8  53.1  lili.4 57.8  60.0  63.2  65.9  66.4  64.8  62.0  58.-3  54.6  59.5 | 3.51  2.95  2.85  .52  .46  .02  1T.  .03  .14  .61  1.37  2.32  14.78 |

**s** T=0.005 inch or less of rain or melted snow.

In another report (Poland, 1959), rainfall records were tabulated for Los Angeles from 1877 to 1945, and for Long Beach from 1921 to 1945; those for Los Angeles were plotted to show cumulative departure from the yearly mean. Because the rainfall at Los Angeles has been observed since 1877 and furnishes much the longest record for any station in the vicinity of the Torrance-Santa Monica area, it is presented again in table 2. Yearly and cumulated departure from the 68-year average from 1877 to 1945 (years ending June 30) also are shown by the table.

TABLE *2.-Rainfall at Los Angeles, in inches, in the years ending June 30: 1877-1946; also surplus or deficiency* (-) *with respect to the 68-year average of 18 77- 1945 1*

[From publications of U.S. Weather Bureau]

Year

Surplus Rainfall or defi­

ciency

Cumu- lated surplus or defi­ ciency

Year

Cumu-

Surplus lated Rainfall or defi­ surplus

ciency or defi­ ciency

4.68

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1877-78 -- -- \_ | 21.26 | 5. 73 | 5. 73 | 1912-13 -- ------ | 13. 42 | -2.11 | -1.36 |
| 1878-79 --  1879-80 -- -- \_ | 11. 35  20.34 | -4.18  4.81 | 1. 55  6.36 | 1913-14 --- ---  1914-15 ------- | 23.65  17.05 | 8.12  1. 52 | 6.76  8.28 |
| 1880-81 --- -- | 13.13 | -2.40 | 3.96 | 1915-16 ------ | 19. 92 | 4.39 | 12.67 |
| 1881-82 -- -- --- | 10.40 | -5.13 | -1.17 | 1916-17------- ------ | 15. 26 | -.27 | 12.40 |
| 1882-83 ----- | 12.11 | -3.42 | -4.59 | 1917-18 -- --• \_ | 13.86 | -1.67 | 10. 73 |
| 1883-84 ---- \_ | 38.18 | 22. *65* | 18.06 | 1918-19 -- -- \_ | 8. 58 | -6.95 | 3. 78 |
| 1884-85 ----- | 9.21 | -6.32 | 11. 74 | 1919-20 - | 12. 52 | -3.01 | * 77 |
| 1885-86 ------- \_  1886-87 \_  1887-88 \_ | 22.31  14.05  13.87 | 6.78  -1.48  -1.66 | 18.52  17.04  15.38 | 192Q-2l --------  1921-22 -- ·- \_  1922-23 ------- | 13.65  19.66  9. 59 | -1.88  4.13  -5.94 | -1.11  3.02  -2.92 |
| 1888-89 -- --- | 19.28 | 3.75 | 19.13 | 1923-24 --------- | 6.67 | -8.86 | -11.78 |
| 1889-90 -- \_ -- | 34.84 | 19.31 | 38.44 | 1924-25 ----- | 7.94 | -7.59 | -19.37 |
| 1890-91 -- -- \_ | 13.36 | -2.17 | 36.27 | 1925-26 \_ | 17.56 | 2.03 | -17.34 |
| 1891-92 --  1892-93 --- \_  1893-94 --- --  1894-95 -- -- | 11. 85  26.28  6. 73  16.11 | -3.68  10.75  -8.80  .58 | 32.59  43.34  34.54  35.12 | 1926-27 \_  1927-28 \_  1928-29 --  1929-30 --- ---- | 17. 76  9. 77  12.66  11. 52 | 2.23  -5.76  -2.87  -4.01 | -15.11  -20. 87  -23.74  -27. 75 |
| 1895-96 ---  1896-97 \_  1897-98 -- \_ | 8. 51  16.86  7.06 | -7.02  1.33  -8.47 | 28.10  29.43  20.96 | 1930-3L. \_  1931-32 -- -- \_  1932-33 -- ------- | 12.53  16.95  11.88 | -3.00  1.42  -3.65 | -30. 75  -29.33  -32.98 |
| 1898-99 -- | 5. 59 | -9.94 | **11.** 02 | 1933-34 ---- | 14.55 | -.98 | -33. 96 |
| 1899-1900 -- \_ | 7.91 | -7.62 | 3.40 | 1934-35 \_ | 21. 66 | 6.13 | -27.83 |
| 1900-1------ --------  1901-2--\_-- -- --- -\_-- | 16.29  10.60 | . 76  -4.95 | 4.16  -.77 | 1935-36 -------  1936-37 \_ | 12.07  22.41 | -3.46  6.88 | -31.29  -24.41 |
| 190032--43 ----------\_ | 19.32  8. 72 | 3. 79  -6.81 | 3.02  -3.79 | 1937-38 -----  1938-39 ---- -- | 23.43  13.07 | 7.90  -2.46 | -16.51  -18.97 |
| 1904-5 ---------- | 19. 52 | 3.99 | .20 | 1939-40 -------- | 19.21 | 3.68 | -15.29 |
| 1905-6 -- -- \_ ---  1906-7 \_  1907-8 -- ----  1908-9 ----- | 18.65  19.30  11. 72  19.18 | 3.12  3. 77  -3.81  3.65 | 3.32  7.09  3. 28  6.93 | **1940-41** -- \_  1941-42 \_  1942-43 --- \_ ---  1943-44 \_ | 32. 76  11.18  18.17  19.22 | 17.23  -4.35  2.64  3.69 | 1.94  -2.41  .23  3.92 |
| 1909-10 -- \_  1910-11 ------ \_  1911-12 ------- | 12.63  16.18  11. 60 | -2.90  0.65  -3.93 | 4.03   * 75 | 1944-45 - - -- - - - - -  1945-45 --------- | 11.59  11.65 | -3.94  -3.88 | -.02  -3.90 |

1 Average for 68 seasons, to 1945, 15.53 inches.

GEOLOGY, HYDROLOGY, TORRANCE-SANTA MONICA AREA **15**

**PHYSIOGRAPHY**

**GENERAL FEATURES**

Most of the major landform features of the coastal plain in Los Angeles and Orange Counties were formed by deformational earth movements during late Pleistocene time. (See table 3 for geologic time classification.) This deformation affected rocks now forming the most important aquifers in the area. Younger aquifers of lesser economic importance were formed by later alluviation in erosional trenches or gaps transecting these deformed older rocks. Thus, a brief discussion of the landforms is pertinent with respect to both the geologic and hydrologic conditions in the area. For a more complete discussion of these landforms, the reader is referred to a previous report in which the physiography of the entire coastal-plain area in Los Angeles and Orange Counties has been treated in detail (Poland, Piper, and others, 1956, p. 11-36, pls. 1-2).

The coastal plain, which includes the Torrance-Santa Monica area

in its western part, is in the Angeles section of the Pacific border prov­ ince (Fenneman, 1931, p. 493). It is bordered by the Pacific Ocean on the west and south and by the Santa Monica Mountains, the Puente Hills, and the Santa Ana Mountains and their foothills on the north and east (pl. 1).

The dominant landform features of the coastal plain are a central lowland plain with six tongues extending to the coast, bordering high­ lands and their foothills, and a succession of low hills trending north­ westward which separate the main lowland plain and a lesser plain to the southwest. The succession of low hills is the land-surface ex­ pression of the Newport-Inglewood uplift-the inland margin of the west basin.

The Torrance-Santa Monica area includes the western part of the main lowland plain and two tongues of this plain which extend to the coast across the Newport-Inglewood uplift. Between these two tongues or gaps and coastward from the uplift is a low plain of marine origin, the Torrance plain, which is flanked on the west by a belt of dune sand fringing the coast. To the north and south are bordering highland areas, the Santa Monica Mountains and the Palos Verdes Hills, respectively.

Excepting the bordering highlands, the total relief in the Torrance­ Santa Monica area is about 500 feet from a high point of 513 feet above sea level at the summit of the Baldwin Hills to sea level at Ballona Lagoon, 5 miles distant in the northwestern sector of the area. The location and extent of the landforms within the western part of the coastal plain are generalized on plate 8; details of their form

are shown on the Geological Survey topographic maps of the area.

**BORDERING HIGHLANDS AND ALLUVIAL APRONS**

The highland areas that border the Torrance-Santa Monica area are the eastern part of the Santa Monica Mountains on the north,. and the Palos Verdes Hills on the south.

The altitudes of the ridge crests in the eastern part of the Santa·. Monica Mountains reach a maximum of nearly 1,800 feet about 3. miles north of the project boundary. The highest point in the Palos Verdes Hills is 1,480 feet at San Pedro Hill; below this, 13 wave-cut terraces at altitudes of about 100 to 1,300 feet (Woodring, Bramlette,. and Kew, 1946, p. 113-116) represent successive pauses during a long period of uplift, which mostly occurred in late Pleistocene time. The lowest terrace is strongly deformed and rises from about 50 feet above sea level in San Pedro to about 400 feet on the north edge of the hills west of Hawthorne Avenue.

Adjacent to the south flank of the Santa Monica Mountains and westward from the Elysian Hills are two surfaces of alluvial aggrada­ tion which have been named the Santa Monica and La Brea plains. These surfaces are considered to be of late Pleistocene age, but they have been extensively modified by the erosion of broad channels in which Recent deposits have been laid down.

These foothill surfaces of aggradation absorb some rainfall and local runoff, and consequently, they contribute to the replenishment of the ground-water supply north of the Baldwin Hills.

**NEWPORT-INGLEWOOD BELT OF HILLS AND PLAINS**

**HILLS**

The Newport-Inglewood uplift is expressed topographically as a belt of discontinuous low hills that extend from the Santa Monica Mountains southeastward into Orange County. In the Torrance­ Santa Monica area this belt is cut by Ballona and Dominguez Gaps near the northwestern and southeastern boundaries.

The uplift and the related plains are underlain at shallow depth, usually less than 30 feet, by a surface of marine planation which was developed upon deformed lower Pleistocene and Tertiary strata. Initially formed in late Pleistocene time, the surface evidently was a plain of low relief. On it were deposited the upper Pleistocene marine Palos Verdes sand and a thin capping of presumed continental origin, where the thickness ranges from *5* to 20 feet. Thus, the present land­ surface forms of the belt offer a fairly accurate picture of the defor­ mation since late Pleistocene time. For example, they reveal certain faults that disrupt the land surface and act as subsurface barriers to water movement across the uplift.

Baldwin Hills is the boldest of the uplifts along the belt, with **a**

relief of about 400 feet above the surface of Ballona Gap, adjacent to

the north and a summit 513 feet above sea level. The Beverly Hills, about 4 miles northwest across Ballona Gap, reach an altitude about 200 feet lower than the Baldwin Hills, and have less relief. The surf ace of the Baldwin Hills is severely dissected by sharply incised valleys; the Beverly Hills have been moderately dissected.

Extending about 8 miles southeastward from the Baldwin Hills to Dominguez Hill, the Rosecrans Hills consist of an irregular low swell about 3 miles wide. The crestal altitude decreases from about 240 feet east of Inglewood to about 100 feet on the north flank of Do­ minguez Hill. The swell is of deformational origin and is asymmetric, with a steeper slope on the west which is modified by two fault es­ carpments. The most pronounced escarpment is about 50 feet high and extends about 2½ miles S. 25° E. from Inglewood. The second escarpment is about 1 , miles long, also trends S. 25° E., and termi­ nates at the north flank of Dominguez Hill.

Dominguez Hill is a simple elliptical dome 3 miles long and about 195 feet above sea level. Like the Rosecrans Hills, it has a flatter slope on the northeast flank and is deformational in origin; however, it is less modified by stream erosion. Its major axis trends N. 60° W., or about 20° west of the general trend of the belt of hills.

**REL.A.TED PLAINS**

The Ocean Park plain is a comparatively undeformed westward extension of the Beverly Hills; it is immediately south of the Santa Monica plain and north of the coastal part of Ballona Gap. It consists of three subdivisions: (1) a small bench to the east, which is about 190 feet above sea level, (2) an extensive central plain, which slopes gently southward, and (3) a ridge-and-trench area which lies parallel to the coast and is ascribed to upper Pleistocene shoreline features (Hoots, 1931, p. 121).

An extensive counterpart of the Ocean Park plain is the Torrance plain, which stretches from the southwest flank of the Baldwin Hills to Wilmington; its surface is essentially continuous with that of the Rosecrans Hills which flank it on the northeast. This plain is inferred to extend beneath the now inactive dune belt of the El Segundo sand hills along its southwest flank. The Torrance plain is somewhat warped, especially along its inland margin. North of Gardena the warping has formed a shallow depression which has no natural external drainage, and is floored with Recent playa deposits. A more pro­ nounced downwarp occurs at the southwest flank of Dominguez Hill, which is floored with Recent deposits, and represents a northwest­ ward extension of the Downey plain into the Torrance plain.

Under natural conditions the Torrance plain was very poorly drained. Drainage from its northern and central parts was to the

downwarp north of Gardena; drainage from its south-central part was to the downwarp southwest of Dominguez Hill by way of Laguna Dominguez and a small creek trending eastward from Torrance. A small area west of Wilmington drained internally to Bixby Slough. Most of this discontinuous natural drainage has been integrated artificially by the Dominguez Channel, which now receives runoff from 56 square miles upstream from its Carson Street crossing and discharges into the east basin of Los Angeles harbor and thence to San Pedro Bay.

The playa deposits flooring the two natural undrained depressions described above are fine grained and dense. Penetration of rainwater and water from surface runoff through these deposits is slow. On the other hand, water from runoff has collected in these depressions and evaporation has concentrated the total-solids content of the water that has penetrated below land surface. Thus, these downwarps are closely related to the naturally inferior quality of the shallow water in the Gardena area.

**GAPS**

In the Torrance-Santa Monica area the Newport-Inglewood uplift is transected by two tongues of fluvial deposits which extend from the central lowland (Downey plain) to the coast. These tongues occupy two stream-cut erosional gaps which are ]mown as Ballona and Domin­ guez Gaps. The streams which formed these gaps maintained their courses during the late Pleistocene deformation along the Newport­ Inglewood u·plift and thus may be classed as antecedent. Both gaps are flanked by stream-cut bluffs, which have greatest relief across the uplift.

Ballona Gap, which is topographically most prominent between the Beverly Hills and the Baldwin Hills, is 1.2 miles wide at its narrowest point and is about 10 miles long from the east end of the Baldwin Hills to Santa Monica Bay. The lower 6-mile segment is within the west basin. Its trench was cut into the upper Pleistocene marine (Palos Verdes) surface by an ancestral westward-flowing Los Angeles River and is floored by Recent alluvial deposits to a depth of 50 feet near the coast and to about 80 feet northeast of the Baldwin Hills, which are about 9 miles upstream.

The stream-cut bluffs flanking Ballona Gap reach a maximum height of 400 feet at the north face of the Baldwin Hills. Although subse­ quent deformation has altered the profile of the trench in Ballona Gap, the incising stream evidently reached a level at least 50 feet be]ow present sea level at the coast and as much as 400 feet below the upper Pleistocene marine surface at the axis of greatest deformation along the Newport-Inglewood uplift. It is believed that the present Ballona Gap represents an inland segment of the trenching-that is, the incised

stream was graded to a base level substantially more than 50 feet below present sea level and possibly as much as 2 to 3 miles seaward from the present coast. It is possible that Ballona Gap was trenched at essentially the same time as Bolsa Gap in Orange County, which was graded to a base level about 70 feet below sea level, prior to diver­ sion of the Santa Ana River to Santa Ana Gap (Poland, Piper, and others, 1956, p. 44-46). After the ancestral stream in Ballona Gap had incised its channel about 50 feet below present sea level at the coast, presumably during late Pleistocene recession of the seas, its course was diverted southward into Dominguez Gap and was main­ tained there during the later stages of the pre-Recent gap-cutting cycle.

Dominguez Gap, which passes between Dominguez Hill and the northwestern extension of Signal Hill, is 1.6 miles wide at its narrowest point and is about 7 miles long. It was trenched mainly by an ances­ tral San Gabriel River, which had a southward-flowing ancestral Los Angeles River as tributary. The highest of the stream-cut bluffs along the gap is at the east face of Dominguez Hill and is about 100 feet high.

Dominguez Gap was eroded to a depth of 150 feet or more below present sea level at the coast, and to about 250 feet below the late Pleistocene surface at the crest of the uplift. The entrenched valley extended inland across the coastal plain to Whittier Narrows, with a tributary trench reaching from Compton to the Los Angeles Narrows. The Recent epoch of aggradation started with the deposition of gravel and coarse sand to a depth of 50 to 70 feet. Subsequently, deposits of silt and fine sand about 75 feet thick were deposited on top of the permeable basal tongue. Thus the trench was backfilled to a thickness of about 150 feet with deposits of Recent age.

**EL SEGUNDO SANDHILLS**

*A* coastal belt of dunes and sandhills about 11 miles long parallels the shoreline from Ballona escarpment to the Palos Verdes Hills, and extends inland from 3 to 6 miles to overlap the Torrance plain. This belt is a conspicuous topographic feature called the El Segundo sand­ hills. It may be subdivided into two distinct elements. One element is adjacent to the coast and is about half a mile wide. For the most part, it is made up of dunes with crests ranging from 85 to 185 feet above sea level. These dunes are inferred to be of Recent age. The main part of the belt is from 2 to 5 miles wide, and consists of stabilized dunes and parallel ridges and alined hills which have been generally interpreted as ancient offshore bars modified by wind and stream action since their emergence from the ocean.

The coastal bar deposits were probably formed during a high level of the seas immediately before the latest Pleistocene withdrawal which instituted the cycle of gap cutting; hence, they are considered to be of late Pleistocene age. The dunes, on the other hand, although probably formed, in part, during the pre-Recent gap-cutting cycle, presumably were formed chiefly during the drier climatic conditions that inferen­ tially accompanied deposition of the later or upper division of the Recent sediments.

**DOWNEY PLAIN**

The western part of the extensive central lowland, or Downey plain, forms the inland border of the Torrance-Santa Monica area. It is the surface formed by alluvial aggradation during the post-Pleistocene epoch of rising base level, and is substantially adjusted in grade to the major streams which enter the coastal plain at the several passes through the bordering mountains and foothills. The alluvial deposits in Ballona and Dominguez Gaps thus represent the coastward ex­ tensions of this plain.

Within the project area, the Downey plain and its extension through Ballona Gap is underlain chiefly by the alluvial fan of the Los Angeles River; the apex of this fan is in the Los Angeles Narrows at an altitude of 275 feet. The tongue of the plain extending through Dominguez Gap is largely a part of the San Gabriel River fan, whose apex at Whittier Narrows has an altitude of 200 feet.

Near the inland narrows the alluvial material composing the Downey plain is coarser and highly permeable; these segments con­ stitute important intake areas for the recharge of the principal aquifers beneath the Downey plain and the extensions into the west basin.

**DRAINAGE**

Within the area of investigation the largest stream is the Los Angeles River which passes southward across the Downey plain from the Los Angeles Narrows and discharges into San Pedro Bay through Dominguez Gap. Upstream from the Pacific Coast Highway at Long Beach, it has a drainage area of about 1,060 square miles; almost all the drainage area is inland from the Torrance-Santa Monica area. In 1894 its channel within Dominguez Gap had two distributaries, which branched about 4 miles north of the shore and discharged into the former Wilmington Lagoon (Mendenhall, 1905a, pls. 1 and 4). Within the past two decades, however, the river has been confined in its channel by flood-control levees and now discharges southward directly into San Pedro Bay.

The streams within the coastal plain in Los Angeles County are intermittent; they carry large flows only after heavy winter rains.

Many times in the past flash flows in winter have been too large for the natural channels to carry and have resulted in very destructive floods.

Thirteen major floods were recorded on the Los Angeles and San Gabriel Rivers from 1811 to 1891. For an unknown length of time before 1825, the Los .Angeles River flowed westward through Ballona Gap, but during the floods of that year it broke out of its course to drain southward into San Pedro Bay via Dominguez Gap. During the floods of 1862 and 1884, part of the flood waters returned tem­ porarily to Ballona Gap, but since 1884 the Los Angeles River has discharged southward to San Pedro Bay (Troxell and others, 1942, p. 385-391).

The largest flood of the Los .Angeles River for which records are available occurred in March 1938. The maximum discharge reached 67,000 cfs at a point a mile upstream from the Main Street bridge in Los .Angeles; at Long Beach, where discharge was swelled by the flood waters of the tributary Rio Hondo, a maximum discharge of 99,000 cfs was recorded (Troxell and others, 1942, p. 12 and 246). On the other hand, during the thirties, for as much as 9 months of the year, the recorded flow of the Los .Angeles River at Long Beach has been less than 10 cfs; at times in 1929, 1930, and 1934 its channel was dry.

Compton Creek drains an area of some 30 square miles north of Dominguez Hill and east of the Rosecrans Hills. In the middle nineties and for several decades thereafter, it maintained a course southward along the west margin of Dominguez Gap and discharged into San Pedro Bay through the former Wilmington Lagoon. In 1938 part of the upstream channel was paved and the creek was joined to the Los .Angeles River about 5.5 miles inland from the coast and about half a mile south of Del .Amo Street.

-The natural unintegrated drainage pattern within the Torrance plain has been discussed elsewhere (p. 17). Most of the drainage has been integrated artificially by construction of the so-called Dominguez Channel, which discharges into San Pedro Bay.

In the northern part of the area the most important stream is Ballona Creek, whose tributaries drain the northern slopes. of the Baldwin Hills, the s;outhern s1opes of the Santa Monica Mountains east of Sepulveda Boulevard, and also a large area east and northeast of the Beverly Hills. .About 4 miles from the.coast, at Sawtelle Boule­

vard, Ballc ma Creek ha-s a tributary drainage area\_ of 111 square

miles. The creek, which .is now pav-ed with concrete except for the 5-mile reach above its mouth, discharge directly into Santa Monica Bay. .\_.

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Centinela Creek, its source originally in Centinela Spring in what is now the Centinela Park well field of the city of Inglewood, drains the south flanks of the Baldwin Hills and the area southwest of the Hills. The following quotation from a report by Kew (1923, p. 157) is of interest:

Before the city of Inglewood obtained its water supply from wells at the Centinela Spring, a stream carrying one hundred and twenty-five inches of water issued from this spring, and flowed down Centinela Creek, forming these channels, which are now nearly obliterated. During wet weather it was even possible to row a boat up to the spring from Playa del Rey.

Centinela Creek flows northwestward into Ballona Gap, turns south­ westward and follows a course nearly parallel to and southeast of Ballona Creek, and then discharges into the coastal marshes.

**GEOLOGIC FORMATIONS AND THEIR WATER-BEARING CHARACTER**

**GENERAL FEATURES**

In the Torrance-Santa Monica area, a thick section of Tertiary and Quaternary marine and continental sediments has been deposited on a basement complex of pre-Tertiary metamorphic and igneous rocks. The pre-Tertiary rocks, which are essentially non-water-bearing beds, crop out only at the bordering highlands in the northern and southern boundaries of the area, where they have been uplifted by deformational earth movements and exposed by erosion.

The Tertiary rocks are almost entirely of marine origin and range in age from Eocene to Pliocene. They consist of sandstone, siltstone, mudstone, diatomite, and siliceous shale, and are exposed extensively in the Palos Verdes Hills and in the Santa Monica Mountains; they underlie the younger rocks in all the area between these highlands.. Within the Torrance-Santa Monica area these Tertiary rocks are penetrated by many oil wells in the several oil fields and by scattered "wildcat" wells. Several of the Tertiary formations are not exposed in the area and are known only from the records of these drilled wells. Except for certain rocks of latest Pliocene age which contain essen­ tially fresh water, the Tertiary rocks contain only saline waters.

The Quaternary rocks contain nearly all the aquifers now tapped by water wells and are chiefly of Pleistocene age; within the west basin deposits of Recent age occur only within the two gaps.

Extensive deposits of coarse gravel and sand of Pleistocene age, amounting to about half the aggregate thickness of the Quaternary rocks, occur beneath nearly the whole project area and are partly exposed on the Baldwin Hills and on the north flank of the Palos Verdes Hills. Within the west basin these coarse deposits are almost entirely of littoral or shallow marine origin. Fine-grained deposits

GEOLOGIC FORMATIONS-WATER-BEARING CHARACTER 23

of sand, silt, sandy clay, and clay, about equal in aggregate thickness to the coarse deposits, commonly overlie them throughout the area. The deposits of finer grain are partly of marine and littoral origin, but to a greater extent are of lagoonal and continental original.

With the exception of the tongues of Recent deposits in the two gaps, the Tertiary and Quaternary rocks have been deformed along the Newport-Inglewood uplift into a succession of anticlines and domes with intervening structural saddles cut by normal and thrust faults arranged en echelon. Flanking this uplift to the southwest and northeast are synclines, where the two systems of rocks attain their greatest thickness. Along the crest of the uplift they are ·as much as 12,500 feet thick; in the syncline beneath the Torrance plain they are probably as much as 15,000 feet thick; in the syncline to the: northeast, beneath the Downey plain, they may exceed 20,000 feet in thickness.

Many of the lithologic and paleontologic data with which the stratigraphic treatment is concerned were obtained from the reports. of geologists (Hoots, 1931; Wissler, 1943, p. 210-234; Woodring, 1946) who have carried out detailed investigations in the region; other data, were obtained from S. G. Wissler, paleontologist, Union **Oil** Co.; and fromM. L. Natland, paleontologist, Richfield Oil Corp., in connection with stratigraphic correlations and paleontologic information derived from well samples.

The areal distribution of those stratigraphic units which crop ou,t in the area is shown on plate 2. The general subsurface stratigraphic sequence and the structural conditions, based largely on well-log information, are shown on several geologic sections, plates 3-6.

A descriptive summary of the rocks in the area, including an appraisal of the water-bearing characteristics of each formation, is presented in table 3. Plate 7 is a stratigraphic correlation chart, showing graphi­ cally the relative thicknesses of the formations represented in each of the eight major oil fields in the area (pl. 18). It is in two sec\_tions, each trending nearly parallel to the Newport-Inglewood uplift. One is adjacent to the coast and includes a columnar section at the Palos Verdes Hills; the other is alined along the Newport-Inglewood uplift from the Inglewood field in the Baldwin Hills to the Dominguez field at Dominguez Hill. Except for the section concerned with the Bald­ win Hills, the data for this chart have been compiled largely from information supplied by S. G. Wissler and are based almost entirely upon micropaleontologic correlations supplemented by electric-log data.

TABLE *3.-Stratigraphy of the Torrance-Santa Monica area, California*

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*a*

Geologic age

Recent

Pleistocene

Formation and symbol on plate 2

Alluvial, coastal, and dune deposits (Qal, Qs)

Unconformity

Terrace cover and Palos Verdes sand

· (Qpu); not differentiated on map from unnamed deposits below.

Unnamed upper Pleistocene deposits (Qpu); not differentiated on map from Palos Verdes sand and terrace cover above.

----Local unconformity

San Pedro formation, including Timms Point silt and Lomita marl members (Qsp).

ness (feet)

0-175

0-50

Q-400(?)

0-1,000

Physical character

Beneath the Downey plain and its coastward extensions, Dominguez and Ballona Gaps unconsolidated silt, gravel, and sand of fluviai origin; coarser materials predominant in lower half of the deposit. Beneath the coastal tide- lands, silt and clay of lagoonal and fluvial origin overlying and enclosing tongues of fluvial sand and iravel. Locally along the coast, accretional beac deposits. Beneath the El Segundo sand- hlllsb dune deposits, designated on pl. 2 by sym ol (Qs).

Reddish-brown sand, silt, and soil, chiefly non- marine in origin; underlain locally by adeposit of fossiliferous sand and gravel of marine origin, the Palos Verdes sand; together tnese mantle the hills and mesas of the Newport-Inglewood uplift.

Silt, clay, and some gravel, of fluvial and marine origin; in the central part of the west basin, the lower portion contains an extensive body of sand, with some gravel.

Unconsolidated to semiconsolidated gravel, sand, silt, and clay; chiefly marine, beach, and lagoonal deposits within tne west basin, but largely of fluvial ori in inland from the Newport-Ine:le- wood uplift; the coarser materials more plentiful in the lower two-tllirds of the deposit. At some places, silt and clay predominate.

Ground-water conditions

Beds of gravel and coarse sand in tbe lower part of tne deposit contain confined water and yield water freely to many wells, especially in tongues extending from Whittier Narrows through Dominguez Gap and from Los Angeles Narrows through Ballona Gap. This water is of good chemical quality inland, but moderately to highly saline from the coast inland about 7 miles in Domin ez Gap and about 6 miles in Ballona Gap. ear the coast, tongues and beds of fine sand, and some of fine gravel, in the upper part of tile deposit, contain unconfined semiperched water that is moderately to highly saline.

Chiefly above the water table and therefore un- saturated; sufficiently permeable to transmit some water from rainfall to underlying materials.

Beds of gravel and sand hold confined and uncon- fined water and suraply small domestic and stock wells and some arger irrigation wells. This water is of good quality within the Torrance- Inglewood subareah except locally at shallow depth, and along t e coast from El Segundo to Redondo Beach, where it is contaminated. This water is of good quality inland from the Newport-Inglewood uplift.

Beds of gravel and coarse sand most commonly in lower two-thirds of deposit, bold confined water and yield copiously to many wells. This water ls of d chemical quality inland from the New- port- glewood uplift, also on coastal side of uplift in the west basin, except along and near the coast from Santa Monica to Redondo Beach. This formation is tile principal source of water within the west basin.

**Local** unconformity

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | =*t,*  'I°  .0s  ll-t | --  -- | Upper division  Local unconformity Middle division  Local unconformity Lower division | 0-1,800 | Semiconsolidated sand, silt, clay, and some fine gravel chiefly of marine origin. Tongues of fluvial(?) sand and fine gravel-the gravel beds north of the Newport-Inglewood uplift and in the upper third of the deposit, the sand layers com- mouly in the lower two-thirds of the deposit. | Beds of sand and gravel in the upper part of the deposits contain confined water and locally might yield freely to wells. This water is soft and low in dissolved solids, but Is dark brown and has **a** temperature of about 100° F. Beds of fine sand in the lower part of the deposits are fairly permeable but have not been tapped bll water wells. This water is essentially fresh a thoufch total dissolved solids content may be too high or domestic use and for irrigation.  Largely impervious; if water-bearing, the sandy members contain connate waters whose salinity ranges from about half that of ocean water to that of ocean water. |
| >c |  |  |
| 8  r:-=l  8 | Pliocene |  |
| 0-1,240 | Olive to dark-brown massive claystone and silt- stone, fine to coarse gray sand;1 all of marine origin. |
|  |  | 0-470 | Fine to coarse gray sand, occasionally pebbly, brown sandy siltstone and claystone; 1 all of  marine origin. |
|  |  | Repetto formation | | 0-4,080 |
| Miocene | Local unconformity Monterey shale, at least in part  (Puente formation of Wissler and others) (Tu).  Unconformity Franciscan(?) formation | | | 0-4,500 | Fine to coarse-grained gray sandstone; sandy micaceous siltstone; bluish-gray to dark-brown  platy shale; all of marine origin. |
| .*!1*.q*1,*t*..*;*..*.*,*.*.*  p o  .,..oo |  |  | Greenish, grayish, or bluish serpentine, talc, or  Schist. 1 | Impervious, nonwater-bearing. |

t After Wissler (1943, p. 210).

In the following paragraphs the formations are discussed in order from youngest to oldest, thereby giving early emphasis to rocks which are of greater importance from a standpoint of ground-water resources. 'fhose rocks of Tertiary age that contain connate saline ground waters are discussed briefly because their waters are a potential source of contamination of the frei:;h-water body in the younger rocks.

**QUATERNARY SYSTEM**

**RECENT SERIES DEFINITION AND GENERAL FEATURES**

The deposits of Recent age comprise chiefly the youngest uncon­ solidated materials formed during the present cycle of alluviation by streams, materials associated with shoreline features, including lagoonal, littoral, and dune deposits, also slope-wash and playa deposits of minor extent.

With respect to water-bearing character, the most important de­ posits of Recent age are those of fluvial origin. They consist of sand, gravel, silt, and clay, and underlie the Downey plain and its tongues, which extend to the coast through the gaps cut in the older rocks (pl. 2). Thus, the top of the Recent deposits is the surface of the Downey plain and its extensions into the several gaps; their base is the former land surface that had been produced by deformation and trenching of the coastal plain in late Pleistocene time.

In Ballona and Dominguez Gaps and inland from the gaps, logs of many wells which have been drilled through the Recent deposits reveal that the relatively fine grained sediments in the upper few tens of feet commonly are underlain by much coarser materials-chiefly coarse sand to cobble gravel, which have been deposited as tongues many miles in length. These important aquifers, which underlie Ballona and Dominguez Gaps, extend inland across the coastal plain; the textural difference between them and the overlying finer grained sediments provides a basis for separation of the Recent alluvial de­ posits of the area into an upper and a lower division.

Within the coastal plain as a whole, and for almost all the deposits of Recent age except those within Ballona Gap, the report on the geology of the Long Beach-Santa Ana area has treated in considerable detail their physical character, mode of origin, and general water­ bearing character (Poland, Piper, and others, 1956, p. 40-52). Accord­ ingly, the treatment in the following paragraphs will summarize the character of these deposits briefly, with emphasis on the two basal aquifers of the lower division which extend across the west basin in Dominguez and Ballona Gaps, and which respectively constitute the Gaspur water-bearing zone and the "50-foot gravel."

**GEOLOGIC FORMATIONS--WATER-BEARING CHARACTER 27**

**UPPER DIVISION**

*Flood-pl,ain deposits.-Some* of the most widely distributed deposits in the upper division of Recent age in the Torrance-Santa Monica area are the alluvial-fan and flood-plain sediments laid down at times of excessive runoff, when the streams overflowed their banks and spread widely over their alluvial fans. These sediments are largely fine sand and silt, with lesser amounts of clay and gravel. The finer sediments have been widely distributed over the coastal flood plains; the sand and gravel have been laid down chiefly on the steeper inland slopes of the alluvial fans and within the larger channels. In the present climatic period, which probably existed throughout the de­ position of the upper division of the Recent series, this type of alluvia­ tion has been the common pattern. However, because of the in­ creased development of the coastal plain and the construction of engineering works designed to control flood runoff, in recent years the streams have overflowed their banks and deposited sediment over their natural flood plains only during the largest floods.

These deposits of the upper division are distributed beneath all the

Downey plain, in the two gaps within the project area, and in local areas tributary to these gaps. Their thickness is as much as 100 feet in the central part of the Downey plain; in Dominguez Gap it ranges from 45 to nearly 80 feet; but in Ballona Gap, where the Recent series as a whole is thinner, the upper division is from 10 to 50 feet thick. In the reach between Dominguez and Ballona Gaps these sediments feather out along the inland flank of the Newport-Inglewood belt of hills. The top of these deposits is the surface of the Downey plain. Within the extent of the lower division of the Recent, the base of the upper division rests almost conformably on the top of these coarser tongues; elsewhere their base is the modified lower Pleistocene land surface.

*Minor deposits.-The* upper division of the Recent series also con­ tains minor deposits which include slope-wash, playa, lagoonal, beach, and dune deposits. With the exception of the beach deposits, these have relatively little importance from the standpoint of this investigation.

The slope-wash and playa deposits probably do not measure more than a few feet in thickness in any part of the area. The former are mainly weathered rock fragments, fine sand, and silt, developed on hill slopes; the latter have accumulated in undrained depressions in or near the Torrance plain (p. 17), and consist of silt and clay of local origin.

The lagoonal marshes, which were formerly behind the barrier beaches at the mouths of Ballona and Dominguez Gaps, have acted as sedimentation basins for some of the load carried by streams dur-

ing intermittent floods. Thus, they have received contributions of fine sand, silt, and clay, which have become interbedded with the organic debris native to the marshes.

Recent beach deposits form narrow arcuate strips of sand and gravel, which flank Santa Monica and San Pedro Bays, fringe the coastal wavecut sea cliffs and connect across the gaps by barrier beaches. These beach deposits have been the chief source of material supplied to the coastal-dune belt.

With regard to saline contamination from the ocean, these beach deposits are of great interest because: (1) at least locally along the coast, they are believed to extend for several tens of feet below sea level; (2) probably they are in direct contact with the Silverado water-bearing zone in the vicinity of Redondo Beach and with the "50-foot gravel" and the main water-bearing zone of the San Pedro formation at the mouth of Ballona Gap; and (3) they are highly permeable. Thus, under the current conditions of landward hydraulic gradient, these beach deposits probably afford conduits for the movement of ocean water into the coastal margins of the main water­ bearing zones within the west basin.

The dune deposits that underlie the El Segundo sandhills are formed almost entirely of fine- to medium-grained sand of uniform texture. They range in thickness from a featheredge to as much as

150 feet. As exposed in an excavation at Hyperion (in 2/15-10), they exhibit several stages of dune formation, with dense cemented layers now buried, which probably represent former land surfaces. These dune deposits mantle an area of about 35 square miles along the southwest flank of the Torrance plain. They are almost entirely above the zone of saturation and thus do not yield water to wells. However, they are relatively permeable and transmit substantial quantities of water from rainfall to the underlying Pleistocene rocks. Where those rocks are impermeable, doubtless a water table occurs within the dune deposits. Also, the denser layers within the dunes may develop perched water bodies of local extent.

**LOWER DIVISION**

The deposits of the lower division of Recent age do not crop out in the area and consequently are known only from logs of wells and from samples taken during drilling. These indicate that the lower division consists almost entirely of coarse sand and gravel, deposited in tongues. In the Torrance-Santa Monica area, the two principal tongues are the Gaspur water-bearing zone in Dominguez Gap and the "50-foot gravel" in Ballona Gap. Physical connection between these two zones is afforded by the so-called westerly arm of the Gaspur zone, which extends southward from the Los Angeles Narrows

to about a mile east of Compton, where it joins the Gaspur water-­ bearing zone (pl. 8).

*Gaspur water-bearing zone.-The* Gaspur water-bearing zone was deposited in early Recent time by an ancestral San Gabriel River, with minor contributions from an ancestral Los Angeles River in the reach coastward from their junction near Compton.

The Gaspur water-bearing zone has been traced for more than 20 miles across the Downey plain from Terminal Island to Whittier Narrows, as shown in an earlier report (Poland, Piper, and others, 1956, pl. 7). Doubtless it extends northward into San Gabriel Valley and southward beneath San Pedro Bay. The maximum width of 4 miles occurs just south of Downey. Within the area covered by this report it is relatively narrow, being about a mile wide at the eastern salient of Dominguez Hill, but increasing some­ what in width to the north and south (pl. 8).

The thickness of the Gaspur zone ranges from 50 to 7*5* feet. Near the coast, its base has a gradient of about 9 feet per mile, from about 70 feet below sea level 2 miles north of Dominguez Gap to 150 feet below sea level at the coast. The gradient steepens somewhat to the northeast so that, reckoned from Whittier Narrows, where the base of the zone is 100 feet below the land surface and 90 feet above sea level, the average gradient to the coast is about 12 feet per mile. Typical deposits of the Gaspur zone are indicated by the log of well 4/13-15All (table 28). The zone generally is characterized by a lower part consisting of coarse clean gravel from 25 to 50 feet thick, containing cobbles as much as 6 inches in diameter, overlain by an upper part of medium to coarse sand from 20 to 50 feet thick. How­ ever, there is considerable lithologic variation and this typical dis­ position of the gravel and sand is best developed southward from the middle of the Downey plain. Beneath the inland part of the Downey plain both the main Gaspur zone and the westerly arm become coarser and contain more gravel and less sand; neither the gravel

nor the sand lie in a characteristic stratigraphic position.

*Westerly arm of the Gaspur water--bearing zone.-A* tributary branch of the Gaspur water-bearing zone, the deposit of an ancestral Los Angeles River, here called the "westerly arm" of the Gaspur water­ bearing zone, has been traced from the Los Angeles Narrows south­ ward and roughly parallel to Alameda Street for about 11 miles to its junction with the main Gaspur zone about a mile east of Compton. The thickness of this westerly arm ranges from 30 to 80 feet; its average wiclth is about 2 miles and its gradient from the south edge of the Los Angeles Narrows to the junction with the Gaspur water-bearing zone is about 20 feet to the mile, although in the 3 miles immediately north of the junction near Compton the gradient is only about 15

feet per mile. At the junction, the Gaspur zone and its westerly arm have a common base 140 feet below the land surface, or 70 feet below sea level. This westerly arm is somewhat coarser in com­ position than the deposits of the Gaspur zone in Dominguez Gap; it is similar to the gravel found in the main tongue of the Gaspur zone from the middle of the Downey plain to Whittier Narrows. Sand and minor quantities of clay are interspersed irregularly with the gravel in this westerly arm.

*"Fijty1oot gravel."-In* Ballona Gap, the lower division of the Recent series is represented by a relatively thin and irregular gravel body which was laid down by an ancestral Los Angeles River. In the area of its most characteristic development, between Culver City and the coast, its base ranges from 40 to 80 feet below the land surface, but its average depth is about 50 feet below the surface. For this reason the name "50-foot gravel" has been assigned for the purposes of this report. By means of well logs it has been traced inland beyond the narrows between the B·aldwin and the Beverly Hills to its junction with the westerly arm of the Gaspur water-bearing zone, south of the La Brea plain and in the vicinity of Vermont Avenue (pl. 8).

The "50-foot gravel" ranges in thickness from 10 to 40 feet and consists generally of coarse gravel and a subordinate amount of sand. Its average thickness is only about a third as great as that of the Gaspur water-bearing zone in Dominguez Gap.

Logs of wells show that the depth to the base, position, and thickness of the "50-foot gravel" are very irregular. Thus, although the over­ all seaward gradient of the base of the "50-foot gravel" from north­ east of the Baldwin Hills to the coast is about 8 feet per mile, that gradient has been estimated by taking an average altitude of the base from well logs that show substantial variation within short distances. Other well logs show only clay or sandy clay (silt) in the depth range where the gravel would be expected to be present. The discontinuity and irregularity in thickness and position of the "50-foot gravel" sug­ gest that (1) it was deposited on an uneven base which may have contained both channels and terrace remnants, and (2) the back­ filling was accomplished by a stream with insufficient transporting power to lay down a broad sheet of gravel across the full width of the gap. Also, during this backfilling stage, the tributary streams that discharged southward to Ballona Gap across the dissected Santa Monica plain may have been building debris cones along the north side of the gap. Those cones would doubtless have contained mate­ rials of substantial1y finer grain than the coarse sediments transported by an ancestral Los Angeles River.

As determined from well logs, west of the Baldwin Hills the trans­ verse profile of the base of the "50-foot gravel" dips southeastward across Ballona Gap. The lowest part of the gravel generally is be­ neath or south of the present course of Ballona Creek; the altitude of the ba.se at that point is about 40 feet lower than on the northwest side of the gap. This feature suggests that southward tilting of the "50-foot gravel" has occurred. If such is the case, the essentially straight alinement of the Ballona escarpment west of the Baldwin Hills may in part represent a fault scarp that has been modified to some degree by stream erosion. The substantial difference in chemical character of the native waters within the San Pedro formation to the north and south of this escarpment (pl. 19) might be interpreted as supporting this inference. Hydrologic evidence gives no clue in regard to the presence of a ground-water barrier along the escarpment.

**WATER-BEARING CHARACTER**

*Upper division.-Because* it is composed chiefly of materials of fine texture and low permeability, the upper division of the Recent is tapped by only a very few small domestic wells. It is sufficiently permeable, however, to absorb a moderate volume of water by infil­ tration of rain, by percolation from the streams-the Los Angeles River and Compton and Ballona Creeks-and by deep penetration of irrigation water. Most of this water first reaches the unconfined semiperched water body and ultimately is transmitted to the coarse tongues of the lower division-the Gaspur water-bearing zone and the "50-foot gravel."

*Gaspur water-bearing zone.-The* character of the Gaspur water­ bearing zone has been discussed at length in a report by Poland (1959), and will be only briefly summarized here. The Gaspur zone is highly permeable and is tapped by wells throughout its 21-mile reach from Terminal Island to Whittier Narrows. However, for its extent within the west basin-from the coast inland some 6 miles to Del Amo Street-the zone has been contaminated by saline waters and in most of this area its water is unfit for use. Yield data are available for five wells in this coastal area. Their yield ranges from 210 to 1,500 gpm. Forfour of these wells, the average specific capacity (gallons per minute per foot of drawdown) is 63. Data available from pumping tests suggest that within this reach the p01meability of the Gaspur zone ranges from 3,000 to 5,000 gpd per square foot.

*"Fifty-foot gravel."-During* the early development of ground water in Ballona Gap, the "50-foot gravel" was tapped by several scores of wells for domestic, irrigation, and stock use. Because of the decline in water levels, this water-bearing zone has been dewatered beneath a large part of the gap. Also, its water has become contaminated

within much of its extent coastward from the Inglewood fault. Hence, most of the wells, which currently withdraw water for irrigation or other uses, tap the underlying deposits of the San Pedro formation.

Fragmentary data on yields from wells tapping the "50-foot gravel" indicate that they have ranged from less than 100 to as much as 800 gpm. No information on specific capacity is available. However, because the "50-foot gravel" is only about one-third to one-half as thick as the Gaspur water-bearing zone, the yields indicate that the permeability may be about the same.

**PLEISTOCENE SERIES GENERAL FEATURES**

Deposits of Pleistocene age crop out over nearly all of the Newport­ Inglewood belt of hills, over the Torrance plain and the Ocean Park plain, and locally on the flanks of the Santa Monica Mountains and the Palos Verdes Hills. They are overlain by alluvial deposits in the gaps and by beach and dune deposits along the coast, and are under­ lain by Pliocene and older rocks. These Pleistocene deposits are chiefly unconsolidated and consist of interlensing beds of sand, gravel, silt, and clay. In downward succession they include a capping terrace deposit, the Palos Verdes sand, certain unnamed upper Pleistocene deposits, and the San Pedro formation of lower Pleistocene. In the area shown on plate 2 the San Pedro formation is the thickest of the Pleistocene deposits.

Along the coast, the Pleistocene rocks range in thickness from about 100 to 600 feet; in the syncline southwest of Dominguez Hill their thickness is as much as 1,200 feet. Along the crest of the Newport­ Inglewood zone their thickness ranges from a feather edge at the Baldwin Hills to 700 feet at the southeast edge of Dominguez Hill. Inland beyond that zone they attain a maximum thickness of about 3,000 feet beneath the central Downey plain and become thinner northward and northeastward toward the inland hills, where they have been faulted, warped upward on anticlinal uplifts, and partly removed by erosion.

**TERRACE COVER AND PALOS VERDES SAND**

The Newport-Inglewood belt of hills, the Torrance and Ocean Park plains, and parts of the bordering highland areas are capped by a terrace cover of nonfossiliferous red sand and silty sand. In most of the area, this cover ranges from a few feet to about 20 feet in thickness. It owes its characteristic red color to iron oxide derived from the processes of weathering.

In the Palos Verdes Hills, according to Woodring (1946, p. 106), the thickness of the cover toward the rear of one terrace "is as much

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as 100 feet, but an exposed thickness greater than 50 feet is excep­ tional." The deposits there represent "cliff talus rubble, stream fan and channel material, and rill and slope wash," and in places the re­ mains of land mammals have been reported. These deposits, there­ fore, are definitely continental in origin. Davis (1933, p. 1055-1056, 1058-1061, figs. 5 and 6) describes the origin and physiographic as­ pects of similar deposits along the Santa Monica Mountains.

At some places, the relatively thin terrace cover over the Newport­ Inglewood zone and the Torrance plain may be of flood-plain origin and may have been formed immediately after emergence of the upper Pleistocene marine surface. But elsewhere the true nonmarine cover may be absent, the red zone being merely the upper few feet of the marine Palos Verdes sand, which has been modified by weathering.

Hoots {1931, p. 120-123, 130) describes alluvial deposits of late Pleistocene age which cap the dissected Santa Monica plain. "These deposits range in thickness from a few feet to at least 200 feet" and are composed of dark brown poorly sorted angular rock fragments "embedded in a soft matrix of reddish-brown clay and sand." Lo­ cally they "rest directly upon a slight thickness of horizontal fossilif­ erous marine upper Pleistocene deposits." Thus, although in places they are considerably thicker than the terrace cover, which occurs farther south, these deposits may in large part be stratigraphically equivalent to that cover.

At several exposures along and near the Newport-Inglewood struc­ tural zone, the nonmarine terrace cover is underlain by a thin layer of fossiliferous gray sand and gravel. First described under the name "upper San P dro series" and later called the "Palos Verdes forma­ tion," this stratigraphic unit has recently been defined by Woodring (1946, p. 56) as the Palos Verdes sand; he describes its typical char­ acteristics as it occurs in the Palos Verdes Hills as follows:

The ·Palos Verdes sand like the older marine terrace deposits, consists of a thin veneer on the terrace platform, which bevels formations ranging in age from lower Pl-eis-tocene to Miocene. Also like the older marine terrace deposits, the strata consist generally of coarse-grained sand and gravel but include silty sand and silt. Limestone cobbles are the prevailing constituent of the gravel, granitic and schist pebbles being locally abundant. The thickness of the Palos Verdes generally ranges from a few inches to 15 feet and is usually less than 10 feet. At places it consists of thin lenses, and at other places it is absent.

According to Woodring, faunal evidence indicates that the Palos Verdes sand is of late Pleistocene age. The lowest, and youngest, marine terrace of the Palos Verdes Hills on which it is deposited presumably is a correlative of the upper Pleistocene marine platform that underlies the Torrance plain and the Newport-Inglewood belt of hills at shallow depth, and which prior to deformation was **of** very low relief.

Outside the Palos Verdes Hills, the Palos Verdes sand or its essen­ tial stratigraphic equivalent has been identified at several localities. Among those in or near the Torrance-Santa Monica area, the following are pertinent:

1. About 6 miles west of Long Beach and 200 feet south of the intersection of Sepulveda Boulevard and Vermont Avenue, a thin lens of gray sand containing marine shells is exposed beneath red soil. On the basis of the megafossils, this sand has been identified by Woodring (personal communication, Nov. 23, 1943) as the essential equivalent of the Palos Verdes sand.
2. A trench dug on the northeast side of the Baldwin Hills about 1925, for the Los Angeles Outfall Sewer, exposed a section, which Tieje (1926, p. 502-503) described as 50 feet of massive grayish green very coarse to gravelly quartzose and loosely cemented sands. He called these the "Palos Verdes sands."
3. About 2 miles northeast of Playa del Rey, at the Ballona escarp­ ment, the Palos Verdes sand has been exposed by the widening of Lincoln Boulevard where it begins to decline onto Ballona Gap. Beneath a thin soil cover, reddish-brown sand 10 feet thick is under­ lain by 10 feet of clay, which in turn is underlain by 15 feet of medium to coarse brown sand. The lower 6 feet of this sand layer contains abundant shell remains. From a study of this fauna, Willett (1937,

p. 379-406) has correlated the enclosing sand as the stratigraphic equivalent of the Palos Verdes sand at the Baldwin Hills locality described by Tieje and cited above. About 20 feet of light-brown sand, which is presumed to be part of the San Pedro formation of early Pleistocene age, is exposed beneath this Palos Verdes sand.

1. Just outside the area, about 2 miles northwest of the city of Santa Monica, sands of "upper San Pedro" (Palos Verdes) age are exposed in Potrero Canyon. Woodring, quoted by Hoots (1931, p. 122), believes that these sands "probably correspond to the sands of the Baldwin Hills section described by Tieje as the Palos Verdes sands."
2. The Ocean Park plain and the Beverly Hills are underlain by "soft sand, clay, gravel, and conglomerate," which are considered by Woodring (Hoots, 1931, p. 121), from faunal evidence, probably to represent "upper San Pedro" (Palos Verdes) age.. Hoots reports that the only fossils found in the area were from a stream-cut bluff at the north edge of Ballona Gap, where a cut bank on the west side of Overland Avenue and about 200 feet south of the crest of the hill exposes a bed about 10 feet below land surface consisting of dark reddish-brown sandy silt and containing shells. This sheH bed is overlain by brown massive silt extending to the land surface.. These

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upper Pleistocene marine sediments in places underlie the Pleistocene alluvial deposits which form the Santa Monica plain.

Because the main water-bearing zones of the west basin occur at depths usually in excess of 150 feet below the land surface, the shell bed that commonly marks the base of the Palos Verdes sand is not often logged by drillers. *A* bed containing oyster shells at a depth of 18 feet, a foot of white sand to 19 feet, and a thin "coral" bed­ evidently a hard-shell bed--:--'--was found in a well about 2 miles north of Torrance, in 3;14-34. It is presumed that these shell beds are at the base of the Palos Verdes sand, and that this formation occurs here to a depth of about 20 feet below the land surface.

For a description of the correlatives of the Palos Verdes sand as it occurs in the adjacent Long Beach-Santa Ana area to the east and southeast, the reader is referred to an earlier report (Poland, Piper, and others, 1956, p. 52-55).

*A* detailed account of its occurrences in the type locality, including fauna} lists, is presented in the report by Woodring, Bramlette, and Kew (1946, p. 56-,59) on the Palos Verdes Hills.

Along the Newport-Inglewood uplift, the terrace cover and the Palos Verdes sand are almost entirely above the water table and therefore they are unsaturated. At places beneath the Torrance plain the Palos Verdes sand is below the semiperched water table and is sufficiently permeable to yield water to shallow wells, although this water commonly is of inferior quality. Where these deposits form the land surface, they are sufficiently permeable to absorb some water from rainfall and to transmit it to underlying deposits.

Although the Palos Verdes sand has little importance as an aquifer, it is of critical importance in establishing the amount of deformation of the Pleistocene water-bearing deposits in latest Pleistocene time. Therefore, its known occurrences within the Torrance-Santa Monica area have' been described in some detail in tha preceding paragraphs.

**UNNAMED UPPER PLEISTOCENE DEPOSITS**

**DEFINITION AND EXTENT**

In an earlier report by the Geological Survey (Poland, Piper, and others, 1956, p. 55-57), certain strata of late Pleistocene age found in wells between definite or probable 'correlatives of the Palos Verdes sand above and the San Pedro formation below have been designated "unnamed upper Pleistocene deposits." \_ These deposits underlie much of the Torrance-Santa Monica area and are described in fol-

1

lowing paragraphs.

In water well 3/13-32F6, near the intersection of Victoria Street a·nd Avalon Boulevard and low on the west flank of Dominguez

Hill, two zones of marine shells were reported-one in sand 20 to 30 feet below the land surface and the other from 238 to 260 feet. The upper shell zone is inferred to represent the Palos Verdes sand, and the lower one the megafossil zone near the top of the San Pedro formation of lower Pleistocene age; the material between these two shell zones has been assigned to the unnamed upper Pleistocene deposits.

About a mile to the east and near the intersection of Victoria Street and Central Avenue on Dominguez Hill, oil wells are reported by Wissler (1943, p. 212) to pass through: (I) nonmarine yellow and brown sand, sandy clay, and gravel to 175 feet below land surface;

(2) lagoonal deposits 40 feet thick; (3) a thin deposit of lignite; and

(4) about 300 feet of marine sand and gravel, including a megafossil zone, San Pedro in age, from 215 to 250 feet below land surface. Wissler has concluded that the top 175 feet of nonmarine sediments are of late Pleistocene age, and he assigns the lagoonal deposits and the marine sand and gravel to the San Pedro formation. It is inferred that the nonmarine beds from about 30 to 175 feet below land surface represent the unnamed upper Pleistocene deposits.

Natland examined samples collected during the drilling of well 4/13-22Dl, about 3 miles south of Dominguez Hill. He reported that samples taken to a depth of 164 feet were nonfossiliferous and that samples below this depth contained fossils (Natland, M. L., written communication, 1943). From this report and other evidence, it is inferred that the upper 30 feet of deposits are of Recent age; those from 30 to 164 feet are believed to represent the unnamed upper Pleistocene deposits.

By means of peg-model studies, the unnamed upper Pleistocene deposits have been tentatively correlated over most of the southern part of the Torrance-Santa Monica area. These sediments extend at least as far north as the Ballona escarpment and southward to the Palos Verdes Hills. Between these north-south limits they extend from the coast over the crest of the Newport-Inglewood structural zone, and inland beneath the Downey plain. They have not been traced beneath Ballona Gap and to the north, although their stratigraphic equivalent may be present; apparently they are absent beneath the Baldwin Hills.

**PHYSIC.AL CHARACTER .AND THICKNESS**

The unnamed upper Pleistocene deposits vary considerably in lithology, both vertically and laterally. Nevertheless, the upper half of the deposits is generally fine grained, chiefly silt, clay, and sand. The lower half is chiefly sand, containing some gravel and subordinate amounts of silt and clay. Because of its coarse texture,

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this lower stratum is a productive aquifer in much of the Torrance­ Inglewood subarea. Its midposition is about 200 feet below the land surface in the area of its most typical occurrence-in the broad syncline extending from Inglewood southeastward through Gardena. Hence, it has been named the "200-foot sand" for purposes of this report.

Although the "200-foot sand" is composed chiefly of sand, logs of wells reveal much variation in its physical character from place to place. Thus, well 3/14-23Ll, about a mile north of Gardena and near the synclinal axis, is reported to have cut through 332½ feet of clay, beneath a surface alluvial sand lj feet thick, before striking an aquifer in the San Pedro formation. Here the "200-foot sand" apparently is wholly absent. At well 3/14-22Al (for log, see table 28), also near the axis of the syncline, the "200-foot sand" is repre­ sented by an upper sandy zone, a middle clayey zone, and a lower sandy zone. Many well logs indicate that the "200-foot sand" is locally a coarse gravel, as at well 2/14-27Jl (table 28), situated on the crest of the Newport-Inglewood uplift at the north end of the Rosecrans Hills. The "200-foot sand" is also largely gravel beneath an area of about 4 square miles near the coast, at and near the city of El Segundo and the Standard Oil Co. well fields in secs. 12 and 13, 'I'. 3 S., R. 15 W., and beneath about 7 square miles in the vicinity of Gardena near the axis of the syncline.

In general, where it occurs northwest of the Gardena area just referred to, the "200-foot sand" is coarser on the limbs of the syncline than along the axis.

In the southeastern part of the west basin, about southeast of a line from Gardena to Torrance, the "200-foot sand" usually is logged as fine sand and is tapped by very few wells. Thus, in the area in and near Dominguez Gap it has little importance as an aquifer.

In the area between Torrance and the northeast flank of the Palos Verdes Hills, the "200-foot sand" is largely in physical and hydraulic continuity with the thick series of coarse-grained sediments of the underlying San Pedro formation (shown in the cross sections, pl.

3 *B, 0).* It is difficult or impossible to separate the two units in

this area.

Within the part of the Torrance-Inglewood subarea where it is a productive aquifer-that is, between Torrance and Inglewood and from the coast to the crest of the Newport-Inglewood uplift-the "200-foot sand" underlies about 70 square miles.

The "200-foot sand" is tapped by at least 200 highly productive wells in the vicinity of Gardena. Although little information is available on drawdown, estimated yields for wells tapping this

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water-bearing zone range from about 100 to as much as 1,300 gpm. Estimated yields for 22 wells as reported by Mendenhall (1905b, p. 75-80) gave an average yield of 575 gpm. Well 3/14-26E2 is re­ ported to yield 50 gpm with a 3-foot drawdown-a specific capacity of 17 gpm per foot of drawdown.

The thickness of the unnamed upper Pleistocene deposits ranges widely from place to place. Table 4 shows the approximate thickness and depth of both the unnamed upper Pleistocene deposits as a whole and the "200-foot sand" for their. occurrence along the synclinal axis from Inglewood southeast to Gardena (pl. *3B),* and along the west coast from El Segundo to Hermosa Beach (pl. 30).

TABLE *4.-Range in thickness and depth (in feet) to the base of the unnamed upper Pleistocene deposits in the northern and central parts of the Torrance-Inglewood subarea*

|  |  |  |
| --- | --- | --- |
| Deposits | Along c0ast (El Segundo to Hermosa Beach) | Along axis of syncline  (Inglewood to Gardena) |
| Thickness of unnamed upper Pleistocene deposits \_ | 60-150 | 180-280 |
| Depth to base below land surface \_  Altitude of base below sea level\_ \_ Thickness of "200-foot sand" \_ |
| 140-250  20-80  20-60 | 240-310  160-260  65-135 |

About 5 miles southeast along the synclinal axis from Gardena, at the intersection of Carson and Alameda Streets, the Pleistocene reaches its greatest thickness within the west basin. · At this point the base of the unnamed upper Pleistocene deposits is about 350 fep,t below the land surface, or 325 feet below sea level (pl. 6).

Along the crest of the Newport-Inglewood uplift the unnamed deposits are thickest at Dominguez Hill and in the saddle between Dominguez Hill and the Rosecrans Hills (pl. *3A).* Here the "200- foot sand" is represented by about 50 to 100 feet of sand and gravel whose base ranges from 100 to 200 feet below the land surface. Far­ ther northwestward along the crest of the Rosecrans Hills, the base of the unnamed deposits is ne rer the surface, owing to uplift, and the aggregate thickness averages 50 feet or less. The deposits may have been eroded to a certain extent during or after the uplift of late Pleistocene time, but it is thought that they may never have reached a greater thickiie.ss. Beyond the northwest end of the Rosecrans Hills they feather out against the Baldwin Hills uplift.

On the basis of data now available from wells and outcrops, the unnamed upper Pleistocene deposits within the west basin· are in­ ferred· to be partly marine origin and partly of continental Drigin. Wissle.r reported that samples of deposits taken from we1ls on ·Domin-

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guez Hill were of nonmarine, presumably fluvial origin. In a very few wells southwest of the Newport-Inglewood uplift, fossils have been reported from these deposits (see logs for wells 4/13-15Al **1** and 4/14-13Fl, table 28), but these have been found in the "200-foot sand" or its stratigraphic equivalent.

The upper half of the unnamed deposits in the Torrance-Inglewood subarea is fine grained and is not known to contain any fossils. Ac­ ordingly, most of this upper division is inferred to be a flood-plain deposit.

Because the "200-foot sand" is of coarse texture, is widespread in extent, and is relatively uniform in character and thickness over areas as great as several square miles; and also because it contains fossils at a few places, it is inferred to have been deposited in a shallow marine or littoral environment. As already pointed out, the "200- foot sand" is thickest and best developed in the vicinity of Gardena; here it may represent a deltaic deposit laid down beyond a shoreline that fringed the southwest flank of the Newport-Inglewood uplift.

**STRATIGRAPHIC RELATIONS**

The stratigraphic relations between the unnamed upper Pleistocene

-deposits and the underlying San Pedro formation are not definitely known. The contact between these two stratigraphic units is nowhere exposed, and well logs are inadequate to supply critical evidence. However, it appears likely that the unnamed deposits are confo able on the San Pedro formation along the synclinal axis; probably they are locally unconformable along the crest of the Newport-Inglewood uplift. Throughout the extent of the 200-foot sand within the Tor­ rance-Inglewood subarea, the base of this sand i presumed to represent the base of the unnamed upper Pleistocene deposits and the top of the San Pedro formation (pls. *3A, B, C,* and 5).

The twelve higher terraces of the Palos Verdes Hills are, at least in part, correlatives of the unnamed upper Pleistocene deposits; this fact indicates that locally, if not regionally, deformation was occurring in the interval during which they were being deposited. Possibly this deformation is reflected in the coarse deposits assigned to the lower part of the unnamed deposits.

**SAN PEDRO FORMATION DEFINITION**

For the ground-water investigation· of the adjacent Long Beach-­

Santa Ana area, the San Pedro formation of early Pleistocene age has been defined (Poland, Piper, and others, 1956, p. 60-62) as that stratigraphic unit underlying. the unnamed upper Pleistocene deposits (just described) and overlying the Pico formation of late Pliocene

age. It has been discriminated for that area partly from outcrops but mostly by data from water and oil wells-drillers' logs, electric logs, samples taken during drilling, and faunal studies. By similar methods of correlation, the San Pedro formation has been traced over most of the Torrance-Santa Monica area.

The San Pedro formation is considered to be essentially correlative with (but much thicker and more heterogeneous) the type San Pedro sand, Timms Point silt, and Lomita marl as defined by Woodring and others (1946, p. 43-53). However, it doubtless includes some younger strata; and it may include some which are older than any exposed in the type section just cited. Owing to the heterogeneous materials of this unit, the nonlithologic designation "San Pedro formation" is preferred to "San Pedro sand." The Timms Point silt and the Lomita marl are treated as the two basal members of the formation.

As here defined, the San Pedro formation embraces all strata of early Pleistocene age. In most of the Torrance-Santa Monica area, the San Pedro formation occurs between the unnamed upper Pleistocene deposits above and the Pico formation below. However, in the northern and southern parts of the area shown on plate 2, major unconformities occur at both its top and its base so that locally it underlies the Palos Verdes sand of late Pleistocene age and rests on rocks as old as upper Miocene (p. 56).

For the stratigraphic units with which the San Pedro formation of this report is correlative-the San Pedro sand, the Timms Point silt, and the Lomita marl of Woodring and others-the type exposures occur low on the east flank of the Palos Verdes Hills in and near San Pedro-the extreme southern part of the area shown on plate 2.

In the type area, the San Pedro sand is made up largely of strati:fied

and crossbedded sand, but it includes some beds of fine gravel, silty sand, and silt. Its component particles are derived chiefly from some distant area of granitic rocks; however, according to Woodring, some of the gravel beds contain pebbles of limestone, siliceous shale, and schist, which are assumed to have been derived locally from the Palos Verdes Hills. In that same area, two local stratigraphic units of early Pleistocene age underlie the San Pedro sand of Woodring; in downward succession they are the Timms Point silt and the Lomita marl. The Timms Point silt of the type area is composed of brownish to yellowish sandy silt and silty sand. Its type outcrop at Timms Point has been described by Clark (1931, p. 25-42). The underlying Lomita marl consists chiefly of marl and calcareous sand.

The type locality of the Lomita marl is near Lomita quarry, about a mile southwest of Lomita. Foraminifera from the Lomita marl at the quarry have been described by Galloway and Wissler (1927).

Woodring ranks the Timms Point silt and Lomita marl as formations. However, because they cannot now be traced as distinct units to the north of the Palos Verdes Hills, for purposes of this report they are treated as the basal members of the San Pedro formation, as was done in the report on the geology of the Long Beach-Santa Ana area.

Woodring reports that in the San Pedro area the greatest exposed thickness of the San Pedro sand is about 175 feet, of the Timms Point silt about 80 feet, and of the Lomita marl about 70 feet. He estimates that these three lower Pleistocene units where concealed in that same area, have a maximum thickness of about 600 feet.

**REPRESENTATIVE EXPOSED SECTIONS**

For the northeast flank of the Palos Verdes Hills, Woodring (1946,

p. 45-53) has described a number of exposed sections of the San Pedro sand, the Timms Point silt, and the Lomita marl. Details will not be repeated here. However, one of the best exposures of the San Pedro sand is about 2,000 feet west of Narbonne Avenue, in 4/14-35E, at the Sidebotham sand pits nos. 1 and 2. Here the Lomita marl is absent, and the San Pedro sand rests directly on the Malaga mud­ stone member of the Monterey formation. The no. 1 pit exposes about 100 feet of sand and interbedded layers and lenses of gravel dipping gently northward. The sand is gray or reddish-brown and includes thin crossbedded units. Its aspect, as shown in a photograph in the recent report by Woodring and others (1946, pl. 19, p. 58), is typical of that observed in exposures in the Baldwin Hills, described beyond, and at Huntington Beach Mesa in the Long Beach-Santa Ana area. In other pits or ravines farther west, along the north border of the hills, the character of the sand and gravel of the type San Pedro sand does not differ significantly from the exposures just described; the Palos Verdes sand was found unconformably overlying the San Pedro in several of these ravines. As exposed in the several gravel pits along the north edge of the Palos Verdes Hills, the San Pedro sand appears to be highly permeable.

In addition to the exposures of the San Pedro formation just described, the only other known outcrops of this formation within the Torrance-Santa Monica area are in the Baldwin Hills and along the Ballona escarpment.

About 40 feet of the San Pedro formation is exposed in the northern part of the Baldwin Hills, in a sand pit on the east side of Moynier Lane about 250 feet southeast of well 2/14-801. The lower part of this section comprises about 25 feet of light-buff massive well-sorted fine granitic sand; this is overlain by about 15 feet of white medium sand, which contains pebbles as large as 1 inch in diameter near the top.

An exposure in another sand pit, about 1,000 feet south of the locality just described but on the west side of Moynier Lane, consists of about 45 feet of silty sand, sand, and gravel. In upward sequence, it comprises: 10 feet of interbedded sand and sandy gravel, with pebbles largely of metamorphic rocks and some granite; 4 feet of coarse loose sand; a 4-inch bed of dark reddish-brown fine sandstone; 6 feet of well-sorted fine loose sand; and at the top of the exposure, 25 feet of massive fine silty sand containing a few layers of scattered pebbles as much as 3 inches in diameter.

In the middle of 2/14-18, at the west border of the Baldwin Hills, about 50 feet of the San Pedro formation is exposed in a gravel pit about 400 feet east of the junction of Overland Avenue and Playa Street. The lower 20 feet of this section consists of light-gray coarse­ grained loose crossbedded sand; this is overlain by about 30 feet of light-brown medium- to coarse-grained loose sand with scattered streaks of gravel from 1 to 2 inches thick, which contains pebbles of quartz, metamorphic rocks, and granite as much as 1 inch in diameter. The upper 6 feet of this sand is weathered to a reddish-brown sandy soil.

**FAUNAL DATA FROM OUTCROPS AND WELLS**

In regard to the San Pedro formation as it occurs within the Tor­ rance-Santa Monica area, faunal studies have been confined to sub­ surface samples except for the type outcrops in the Palos Verdes Hills,. which have been studied by Woodring and his associates (1946, p. 43-53) and by several other investigators. (For references, see Poland, Piper, and others, 1956, p. 64.)

For this report, as in the report on geology of the Long Beach­ Santa Ana area the nomenclature and faunal divisions employed by

1. G. Wissler (1943) are usually accepted in order to develop the most uniform correlation of Pleistocene and Pliocene strata.

During the drilling of well 4/13-15All, near the intersection of Alameda and Carson Streets in Dominguez Gap, samples were col­ lected at IO-foot intervals by Paul Karnes of the Roscoe Moss Co. These samples were examined by S. G. Wissler for faunal correlation. From foraminiferal determinations, Wissler (oral communication,. January 7, 1947) reported the first good San Pedro fauna at 690 feet below the land surface and suggested from fragmentary data that the top of the San Pedro formation might be as high as 450 feet. On the basis of lithologic correlation, the top is here taken at 415 feet below the land surface, at the base of a bed of sand and gravel 65 feet thick,, which is inferred to represent a coarse southeasterly correlative of the "200-foot sand" in the unnamed upper Pleistocene deposits already described. The strata from 415 feet to the total depth of 1,040 feet

are assigned to the San Pedro formation. From logs of nearby wells, it is believed that this part of the San Pedro formation is about 800 feet thick and that its base is about 1,200 feet below land surface (pl. 2).

Core samples from well 3/14-1002, which was drilled for the city of Inglewood (well 30) about 1 mile northeast of Hawthorne, were· made available by the Kalco Drilling Co. and were examined by Wissler and Natland for fauna! correlation. Both men were in agreement (Wissler, S. G., oral communication, January 7, 1947; Natland, M. L., oral communication, January 9, 1947) that a fauna essentiaUy equivalent to that associated with the Timms Point silt and the Lomita marl is present from 564 to 825 feet below the land surface at this well. Wissler inferred that the base of the San Pedro formation is just below the deepest core obtained, which was at 825 feet be]ow the surface. The base of the Silverado water-bearing zone is 710 feet below the land surface at this well.

Samples from well 3/14-29D3 (well 11 of the city of Manhattan Beach) were also examined for fauna! correlation by Wissler (oral communication). He reported that the base of the San Pedro forma­ tion, placed by the Geological Survey at 431 feet below land surface, essenti.aUy agrees with the position indicated by the megafossils found in the samples.

Samples were collected at about 10-foot intervals during the drilling of" a test well for the Richfield Oil Corp. about 2 miles east of El Segundo (well 3/14-8N3, Richfield Leuzinger No. 1). Wissler examined these samples and placed the base of the San Pedro forma­ tion at about 790 feet below the land surface. A megafossil zone, which occurred from 180 to 240 feet below the surface is inferred to· mark the top of the San Pedro formation. The base of the SiJverado water-bearing zone here is about 440 feet below the land surface; and fine-grained silt and clay containing Timms Point-Lomita fauna extend some 350 feet below the base of the Silverado water-bearing zone.

From paleontologic examination of ditch samples from oil wells drilled near the crest of Dominguez Hill, Wissler concluded that the San Pedro formation was reached from 175 to about 670 feet below

]and surface (1943, p. 212).

In regard to the Rosecrans Hills, Wissler based his determination on paleontologic evidence from an oil well in 3/13-19A (about half a mile west of the crest of the Newport-Inglewood uplift) Wissler (written communication) assigned the deposits from 210 to 570 feet below land surface to the San Pedro formation.

Additional data on depth and thickness of the San Pedro formation obtained from other oil fields are shown graphically on plate 7 as

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diagrammatic columnar sections. In certain fields, particularly in the Potrero oil field, the base of the San Pedro formation is estimated by Wissler to be somewhat lower than is shown by the contacts on the geologic sections (pl. *3A, 0)* and by the contours on the geologic map (pl. 2). In such areas, it is probable that the fine-grained deposits underlying the water-bearing zones represent a basal interval con­ taining the Timms Point-Lomita fauna.

Water-bearing deposits that contain a similar faunal assemblage as much as several hundred feet thick have been deposited extensively to the north and northeast of Signal Hill in the Long Beach area (Poland, Pjper, and others, 1956, p. 67).

From the evidence just presented, it is apparent that, at least locally within and near the west basin, deposits of impermeable silt and clay underlie the Silverado water-bearing zone and contain a Timms Point-Lomita fauna; therefore these deposits are a basal part of the San Pedro formation. Thus, the contours on the base of the water-bearing zones of Pleistocene age shown on plate 2 do not every­ where represent the base of the San Pedro formation. However, the contours on plate 2 are believed not only to depict with fair accuracy the base of these water-bearing beds of the San Pedro formation but also, for most of the area, to represent generalized structure contours on the base of the deposits of Pleistocene age.

**THICKNESS**

The thickness of the San Pedro formation varies greatly within the Torrance-Santa Monica area, largely because deformation and erosion have been active since its deposition. 'l'be formation has been up­ turned and beveled by erosion at the outcrop aJong the north border of the Palos Verdes Hills (pls. 2, and 3B, *0).* Along the south flank of the Santa Monica Mountains the San Pedro formation doubtless is also upturned and beveled, but there it is capped by upper Pleistocene and Recent terrace and alluvial deposits and is not exposed at the land surface. In the Baldwin Hills, the San Pedro formation is domed upward and broken by faults and is at or near the surface over more than half the total area of the hi11s, as shown on plates 2 and 3A. The San Pedro is folded into an anticline and faulted over the crest of the Newport-Inglewood uplift southeast of the Baldwin Hills; it does not crop out on the Rosecrans and Dominguez Hills.

The general range in thickness of the San Pedro formation is shown on the several geologic sections. In the west basin it attains a thick­ ness *of* about 800 feet in the synclinal trough beneath Dominguez Gap, near the intersection of Carson and Alameda Streets. It may have a greater thickness, possibly 900 feet, in the sharp syncline beneath the inner harbor in Wilmington (pl. 2). To the northwest

its greatest thickness is in the synclinal trough extending past Ingle­ wood to Ballona Gap, but it decr ases gradually in thickness to about *500* feet at Gardena, to 400 feet west of Inglewood, and to 300 feet beneath Ballona Gap. Thicknesses along the crest of the uplift and along the coast are shown by geologic sections on plate 30. Except within the Baldwin Hills and the Palos Verdes Hills, where the forma­ tion has been partly or completely removed by erosion, it is thinnest along the coast near El Segundo (about 100 feet) and along the New­ port-Inglewood uplift crest beneath Ballona Gap (about *50* feet, pl. *3D).*

Inland from the Newport-Inglewood uplift, its greatest thickness is in the synclinal trough that trends northwest through Huntington Park and terminates beneath Ballona Gap at the north flank of the Baldwin Hills (pl. 2). Beneath Huntington Park the thickness of the San Pedro formation may be as much as 1,500 feet (pl. 4); farther southeast toward Orange County and beyond the extent shown on plate 2, it is about 3,000 feet thick.

Contours drawn on plate 2 show the altitude of the base of the water­ bearing zones of Pleistocene age. It has already been pointed out (p. 44) that for the treatment in this report the base of the San Pedro formation is assumed to be at the base of these water-bearing zones, although, from faunal evidence, locally the base of the San Pedro is somewhat lower. As shown by these contours, the approximate base of the San Pedro formation is lowest at Wilmington and at the intersection of Carson and Alameda Street about a mile south of Dominguez Hill; at these places it is about 1,200 feet below sea level. Along the crest of the Newport-Inglewood zone it rises to about 400 feet below sea level at Dominguez Hill, less than 100 feet below sea level in the middle of the Rosecrans Hills, and to 400 feet above sea level in the Baldwin Hills, where in places it intersects the land surface.

**PHYSICAL CHARACTER AND WATER-BEARING PROPERTIES**

*General features.-Study* of data from well logs shows that the San Pedro formation underlies most of the Torrance-Santa Monica area south of the Santa Monica plain, except where older rocks are exposed on the Baldwin Hills and the Palos Verdes Hills. For much of the area north of Ballona Gap (beneath the Santa Monica plain) the deposits of Pleistocene age cannot be divided on the basis of data now available, and the northward limits of the San Pedro formation are not known.

As shown on the geologic sections (pls. 3-5), along the northern border of the Palos Verdes Hills from Redondo Beach to Wilmington, the San Pedro formation is composed almost entirely of sand and gravel. To the north and east, the formation contains extensive beds

of silt and clay. Within the Torrance-Inglewood subarea, these impe1meable beds commonly are in the upper part of the formation and hence overlie and confine the Silverado water-bearing zone. Northward beneath Ballona Gap, west of the Baldwin Hills, the San Pedro formation is mostly sand with some gravel. Locally, however, it includes thick interbeds of silt.

Northeast of the Newport-Inglewood uplift, in the main coastal basin, the San Pedro formation cannot be subdivided into an upper part of clay and silt and a lower part of sand and gravel. Instead, it becomes heterogeneous in character and the water-bearing beds inter­ finger irregularly with layers of silt and clay.

Along the central part of the synclinal trough, from Inglewood to and beyond Gardena, the silt and clay beds within the San Pedro formation separate the coarser water-bearing deposits into two distinct aquifers (pl. *3B).* The upper of these two aquifers wedges out along both limbs of this syncline. The lower can be traced beneath nearly all the area from El Segundo and Inglewood southeast to the Palos Verdes Hills and Long Beach. It is the major aquifer within the west basin and has been named the Silverado water-bearing zone. These two water-bearing zones are described in considerable detail in the following paragraphs.

*"Four-hundred-foot gravel."-From* study of well logs on a peg model, correlated with the position of the water level, a distinct water­ bearing zone in the upper part of the San Pedro formation has been located in the synclinal trough southwest of the Newport-Inglewood uplift. This water-bearing zone is well defined from Inglewood southeast to about 3 miles beyond Gardena-a total distance of about 10 miles. Where best developed, it is characteristically composed of gravel or of sand and gravel, and its base is about 400 feet below land surface along the axis of the syncline (pl. 3B); accordingly, it has been designated the "400-foot gravel" for purposes of this report. Along the synclinal axis the thickness ranges from 20 to 120 feet. To the west and east of the axis it feathers out against the two limbs of the syncline. The limits of the "400-foot gravel" cannot be precisely defined because weH logs suggest that locally it merges with the Silvera.do water-bearing zone, especially southwest of Gardena. However, the approximate extent of the "400-foot gravel" has been shown on figure 2. As shown there, it is about 10.5 miles long, about 2 miles wide, and underlies approximately 20 square miles. Beyond its southeastern limit as shown on the illustration, and extending along the synclinal trough to Dominguez Gap, a deposit of fine sand of irregular thickness is shown in logs of many wells; this deposit of fine sand possibly represents the stratigraphic extension of the "400-

foot gravel". Doubtless the fine sand has general hydraulic con­ tinuity with the "400-foot gravel."

Along the axis of the syncline (pl. 3B) the "400-foot gravel" com­ monly is overlain and underlain by impermeable layers of silt and clay from 50 to 180 feet thick and thus is physically and hydraulically separated from the "200-foot sand" above and the Silverado water­ bearing zone beneath.

The "400-foot gravel" does not crop out at the land surface and so is known only from its occurrence as shown by well logs. Repre­ sentative logs are given in table 28. (See logs for wells 2/14-28Ll 3/13-30A2, 3;'14-4N2, 1001, and 22Al.) It is tapped by several wells of the city of Inglewood, and by three wells of the Southern California Water Co. (3/14-l0Cl, 22Al, and 23Ll); also by many privately owned irrigation wells.

The yield is known for only two wells tha,t tap the "400-foot gravel." Well 3;14-l0Cl has a reported yield of 500 gpm; tests show that well 3;14-23Ll yielded 600 gpm with a drawdown of 51 feet, giving a specific capacity of about 12 gpm per foot of drawdown. This water­ bearing zone is less than 50 feet thick as tapped in these two wells; thus the peimeability is inferred to be relatively high, and about the

-same as that of the underlying Silverado water-bearing zone.

The "400-foot gravel" is entirely a confined aquifer and contains water under artesian pressure. As shown by the hydrograph for well 3/14-23Ll (fig. 5), the water level in this gravel near Gardena in 1945 was only a few feet above the pressure level in the Silverado water­ bearing zone beneath. Because under native conditions recharge to the "400-foot gravel" presumably was chiefly through its marginal hydraulic contact with the Silverado water-bearing zone, the current head differential would indicate that the "400-foot gravel" now is receiving little recharge.

*Silverado water-bearing zone.-In* an earlier report (Poland, Piper,

-and others, 1956, p. 69) the name "Silverado water-bearing zone" was

.assigned to the most extensive of the Pleistocene aquifers of the Long Beach-Santa Ana area. The informal term Silverado water-bearing zone is not to be confused with the formal term Silverado formation (of Woodring and Popenoe, 1945) of Paleocene age of the Santa Ana Mountains, Orange County. The Silverado water-bearing zone was named for its typical occurrence in well 4/13-23G2 in Silverado Park within the city of Long Beach; the log is given in table 28. At this well the Silverado water-bearing zone is represented by 478 feet of sand and gravel from 596 to 1,074 feet below land surface. From data

-on other wells in the vicinity, the base of the Silverado water-bearing zone at this well is considered to be about 1,100 feet below ]and surface,

.and the full thickness to be about 500 feet (pl. 2 and fig. 2). The

upper 300 feet of the zone is highly permeable clean sand and gravel; the lower 200 feet is chiefly coarse sand.

The Silverado water-bearing zone underlies most of the Torrance­ Inglewood subarea and extends inland about 2 miles beyond the crest of the Newport-Inglewood uplift. Its known extent and thickness within the area treated in this report are shown on figure 2. As de­ limited on that illustration, it underlies about 140 square miles and also extends southeastward about 6 miles beyond the east margin shown on figure 2, almost to the Orange County line as shown in an earlier report (Poland, Piper, and others, 1956, pl. 8). Its over-all extent within Los Angeles County is about 165 square miles.

Figure 2 shows the known range in the thickness of the Silverado water-bearing zone by means of isopachs (lines showing equal thick­ ness) based on well-log information. Thus it is to be noted that the Silverado zone attains its greatest thickness (about 700 feet) near Bixby Slough in the Wilmington district. In general it is thinnest along the northern border of its known extent-about 100 feet at the coast near El Segundo, and less than 50 feet in Centinela Park in Inglewood. Except for the inordinate thickening in the synclinal fore­ deep immediately north of the Palos Verdes Hills, the average thick­ ness of the Silverado water-bearing zone is about 200 feet.

The range in physical character of the Silverado zone from gravel to sand and gravel, and in places to sand, is well shown on geologic sec­ tions, plates *3A-O* and 5. Many of the logs included in table 28 are of wells that penetrate the Silverado water-bearing zone. Among those in which the material ascribed to the Silverado is most characteristic are wells 3/13-28Al, 3/14-4N2, 3/14-22Al, 3/15-13R2, and 4/14-13Fl.

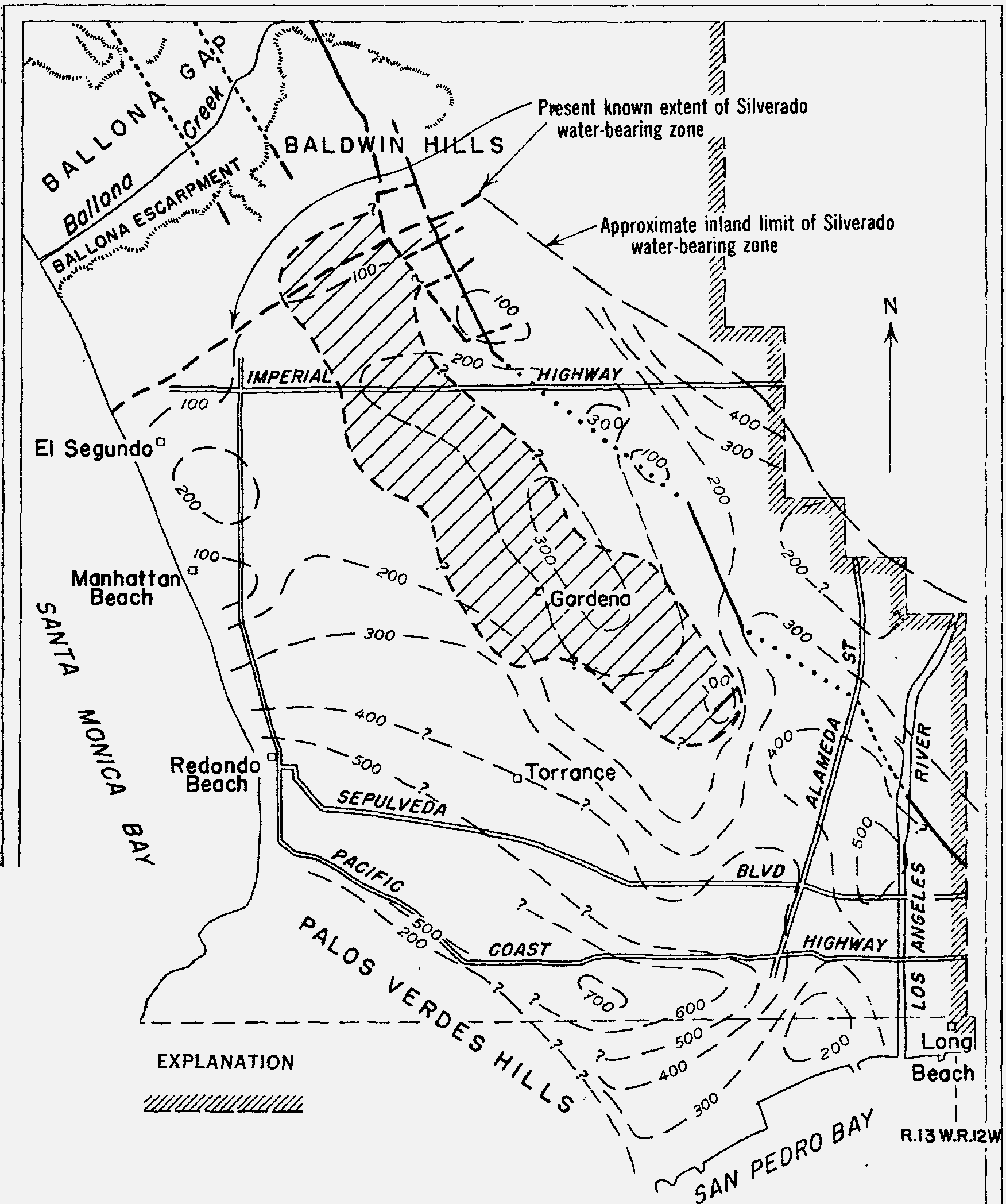
These logs indicate that the water-bearing parts of the zone are pre­ dominatly coarse sand and gravel; the maximum pebble diameter averages *½* to 1 inch, and reach a maximum of 2 inches (3/15-13R2, 4/14-13Fl) and 4 inches (3/14-4N2). In the Torrance-Inglewood

subarea interbedded layers of impervious silt, sandy clay, or clay within the Silverado zone locally reach a few tens of feet in aggregate thickness.

In most of the area between Long Beach and Redondo Beach the Silverado water-bearing zone is essentially a uniform mass of sand and gravel, with almost no interbedded clay or silt layers. It is chiefly gravel in the vicinity of Wilmington but becomes finer westward to Redondo Beach and Hermosa Beach, where it is largely sand. The Silverado zone is the thickest and the most productive water-bearing unit in this southern reach.

In the vicinity of Gardena and Hawthorne, where it is about 200 feet thick, the Silverado zone usually consists of about half sand and half sand and gravel, and contains few layers of silt. At Manhattan

T.4S.



1. 5S.

Project boundary

*--400--*

lines of equal thickness of the Silverado water-bearing zone. in feet

*277/L*

**Area** underlain by the

"400-foot gravel"

Trace of fault, dashed where approxi­ mately located; dotted where concealed

0 5 Miles

Approximate location of ground-water barrier not related to known fault

FIGURE 2.-Map showing extent and thickness of the Silverado water-bearing zone within the 'l'orrance­ Santa Monica area.

Beach, as tapped by the municipal wells west of Sepulveda Boulevard in 3/15-25A, the Silverado zone is irregular, but in most wells it in­ cludes one layer of sand and gravel about 50 feet thick, with a thinner layer below (pl. 4). To the north, near El Segundo, in sec. 13, T. 3 S.,

R. 15 W., logs of wells show that the Silverado zone is about 230 feet thick and contains from 2 to 4 layers of gravel separated by bodies of silt or clay (pl. 30).

The Silverado water-bearing zone is tapped by many of the wells of the city of Inglewood. It is thickest (230 feet) in well 3/14-lOGl (Inglewood well 28), northeast of Hawthorne. Near the center of Inglewood, at well 2/14-28Ml (Inglewood well 26), it is only 45 feet thick. Within the Inglewood area, however, the zone is almost entirely gravel or sand and gravel and is moderately permeable.

Few water or oil wells have been drilled in the northern part of the Torrance-Inglewood subarea (an area about 5 miles long and 2 miles wide, parallel to and just south of the Ballona escarpment). Logs are not available for this area to show if the Silverado water-bearing zone is stratigraphically and hydraulically continuous with the thick water­ bearing zone of the San Pedro formation beneath Ballona Gap. How­ ever, because of the general similarity in physical character and com­ mon position in the lower part of the San Pedro formation, it is inferred that the water-bearing zone in the San Pedro beneath the gap is correlative to the Silverado zone to the south and that the two zones have hydraulic cont inuity. 2

Beneath the coastal 4-mile segment of Ballona Gap, most of the San Pedro formation is composed of permeable sand and gravel (pl. 3D). Farther inland, beyond the Inglewood fault at the Sentney plant of the Southern California Water Co., in the NW} sec. 5, T. 2 S., R.

14 W., the San Pedro formation contains three distinct aquifers separated by impervious layers of silt or clay (2/14-5D6, table 28); the lower two aquifers probably are stratigraphic equivalents of the Silverado water-bearing zone.

Inland, beyond the crest of the Newport-Inglewood uplift, the Silverado water-bearing zone and the whole San Pedro formation interfinger into more silty and clayey types of beds. This change from coarser to finer sediments involves a transition from shallow-water marine and littoral deposits to nonmarine deposits.

**2** Since the present report was released to the open file (1948), the California Division of Water' Resources has completed its investigation (draft of report of referee, 1952). Additional information obtained in the State's investigation confirms the stratigraphic and hydraulic continuity **of** the Silverado water-bearing zone in the Torrance-Inglewood subarea with the thick water-bearing zone of the San Pedro formation beneath Ballona Gap. Hence, plate 6 **of** the State's report shows that the Silverado water-bearing zone extends north to and underlies the Ballona Gap.

The Geologic,al Survey has made a laboratory examination of samples collected during the drilling of two deep wells within the west basin. Detailed descriptions of the material in these wells is presented in table 28 (3/14-29D3 and 4/13-15All). The lithologic character of the material in these wells\_. which has been ascribed to the Silverado water-bearing zone; may be summarized as follows Relatively clean fine to coarse gray arkosic sand, which is moderately well sorted, with particles subangular to subrounded; and clean gravel consisting of subrounded to rounded fragments of granitic and metamorphic rocks as much as 2 inches in diameter. A variation from fine sand to coarse gravel is usually represented in beds within the zone; the gravel is predominant in the basal part.

As discussed previously (Poland, Piper, and others, 1956, p. 78-84)r the San Pedro formation is thought to have been formed by streamsr which carried rock debris from an inland uplifted source across a coastal plain and deposited the material as coastal deltas. These deltas were continuously reworked by strong longshore currents. Throughout much of early San Pedro time, the shoreline maintained a position about 3 miles northeast and nearly parallel to the Newport­ Inglewood uplift; that shoreline extended southeastward from the east edge of the Baldwin Hills through what is now the city of Comp­ ton. The Silverado zone was deposited seaward from the shoreline, chiefly as beach and shallow marine deposits.

The Silverado water-bearing zone is by far the most important aquifer in the Torrance-Inglewood snbarea. In 1945 the Silverado zone was the source of water for essentially all the withdrawals by industries; essentially all the withdrawals by the municipal well fields of Hawthorne, El Segundo, Manhattan Beach, and Torrance, and about one-third of the withdrawal by the well fields of the city of Inglewood within the west basin; nearly all the withdrawals by the larger water companies, and at least half the withdrawals by private irrigators and by the smaller water companies. Of the total with­ drawal from the Torrance-Inglewood subarea in 1945-some 78,000 acre-feet-about 68,000 acre-feet, or about 87 percent, was taken from the Silverado water-bearing zone (p. 110).

Wells tapping the Silverado water-bearing zone in t,he Torrance­ Inglewood subarea range in tested capacity from a few hundred to as much as 4,000 gpm. For the area immediately west of Long Beach **in T.** 4 S., **R. 13 W.,** the yield characteristics have been given in another report (Poland, 1959). Table 5shows the yield characteristics of 39 wells that draw water solely from the Silverado zone within the Torrance-Santa Monica area (fig. 2).

TABLE *5.-Yield characteristics of 39 wells tapping the Silverado water-bearing zone in the Torrance-Santa Monica area*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Water-yielding zone or zones | | Yield characteristics | | | |
| Well | Depth (feet) | Depth  range | Thick• ness | Yield  (gallons | Draw-  down | Specific | Yield |
|  |  | (feet) | (feet) | per minute) | (feet) | capacityi | factor a |
| 2/14-34CL•. --- --- ------  3/14-lB2 -  1lFL - - -- -- ----  Gl  9N4. -----------------  1001 -- ----------------  13BL  13J3\_ ---------- ------- -----  19CL ----------  21B2  29D3. . - -- - -- ------  3209A021 ---. --------- ----    30Dl\_ ---------------------  3/15-12BL  13H2 ---------------\_--  13RJl~~2~~ ------- . --- -- -- | 450  390  350  598  670  798  800  620  400  527  520  570  525  350  400  456  400  480  440  504  495  350  1,054  731  946  695  680  900  888  596  596  518  400  404  390  640  500  610  ---990  580 | 264-362  184-282  165-339  220--290  30Q-402  492-711  273-543  359-602  221-268  3lo-468  19Q-431  173-350  187-297  225-255  185-240  352-425  181-373  339-460  366-407  284-456  275-410  222-295  765-990  440-731  266--800  216-492  23o-655  675-822  669-800  475-538  418-547  166-510  206-394  206-404  212-390  486-640 lS0-500 152-610  735-842 | 700  508  1,240  512  1,050  600  675  700  800  433  600  1,800  1,125  905  680  1,000  850  860  560  1,000  900  615  2,000  1,450  3,000  2,900  4,000  1,650  2,500  810  1,375  1,500  640  375  215  945  1,300  1,340  1,470 | 70  16  12  21  50  17  30  20  50  3  25  28  55  54  54  20  32  13  16  34  /iO  36  14.5  5  12  28  10  28  19  29  33  13  7  6  2  13  19  15  32 | 10  32  103  24  21  35  23  35  16  144  24  64  20  17  12. 6 50 27 66 35  29  18  17  138  290  250  104  400  59  131  28  42  115  91  63  108  73  68  89  46 | 10  33  59  40  28  30  14  27  57  91  21  36  19  56  23  69  22  *55*  85  52  17.5  **32**  59  100  47  38  94  40  **100**  62  60  33  48  32  61  47  21  19  43 |
| 98  98  174  61  76  118  161  129  28  158  112  177  110  30  55  73  123  121  41  56  103  54  235  291  534  276  425  147  131  45  70  344  188  198  178  154  320  458  107 |
| 13R4 --- ----------- |
| 13R5 ------------------- |
| 1235AR36 ------------------- |
| 4/13-15AlL. -- --- -- - -- . - ---- |
| 21H5 |
| 27M3 -------------------- |
| 310E24\_ ---------------•------ |
| 4/13-3331PDLl. •-•--•-.•- |
| 4/14-1H2 ------------------ |
| 1H3\_.• •. ------------------ |
| 1870N1.l ------- ----------- |
| 22Dl. ------------------  4/14-22D2. . \_ --- •. --•  23N2  35Jl  36Hl.  5/13-6D2  Average |
| ---------- | 160 | 1,169 | 25 | 75 | **46** |

**1** Gallons per minute per foot of drawdown.

2 y· Jdf t Specific capacity X 100

ie ac or Thickness of aquifer, in feet

NOTE.-In tables 5 and 6, specific capacity (relation of drawdown to discharge) is used as the convenient scale for the water-yielding capacity of a well and for the relative transmissibility of the water-bearing zone at the place. In addition, specific capacity has been divided by thickness of water-bearing material yielding water to the well, and the quotient so obtained has been multiplied by 100 for convenience in expression. The result has been termed the "yield factor." The yield factor here is introduced as an approximat\_e rela­ tive measure for the permeability of the water-bearing material tapped by a well. Specific capacity and yield factor both involve drawdown, which *(as* measured in a well) is due to two increments of head loss:

1. tbat incident to movement of water toward the well through material of a certain average permeability and (2) that incident to entrance of water into the well casing. Thus, both specific capacity and yield factor depend n!)t only on the characteristics of the water-bearin material tapped but also on the number, size, and condition of perforations in the casing and their distribution within the water-bearing zones tapped.

The 39 wells listed in table 5 show averages as follows: Yield 1,169 gpm, drawdown 25 feet, specific capacity 75 gpm per foot of draw-­ down, and yield factor 46 (specific capacity X100 divided by the thick­ ness of aquifer, in feet). Within the Torrance-Inglewood subarea, table 5 shows no significant difference in yield factor for wells in the several townships, which indicates that although the thickness of the Silverado zone is more than twice as great between Long Beach and Redondo Beach as in the area north of Gardena, the permeability is essentially the same throughout its known extent in the west basin.

The permeability is a measure of the ability of a material to trans-· mit water. It may be expressed as a field coefficient of permeability, expressed as the number of gallons of water per day that percolates through each mile of the water-bearing bed (measured at right angles, to the direction of flow) for each foot of thickness of the bed and for· each foot per mile of hydraulic gradient (Wenzel, 1942, p. 7).

Within the west basin the permeability of the Silverado water­ bearing zone was determined from a pumping test near Bixby Slough: in sec. 31, T. 4 S., R. 13 W. This pumping test was made chiefly' to determine whether a barrier to ground-water movement existed between the wells of the Union Oil Co. (wells 4/13-31Pl and 5/13-6D2) and nearby wells at. (1) the Lomita plant, city of Los Angeles, in 4/13-31E, and (2) the Palos Verdes Water Co., in 4/14-36H (pl. 2)., The conclusions with respect to a hydraulic barrier are described: elsewhere (p. 139 and fig. **8).** The data also afforded an opportunity

1

to determine transmissibility 3 and permeability. · ;

On September 28, 1946, the pumps at the Lomita plant were idle · and had been shut down for several days previously. The wells .of the Union Oil Co. had been pumped continuously for several :tnont ·s before the test, and the wells of the Palos Verdes Water Co. had been· operated intermittently. During the day, wells 4/13-31Pl and 5/13-' 6D2 (Union Oil Co.) and well 4/14-36Hl (Palos Verdes Water· *Co. 1* well 1) were pumped intermittently on an alternating schedule (fig·.. 8) and water-level measurements were· made at about 10-minute ' intervals from 10:00 a. m. o 9:00 p. m. at wells 4/13-31E4, 4/13-31Pl, and 4/14-36Hl. The fluctuation of water level in these wells is shown on figure 8. Between 12:10 and 4:10 p. m., the water level in well 31E4 recovered along a uniform curve, as a result of the shut­

down of the pumps in the Union Oil Co. wells from noon to 4:00 p. m. From 4:10 to 7:10 p. m., the water level in well 31E4 declined concur-. rently with pumping of the Union Oil Co. wells. The time-drawdown\_

graph for .well 31E4 was utilized to compute transmissibility in ac-

a Transmissibility is expressed as the field coefficient of permeability multiplied by the thickness of th&· saturated part of the aquifer in !eet..

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cordance with a procedure described by Cooper and Jacob (1946). The transmissibility was determined by use of the equation

T=263.9Q

As

where Tis transmissibility in gpd per foot, *Q* is discharge of the pumped well in gallons per minute, and As is the change in drawndown in an observation well over one logarithmic cycle (drawdown plotted against time on semilogarithmic paper, with time on the logarithmic scale). During the test the average joint discharge from the Union Oil Co. wells was about 2,150 gpm and the change in drawdown in well 31E4 was about 0.97 foot during one logarithmic cycle Thus, the indicated transmissibility is about 600,000 gpd per foot. The thickness of the water-bearing deposits tapped at well 31E4 is 425 feet, indicating a permeability of about 1,400 gpd per square foot.

The transmissibility and permeability of the Silverado water­ bearing zone in the reach between Wilmington and Torrance were determined from the fluctuation of pressure level in well 4/14-13Fl, near Torrance, during the pumping of wells 4/13-30Gl and 4/13-30Kl (city of Los Angeles, Lomita plant wells 6 and 7), 12,000 feet fo the southeast, in Wilmington. The hydrograph for well 4/14-13Fl and the draft at the Lomita plant are shown elsewhere on figure 6. A time-drawdown graph was constructed as described for the pumping test of the Union Oil Co. wells near Bixby Slough. The average joint rate of discharge from wells 4/13-30G1 and 4/13-30Kl from April 19 to May 2, 1944, was 4,340 gpm. The change in drawdown in well 4/14-13Fl was about 1.41 feet during one logarithmic cycle. Thus, utilizing the equation for obtaining transmissibility given in the preceding paragraph, the indicated transmissibility is about 813,000 gpd per foot. The average thickness of the Silverado water-bearing zone between the pumped wells and observation well 4/14-13Fl is about 400 feet, indicating a permeability of about 2,000 gpd per square foot. This test is considered to furnish a more accurate and more representative value for the permeability of the Silverado water­ bearing zone between Torrance and Long Beach than the test at Bixby Slough, because the latter pumping test was made in an area where physical texture, thickness, and permeability of the Silverado water­ bearing zone are believed to change between the pumped wells and the observation well-whereas between Wilmington and Torrance the physical character and thickness are reasonably uniform. .Also, the Silverado water-bearing zone wedges out on the flank of·the Palos Verdes Hills about 4,000 feet southwest of the Union **Oil** Co. wells and about 10,000 feet southwest of wells 4/13-30G1 and 4/13-30Kl. Thus, for the pumping test at the Union Oil Co. wells, the cone of

**.',GEOLOGIC F0RMATIONS----WATER-BEARING CHARACTER 55:**

pressure relief, must have extended rapidly to the non-water-bearing: rocks, resulting in distortion during subsequent growth of the cone.: On the other hand, the cone surrounding wells 4/13-3001 and 4/13\_,· 30Kl would reach well 4/14-13Fl about as soon as it impinged upon the non-water-bearing rocks and the distortion would have little if any effect on drawdown in well 4/14-13Fl, which is about 3.4 miles. distant from the south boundary of the basin.

At the Centinela Park well field of the city of Inglewood the permea bility of the water-beari:0:g beds of the San Pedro formation-beds· essentially correlative to the Silverado water-bearing zon has been• determined from the fluctuation in observation well 2/14-27D1 (city. of lnglewood;well 7) during the pumping of well 2/14-22N2 (city of Inglewood, well 9). The hydrograph for well 2/14-27D1 is shown on figure 7. Utilizing the time-drawdown graph and applying the for- 1 mula of Cooper and Jacob (p. 54), the transmissibility has been estimated at about 55,000 gpd per foot. The saturated thickness of water-bearing beds was about 50 feet at the time of the test. Thus/ the permeability here is about 1,100 gpd per square foot.

For the extent of the water-bearing zones of the San Pedro forma­ tion in and near the Ballona Gap-zones correlative with the Silverado water-bearing zone in age and physical character-table 6 gives the yield characteristics of eight wells. ·

TABLE *6.-Yield characteristics of eight wells tapping the San Pedro formation in.*

*the vicinlty of Ballona Gap* · '

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Well | | Depth (feet) | Water-yielding zone or zones | | Yield characteristics | | | '' *:*  ,, |
| Depth range (feet) | Thick- ness (feet) | Yield (gallons per min- ute) | Draw- down (feet) | Specific capac- ity,1 | Yield factor 2 i |
| 2/14--4NL ·- | | 300  265  827  480  405  452  380  --- 208  415 | 118-219  112-187  449--796  198-340  196-376  217-430  168-346  ---91-133  ---------- | 66  18  136  114  169  181  176  42 | 1,010  550  3,050  345  1,125  1,155  1,805  355 | 31  75  **40**  24  17  36  32  **21** | 33  7.3  76  14  66  32  56  17 | 50.  **41**  56·  12  39  **18'**  32  **40** |
| 2'Z3PH22. - -- - - ------- ----- | |
| 2/15-11D2 |  |
| 11E3 | |
| 11E5 | |
| UF4 | |
| 34Kl | |
| Average -,------- | | 113 | 1,174 | 35 | 38 | 36' |

1 Gallons per minute per foot of drawdown.

2 y· Id f t Specific capacityXlOO

ie ac or Thickness of aquifer, in feet'

As shown by this table, the average yield of the 8 wells is 1,17,f gpm, almost identical to the average yield for the 39 wells tapping the Silverado water-bearing zone to the south. The yield factor for the 8 wells is 36, as compared to a factor of 46 for the 39 wells of table-

5. ·Thus, it is concluded that the permeability of the water-bearing

beds in the San Pedro in the vicinity of Ballona Gap is somewhat lower than that of the Silverado water-bearing zone, probably about three-quarters as great.

**STRATIGRAPHIC RELATIONS**

The rocks overlying and underlying the San Pedro formation are separated from it by unconformities. The unnamed upper Pleistocene deposits apparently were laid down after some folding of the San Pedro formation had occurred along the Newport-Inglewood uplift, and are inf erred to overlie the San Pedro unconformably at places along this uplift. Subsequent to their deposition, parts of these upper Pleistocene deposits and parts of the San Pedro formation were eroded during the development of the upper Pleistocene marine (Palos Verdes) surface. Therefore, the Palos Verdes sand, which was deposited on this surface, doubtless is locally unconformable on the unnamed upper, Pleistocene deposits, and in some places, as at Signal Hill and at the intersection of Lincoln Boulevard and the Ballona escarpment, it rests directly on the San Pedro formation.

The Tertiary rocks underlying the San Pedro formation are reported by Woodring {1946, p. 109, and pl. 1) to be unconformable with it wherever the relations have been clearly exposed in the Palos Verdes Hills area. Here the Pico formatiqn of late" Pliocene age is missing and the San Pedro formation rests in part on lower Pliocene and upper Miocene rocks.

Throughout the remainder of the Torrance-Santa Monica area, with the exception of the Baldwin Hills, the contact of the San Pedro formation with the underlying Tertiary rocks is concealed. Uncon­ formities are more likely to be present along the Newport-Inglewood belt than beneath the Torrance or Downey plains. Structural activity along this zone, if it took place during or after the deposition of a oup of rocks, could rarely avoid causing a break in the sedimentation, and would be registered as an unconformity within that group or be­ tween it and the overlying younger deposits. Wissler (oral communica­ tion) believes that activity along the Newport-Inglewood belt began in early upper Miocene time, and he infers (Wissler, 1943, p. 231) that there is an unconformity between tbe Pico and San Pedro formations in the Dominguez and Rosecrans fields.

The Tertiary rocks (upper division of the Pico formation) in the Baldwin Hills area are exposed at several places and are cut by the main Inglewood fault into an eastern and a western block. Driver (1943, p. 308) states that "the Pleistocene is conformably deposited over the Pliocene in the western block, but is unconformable in the eastern block."

During excavation for a storm drain, east of Culver City and one-third of a mile north of the Baldwin Hills, in 1936, Natland 4 found that the Tertiary strata were separated by an unconformity from the overlying sands of the San Pedro formation.

**TERTIARY SYSTEM PLIOCENE SERIES GENERAL FEATURES**

In most of the area shown on plate 2, strata of Tertiary age underlie the Quaternary rocks. They crop out at the surface only in the flanks of the Santa Monica Mountains and in the Baldwin and Palos Verdes Hills. These rocks consist chiefly of marine silt and sand, containing only local lenses of gravel.

The Pliocene series is subdivided on the basis of microfauna into two formations in the Los Angeles basin- the Pico above and the Repetto below. The Pico formation, although absent from the geologic column in the Palos Verdes Hills, is present throughout the remainder of the Torrance-Santa Monica area and so is underlain by the Repetto formation.

The Pico formation has been divided by stratigraphers into upper, middle, and lower divisions on the basis of distinct microfaunal assemblages (Wissler, 1943, p. 212-213). For the purposes of the present investigation, a discussion of the upper division of the Pico formation and its water-bearing characteristics is pertinent, because the relatively permeable sand members in the lower part of the upper· division generally contain essentially fresh ground water. In much of the area shown on plate 2, the base of the main fresh ground-water body is approximately at the base of the lowest of these upper Pico sand members (p. 86 and pl. 8).

Because permeable sand beds in the middle and lower divisions of the Pico formation within the project area contain only connate saline water, those divisions will be treated only briefly here; they are dis­ cussed in detail in many reports on the petroleum geology of the Los Angeles basin.

**PICO FORMATION, UPPER DIVISION**

**PHYSICAL CHARACTER AND THICKNESS**

The upper division of the Pico formation consists of semiconso1i­ dated sand and micaceous silt and clay of marine origin. Locally, beds of fine gravel occur in the upper part of the division, presumably also of marine origin.

The upper division of the Pico formation underlies all the area shown on plate 2 except the south flanks of the Santa Monica Mountains

**'Natland, M. L., unpublished data Crom Shell OU Co., 1936.**

and the northern border of the Palos Verdes Hills. The only known exposures of this upper division are in the northern sector· of the Baldwin Hills, where they occur as buff siltstone and buff fine silty sand or sandstone with limonitic clayey partings and limon1tic con­ cretions. The exposures in these hills are not differentiated on plate 2 from the rocks of Jower Pliocene and Miocene age.

Hoots (1931, p. 116) reported that the upper part of the Pliocene section which is exposed about 2 miles outside the west boundary of the area, in Potr:ero Canyon, "is equivalent to a part of the Pico forma­ tion exposed at its type locality in Pico Canyon."

Along the Newport-Inglewood structural zone and in the west basin, the upper few hundred feet of the upper division is composed chiefly of silt and clay. Beneath the Baldwin Hills, according to Wis­ sler (1943, p. 213), most of the entire upper division of the· Pico is silt. To the north the character of the upper division of the Pico is not known. However, in almost all of the area south and southeast of the Baldwin Hills, the lower 600 to 1,000 feet of the upper division includes several beds of fine- to medium-grained sand and sandstone and, locally, beds of fine gravel. The geologic sections, plates *3A* and 4 to 6, show the general disposition of these permeable zones as revealed in a few cored wells and as inferred from electric logs.

These coarser beds commonly range from 25 to as much as 100 feet in thickness, and are separated by beds of massive micaceous siltstone. Thus, about 2.5 miles southeast of Dominguez Hill, well

,4/13-17Dl reached the upper division of the Pico from 683 to 1,701 feet below land surface (Poland, Piper, and others, 1956, p. 87, 143). In this well the sand occurs in 10 layers totaling 282 feet-about 28 percent of the thickness. The casing of this well was never perforated, so neither the yield of the deposits nor the chemical character of the water is known.

· ·well 4/13-12A2 (city of Long Beach, North Long Beach well 6), about a mile northeast of the Newport-Ing]ewood uplift and a mile ast of the Los Angeles River, was drilled to a depth of 1,955 feet, cutting through about half the upper division from 726 feet to the bottom. (See log, table 28.) Within this depth interval, the drillers reported nine water-bearing beds, totaling about 240 feet, or about 20 percent of the top half of the upper division of the Pico, which consist of fine sand and fine gravel with some clay.

Well 3/14-17Jl, an oil-test hole about a mile southwest of Haw­ thorne cut through the entire thickness of the upper division, begin­ ning at about 500 feet below land surface. The electric log indicated fresh-water-bearing sand between 1,110 and 1,320 feet. Three other beds of sand, each about 50 feet thick, were reached in this well be­ tween 1,750 and 2,100 feet, but these lower sand members, near the

base of the upper division, are inferred to contain brackish water (pl. 8). *A* pumping test, made to determine the productivity and the quality of the water in the sand member between 1,110 and 1,320 feet, is described on page 61. -

In1and from the Newport-Inglewood uplift, in the area northeast **of**

Dominguez Hill, the deposits of the upper division of the Pico are not tapped by water wells, so far as known. However, electric logs and samples from a few oil-test holes on the Downey plain indicate that this section of the upper division of the Pico formation is almost entirely of marine origin and of the same general character as its west basin equivalent.

Within the area shown on plate 2, the upper division of the Pico formation ranges in thickPess from 1,800 feet beneath Dominguez Gap at the southeast end of the Dominguez anticline to feather edges

·against the uplifts of the Santa Monica Mountains and the Palos Verdes Hills. As shown on plate 7, the thickness is about 1,000 feet at Playa del Rey; 1,300 feet at the El Segundo oil field, and 1,100 feet at the Torrance oil field; about 900 feet at the Inglewood oil field, in the Baldwin Hills; about 1,200 feet southeastward along the Newport­ Inglewood uplift at the Rosecrans oil field; 775 feet at the crest of Dominguez Hill, and 1,440 feet at the northwest end of the Long Beach oil field. In1and, beyond the area shown on plate 2, the upper division probably increases in thickness to much more than 2,000 feet beneath the central Downey plain.

**STRATIGRAPHIC RELATIONS**

At least locally, the upper division of the Pico was deposited on a surface of unconformity. However, throughout much of the Torrance­ Santa Monica area, data are insufficient to determine with assurance the stratigraphic relation of the upper division to the under]ying older rocks. Furthermore, the relations of this upper division to the over­ lying Pleistocene rocks are uncertain in many places.

In the Torrance-Wilmington area relations are well established and, according to Wissler (1943, p. 213), the upper division overlaps the middle division of the Pico; in the Long Beach harbor district of the Wilmington oil field it rests directly on the Repetto formation of early Pliocene age. At the north border of the Palos Verdes Hills, where the San Pedro rests locally on the Repetto aud on rocks of Miocene age, the upper division of the Pico is absent.

Along the Newport-Inglewood uplift, an unconformity between the upper division of the Pico and the San Pedro formation in the Rose­ crans and Dominguez oil fields was inferred by Wissler (1943, p. 212), because of the apparent absence in these fields of the Timms Point fauna, which occurs at the Seal Beach oil field:

**.60 GEOLOGY, HYDROLOGY, TORRANCE-SANTA MONICA AREA**

Inland beyond the Newport-Inglewood uplift, beneath the Downey plain, it is likely that no unconformity exists and that sedimentation took place almost continuously from late Pliocene into Pleistocene (San Pedro) time.

**WATER-BEARING CHARACTER**

Within most of the area shown on plate 2, except beneath and north of the Baldwin Hills, the upper division of the Pico formation contains layers of semiconsolidated sand which should yield substantial quan­ tities of essentia1ly fresh water to wells of adequate construction. The productivity of these sand layers in this area can be inferred from pumping tests at two wells and from a laboratory test of permea­ bility of the sand from a third well, as described beyond.

Information derived largely from electric logs of oil wells and pros­ pect holes suggests that, in much of the area covered in this report, the water in these sand members of the upper division of the Pico is either fresh or suitable for certain industrial uses.

The position of the top of the transition zone between fresh and saline ground water has been ascertained from the electric logs of representative oil wells and prospect holes. Contours drawn on the top of the transition zone are presented on plate 8, these contours mark the approximate position of the base of the principal fresh­ water body, as defined elsewhere in this report. Although correlation between oil fields in this region is precarious because of the usually pronounced lateral variation in lithology (Wissler, 1943, p. 234), the group of sand members generally prevalent in the lower part of the upper division of the Pico can be traced from one field to another; this general lithologic correlation is supported by studies of the fora­ miniferal assemblages. A comparison of the position of the top of the transition and of the base of the upper division, as determined by micropaleontologists, shows that they almost coincide in this region. Notable exceptions are at the Potrero oil field, where the top of the transition zone is as much as 400 feet above the base of the upper division of the Pico; and at the west end of the Torrance oil field, in the Redondo Beach area, where the transition to saline water is 300 feet above the base of the upper division. In these two areas, and also locally in the Wilmington oil field, one or more of the lowest sand members ascribed to the upper division contain connate saline ground water.

With respect to specific information on water-bearing character­ istics of the upper division of the Pico formation, some data are avail­ able as a result of two recent attempts to construct wells that pene­ trated the fresh-water sands of this formation.

One of these wells, 3/14-17Jl, about a mile southwest of Hawthorne, was initially a "wildcat" oil well drilled to a depth of 4,200 feet by the

Loren L. Hillman Co., Inc., and designated "West Hawthorne No. 1." This well was utilized by the Standard Oil Co. of California in 1946 to test the aquifers in the upper division of the Pico formation with respect to quality of the water and productivity of the sands. The electric log indicated a permeable zone containing essentially fresh water from 1,120 to 1,320 feet below the land surface. To test this zone, the hole was plugged off below a depth of 1,294 feet. A double liner with an outer-pipe diameter of 8% inches and an inner-pipe diameter of 7% inches, prepacked with gravel between the two pipes, was landed at 1,294 feet and extended into the 11%-inch casing set at 849 feet. The prepacked liner was perforated from 1,089 to 1,294 feet, opposite the permeable zone.

An initial bailing test was made on this well late in May 1946, at

an estimated rate of 25 gpm for about 24 hours. After 20,000 to 30,000 gallons was bailed, the chloride concentration was about 120 ppm. The apparent static level then was about 119 feet below land surface, or about 38 feet below sea level, and the drawdown was about 38 feet after the water became relatively clear.

Subsequently, a pump was installed and a yield test was made by the Standard Oil Co. on August 1-4, 1946. The static level before the test was 111 feet below the land surface, or 30 feet below sea level. The pump bowls were set 400 feet below the land surface. The water yielded during the test contained a large amount of fine sand as well as particles of colloidal size; it was still turbid after standing several days. The maximum yield was at a rate of about 25 gpm; but this yield is not indicative of the productivity of the zone because the liner presumably filled with sand early in the test. At the end of the test, sand filled the casing to 728 feet below the land surface, about 360 feet above the top of the perforations.

In the latter part of August 1946 the sand was removed from the casing and a bailing test was made. The maximum rate of bailing was reported to be about 50 gpm with a drawdown of 50 feet. At the end of the bailing test, when the drawdown was 38 feet, the water level recovered 35 feet in 20 minutes. Large quantities of sand were removed from the well during this bailing test. The company decided that further tests were not warranted and the well was abandoned.

Chemical analyses of water collected during the pumping test and in the final bailing test were made by the Standard Oil Co. (see table 30). The quality of the water is discussed on page 183.

Although the tests made on well 3/14-17Jl were unsuccessful from the standpoint of yield, it is believed that a well constructed to exclude sand, such as a gravel-packed well of 24- to 30-inch diameter with an envelope of fine gravel or coarse sand, probably would yield several times as much water as was obtained during this test. The prepacked

gravel liner utilized for the test was only 8% inches in outside diameter and the gravel screen was less than half an inch thick.

The other type of the two wells tapping the sand members of the upper division of the Pico on which yield-test data are available is a water well drilled by the city of Long Beach in the spring of 1946- well 4/13-12A2 (city of Long Beach, North Long Beach well 6)­ about 6 miles north of the business district of Long Beach. Drilled to a total depth of 1,955 feet, the well penetrated about 1,200 feet into the upper division of the Pico-or about 50 percent of the total depth range of the sand zones containing fresh water in the upper division at that locality (see log, table 28). A 26-inch casing was set to a depth of about 360 feet and a 16-inch casing to 1,955 feet; the latter casing was perforated from 1,805 to 1,955 feet. The well flowed 106 gpm. The water was dark brown and had a temperature of 104° to 106°F. Sufficient methane was present to burn continuously when ignited at the open casing.

On October 7, 1947, a yield test was made on this well and the yield was estimated at 400 gpm, with a drawdown of about 60 feet from a static level about 15 feet above land surface, or 53 feet above sea level. Thus the specific capacity was about 7 gpm per foot of drawdown.

Although the content of dissolved solids was moderate (see chemical analysis, table 30), the water was not considered suitable for public supply because of its high temperature and dark color. The cost of treatment to make the water suitable for use was considered too costly, and the well was abandoned.

During the drilling of the well, samples were collected by the city at each change in character of the material, and at 10-foot spacings below 1,470 feet. In the laboratory of the field office of the Geological Survey at Long Beach, permeability tests were made on samples from four of the coarser zones within the depth range of the casing perfora­ tions. Coefficients of permeability for these four zones, as determined in the laboratory, are as follows: at 1,890 feet below land surface, fine to coarse sand, some fine gravel, 454 gpd per square foot; 1,900 feet-fine to coarse sand, some silt, little fine gravel, 212 gpd per square foot; 1,910 feet-silty sand and gravel, pebbles as large as inch in diameter, 20 gpd per square foot; 1,940 feet-silty fine to medium sand, **16** gpd per square foot.

Additional information on the permeability of the tipper division of the Pico was obtained from well 3/14-8N3 (Richfield Leuzinger well 1), which was drilled by the Richfield **Oil** Corp. about 2 miles east of El Segundo to test the oil and gas possibilities of the Pico formation. Through the courtesy of this company, a sample of sand from a per­ meable zone in the upper division of the Pico formation between 1,220 and 1,240 feet below land surface was made available to the Geological

**GEOLOGIC FORMATIONS-WATER-BE.ARING CHARACTER 63**

Survey. A laboratory test indicated a permeability of 242 gpd per square foot. A mechanical analysis of this sand gave the composition\_ tabulated below, indicating that the size ranges from fine gravel to very fine sand, but that 34 percent is medium sand.

*Mechanical composition ( millimeters)*

Fine gravel (more than 1.00) \_

Coarse sand (1.00 to 0.5) -- ---------

Medium sand (0.5 to 0.25) \_

Fine sand (0.25 to 0.125) \_

Very fine sand (0.125 to 0.05) \_

*Percent of dry weight*

2. 3

24. 6

34. 0

31. 1

8. 0

Information summarized on preceding pages suggests that the pro­ duction of water from the upper division of the Pico formation within or near the west basin would require wells of substantial depths, probably as much as 1,500 feet on the average. Also, the sand mem­ bers of the upper division are fine grained and wells of special con­ struction-with a thick gravel pack or a carefully selected screen­ would be required to withdraw water effectively. Such wells would be much more expensive than the water wells now utilized in the area. At some places, especially along and near the crest of the Newport­ Inglewood uplift, yields of as much as 1,000 gpm might be obtained locally with a drawdown of not more than 100 feet. Within most of the west basin, however, it is doubtful that yields would exceed a few hundred gallons per minute with such a drawdown.

Although yields from the upper division might be substantial along the Newport-Inglewood uplift, it is concluded that the color of the water probably would be amber to dark brown and thus the water probably would require treatment for domestic use, even though the chemical quality should prove to be satisfactory. This color is pre­ sumed to be caused by organic matter in colloidal suspension. It is believed that coloring by organic matter would not be excessive within most of the west basin, but the water might be turbid, similar to the water of well 3/14-17Jl, and might require treatment.

The temperature of waters withdrawn from the upper division of the Pico ranged from 90° to U0°F. Therefore, these waters probably would have to be cooled for domestic use although such temperatures might not be objectionable for some industrial uses.

For wells tapping the upper division along the Newport-Inglewood uplift but inland from the west basin boundary, the static level would be above the current water levels in the Pleistocene water-bearing zones, and at places where the altitude of land surface is low, as at well 4/13-12A2, the wells would flow.

Wells tapping the upper division of the Pico formation within the west basin probably would register initial pressure levels ranging from

sea level to possibly as much as 40 feet below sea level. Thus, to yield substantial quantities of water even from wells of special con­ struction, initial pumping levels probably would be about 100 feet or more below sea level. Because replenishment to the water-bearing beds of the upper division in the west basin is inferred to be small **or** negligible, pressure levels presumably would decline fairly rapidly if large quantities of water were withdrawn from the sands of the upper division.

The water-bearing beds in the upper division of the Pico within the west basin contain a large quantity of water. If the average aggregate thickness of the sand layers containing essentially fresh water is approximately 200 feet, and the area is about 120 square miles, an assumed effective porosity of 25 percent would indicate storage of about 3 to 4 million acre-feet. If replenishment is negligible, as seems likely, only a small part of this quantity could be withdrawn without lowering pumping levels far below sea level. Because exploratory and well-construction costs would be high, the water yielded from the upper division of the Pico would cost substantially more per acre-foot than the ground water now yielded by wells in the west basin. Ex­ tensive development of the water in the water-bearing beds of the upper division to abate the current overdraft in the west basin does not offer a permanent solution to the water-supply problems of the basin.

**PICO FORMATION, MIDDLE AND LOWER DIVISIONS**

The middle and lower divisions of the Pico formation do not crop out within the area shown on plate 2. As determined from cored samples from oil-test holes, they comprise interbedded sandstone, claystone, siltstone, and shale. According to Wissler (1943, p. 214- 215), the percentage of sand in the middle Pico averages about 40 percent for the oil fields within the Torrance-Santa Monica area; on the other hand, the lower division of the Pico contains about 60 percent of sand.

Among the oil fields within the area, the combined thickness of the middle and lower divisions ranges from about 400 feet at the Torrance oil field to more than 1,700 feet at the Potrero field (pl. 7), although somewhat greater thicknesses presumably occur in the basin areas between the structurally high oil fields.

In the Torrance-Wilmington area the lower division is overlapped by the middle division, the latter resting with angular discordance on the Repetto formation of early Pliocene age (Wissler, 1943, p. 215).

Along the north border of the Palos Verdes Hills, the entire Pico and in many places the Repetto are overlapped by the San Pedro formation of lower Pleistocene age (Woodring and others, 1941, p. 40-41).

GEOLOGIC FORMATIONS-WATER-BEARING CHARACTER 65

Elsewhere within almost all the Torrance-Santa Monica area and south of the Santa Monica Mountains, both the middle and lower divisions of the Pico formation are present and are essentially conformable with each other and with the overlying upper division and the underlying Repetto.

Within the area shown on plate 2, the water in the sand zones of the­ middle and lower divisions of the Pico formation is believed to be saline. However, inland beneath the Downey plain, electric logs from scattered "wildcat" oil wells indicate that essentially fresh water is contained in the sandier zones of the middle division of the Pico.

**OLDER ROCKS OF TERTIARY .AGE**

Underlying the Pico formation in the Torrance-Santa Monica area are sedimentary rocks of lower Pliocene (Repetto formation) and of Miocene age. Lithologic descriptions of these rocks and their known range in thickness are given in table 3. Their distribution and thick­ ness in the several oil fields of the area are summarized in plate 7. They include most of the oil-producing zones of the Los Angeles basin area and thus have been treated in detail in many reports con­ cerned with the production of the oil resources of this area; however, they do not contain fresh water. The reader who desires information about these older formations is referred to the selected references given in an earlier report (Poland, Piper, and others, 1956, p. 93).

**PRE-TERTIARY ROCKS**

The pre-Tertiary rocks that crop out within the Torrance-Santa Monica area are generally considered to be of Mesozoic age. All are non-water-bearing and are briefly described here merely to complete the stratigraphic sequence.

As shown on plate 2, the pre-Tertiary rocks crop out only locally along the south border of the Santa Monica Mountains. According to Hoots (1931, p. 88-93), they are represented by the Santa Monica slate of Triassic(?) age, a Jurassic(?) igneous intrusion of granite and granodiorite, and the upper Cretaceous Chico formation consisting of conglomerate, sandstone, and shale. The Chico formation, where it occurs in the area, was not differentiated by Hoots from the Mar­ tinez formation of Paleocene age because of a dense covering of brush and unexposed structural complications.

In the Palos Verdes Hills, the pre-Tertiary rocks constitute **a** metamorphic complex which forms a central core, which crops **out** only in a limited area on the northern slope of the hills about a **mile** south of the southern boundary of the area mapped on plate 2. These rocks consist of quartz-sericite, quartz-talc, and quartz-glaucophane schist and altered basic igneous rocks which have been ascribed by

Woodford (1924, p. 62) to a correlative of the Jurassic(?) Franciscan group of the Coast Ranges. However, because there are no unaltered sedimentary rocks among these schist beds, Woodford considered the alternative that they might be older than the Franciscan-a possibility which also has been emphasized by Taliaferro (1943, p. 122-125).

**GEOLOGIC STRUCTURE**

**REGIONAL FEATURES**

The thick sequence of sedimentary rocks underlying the coastal plain has been deposited in a broad synclinal depression often referred to as the Los Angeles basin. In the structurally deepest part of the basin, beneath the central part of the Downey plain, the rocks of Tertiary and Quaternary age probably are more than 20,000 feet thick. Along the north and northeast margins of the basin, and locally to the southwest at the Palos Verdes Hills, these rocks have been extensively elevated, folded, faulted, and eroded, to expose a complex of igneous and metamorphic rocks (pl. 1).

The general synclinal structure of the basin is interrupted by th composite faulted anticlinal belt that extends southeastward from the Beverly Hills to Newport Beach-the Newport-Inglewood uplift. In effect, this uplift divides the coastal plain into two synclinal troughs. To the northeast, a broad syncline underlies the Downey plain and extends southeastward from the north flank of the Bald win Hills through Huntington Park and continues into Orange County. To the southwest, a relatively narrow syncline extends from Santa Monica to Long Beach and forms the structural trough known as the west basin.

The Tertiary and Quaternary rocks dip gently inland and coast­ ward from the crest of the Newport-Inglewood uplift. Along the synclinal axis within the west basin, their thickness ranges from a few thousand to as much as 13,000 feet. Here they overlie a schist base­ inent complex which has been reached by many oil wells (White, 1946; also see Schoellhamer and Woodford, 1951). Southwest beyond the syncline, these rocks are warped over the Torrance-Wilmington anti­ clinal structure and are flexed sharply upward into the Palos Verdes

.Hills·. Along the north flank of the Palos Verdes Hills, a deep fault is

indicated by data from oil-prospect holes, but the Pleistocene rocks at the land surface are not ruptured (Woodring, 1946, p. 110, pls. 1 and 21; Schultz, 1937, fig. 4) except in the local area southeast of Redondo Beach (pl. 2).

Within the Newport-Inglewood uplift and in the two flanking syn­ clines, all rocks older than the alluvial deposits of Recent age are deformed. Also, because the rocks have been deformed- recurrently

**GEOLOGIC STRUCTURE** 67

since Miocene time, the flexure in the Pleistocene rocks is reflected with increasing amplitude in the rocks of Pliocene and late Miocene age. As shown by the contours on the base of the water-bearing zones of Pleistocene age (pl. 2), however, much of the structural deformation has occurred since the time of early San Pedro deposition, chiefly during the so-called mid-Pleistocene revolution, which took place after deposition of the San Pedro formation.

**NEWPORT-INGLEWOOD UPLIFT**

**GENERAL FEATURES**

The Newport-Inglewood uplift is a regional anticlinal fold broken by echelon faults, and extending northwestward from the Newport Mesa to the Beverly Hills, a distance of 40 miles. Throughout its extent within Los Angeles County, it is marked at the surface by the common alinement of Signal, Dominguez, Rosecrans, Baldwin, and the Beverly Hills. The continuity of these five hills is broken by two erosional gaps-Dominguez and Ballona Gaps (pl. 8).

Superimposed on this regional anticlinal structure are successive closed anticlines or domes and intervening structural saddles. The domes and, to a lesser degree, the saddles are broken by discontinuous normal and reverse faults arranged in echelon, many of which do not reach the land surface.

According to Wissler, the Newport-Inglewood uplift has been a zone· of structural activity since Miocene time. Stratigraphic evidence has been presented that indicates recurrent movement along the zone during later Tertiary and Quaternary time. Recent major earth­ quakes-the Inglewood earthquake of 1921 and the Long Beach earth­ quake of 1933-and a minor earthquake in 1941, which damaged several oil wells in the Dominguez oil field, indicate that the zone is still active.

The folds and faults along the Newport-Inglewood uplift at the inland boundary of the west basin form a substantial if discontinuous· barrier to water movement from the main (central) coastal basin to the west basin. For example, the crestal position of the impermeable rocks at the base of the water-bearing zones of Pleistocene age deter­ mines the depth of the lip below which water cannot pass into the west basin. The depth of this lip in the reach south of the Baldwin Hills has been shown on plate *3A.* Also, the discontinuous faults along the uplift have produced ground-water barriers that partly restrain the coastward movement of ground water. This restraint has been produced to a small degree by displacement of water-bearing zones but it is chiefly due to cementation, which has developed along the fault planes. Thus, both folds and faults are critical features in an appraisal of the problem of replenishment to the west basin.

**FOLDS**

Four domal uplifts along the Newport-Inglewood structural zone in the Torrance-Santa Monica area are topographically expressed in order from the southeast by Dominguez, Rosecrans, Baldwin, and the Beverly Hills, respectively. Oil fields have been developed on each of these hills: the Dominguez oil field; the Rosecrans and Potrero fields (near the south and north ends) of the Rosecrans Hills, respec­ tively; the Inglewood field on the Baldwin Hills; and the Beverly Hills field. Consequently, because of the studies incident to the development of each field, much information is available on their subsurface geology.

In general, the land-surface contour of the several domal folds is a moderate replica of the subsurface structure, although the initial land surface on the hills has been modified by erosion.

The structure at Dominguez Hill has been described as follows (Poland, Piper, and others, 1956, p. 96):

The most regular domal structure underlies Dominguez Hill, whose general outer **form** reflects the deeper structural pattern in a subdued degree. Thus, whereas the crest of Dominguez Hill is only about 150 feet above the surrounding plains, the structural relief at the base of the Pleistocene is about 400 feet. [See pl. 2.] According to Grinsfelder (1943, p. 318), mapping on successive strati­ graphic horizons indicates that the effect of the tectonic forces was progressively greater at increasing depth, and that "mapping on horizons as deep as 4,000 feet reveals an elliptical anticline with a northwest-trending axis, steep :flanks on the southwest, with dips of from 15° to 20°." Thus the structural development of this anticline has gone on recurrently through much of Tertiary and Quaternary **time.**

The Rosecrans Hills comprise an irregular low swell about 3 miles wide and 8 miles long extending from Dominguez Hill northwestward to the Baldwin Hills.

Near the south end of the hills, structure contours at a depth of about 4,000 feet reveal three small domes with a northwest alinement which constitute the Rosecrans oil field (Musser, 1925). Musser has inferred that the three domes are separated by minor faults trending northeastward. At shallow depth the inferred faults apparently are absent, and the attitude of the base of the Pleistocene water-bearing zones, about 200 feet below sea level, assumes a somewhat irregular

elliptical shape. The inland and coastward dip of the base of these water-bearing zones is about 2° to 3°.

At the north end of the Rosecrans Hills, the steeper western slope has a nearly straight topographic break parallel with the long dimen­ sion of the hills which marks the surface trace of the Potrero fault (see p. 72). This fault passes through the center of the structure on which the Potrero oil field is developed (Willis and Ballantyne, 1943, p. 310)-an elongated dome whose long axis trends about N. 65°

**GEOLOGIC STRUCTUR·E 69**

W. The top of the producing zones, at the highest part of the dome, is about 3,000 feet below the land surface. At this depth the dips average 8°, whereas at the base of the Pleistocene water-bearing zones,. about 250 feet below the surface (pl. *3A),* the dips are much gentler­ from about 1° to 2°. Impermeable beds underlie these water-bearing zones at a depth of about 50 feet below sea level.

The most pronounced and complex uplift along the Newport­ Inglewood structural zone, at the Baldwin Hills, consists of a north­ westward-trending dome, whose central crest has been dropped between two fault zones (Driver, 1943, p. 308). Of these two fault zones, the easterly one is known as the Inglewood fault (pl. 2). At the depth of the upper oil zone, about 900 feet below sea level, the crest of the dome underlies the SW} sec. 8, **T.** 2 S., R. 14 W., which is about half a mile west of the topographic summit of the Baldwin Hills. The peripheral outward dips generally are less than 20°, except at the northwest edge of the hills, where the dip is 35° to the west (Driver, 1943, p. 308). The uplift is greatest at the northern part of the hills, where the upper division of the Pico formation crops out at the surface (pls. 2, *3A).* Within most of the Baldwin Hills area, the base of the permeable beds of Pleistocene age is above sea level; these beds are non-water-bearing.

The Beverly Hills constitute the northernmost of the domal struc­ tures which mark the Newport-Inglewood uplift. It is a triangular asymmetric dome underlying the northern part of the hills and is elongated in an east-west direction (Hoots, 1931, p. 132-133 and pl. 34); the closure on this structure trapped the oil produced at the small Beverly Hills oil field in the years following 1908. The oil field is now of little importance as a producer. At the oil zone, 2,500 feet below sea level, the dips on the north flank are from 15° to 20°, and are nearly 45° on the south flank. Along the crest of the Beverly Hills, the base of the water-bearing beds of Pleistocene age is less\_ than 200 feet below land surface and from a few feet to as much as 100 feet above sea level.

**FAULTS**

In the area shown on plate 2, the Newport-Inglewood structural zone is broken by four known major faults which, in order from the southeast, are the Cherry-Hill, the Avalon-Compton, the Potrero, and the Inglewood faults. As shown on olate 2, these faults are arranged in echelon, and strike, generally, more northward than the trend of the zone as a whole.

**CHERRY-BILL FA.ULT**

The Cherry-Hill fault, which has a known extent of about 5 miles from the east side of Dominguez Gap to and beyond the southwest.

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flank of Signal Hill, has been discussed in some detail in an earlier report (Poland, Piper, and others, 1956, p. 98). Only the northwestern part of this fault is within the area shown on plate 2.

The Cherry-Bill is a reverse fault, dipping northeast. Land-surface displacement ranges from more than 100 to 40 feet along the south­ west flank of Signal Hill, diminishing northwestward. Near the east edge of sec. 24, T. 4 S., R. 13 W., at the east boundary shown on plate 2, the throw or vertical displacement is about 150 feet (Stolz, 1943, p. 321) at a depth of more than 4,000 feet in lower Pliocene rocks. Extension of the fault northwestward across Dominguez Gap (pl. 2) is based upon information obtained during drilling or prospecting for oil, and from an apparent hydraulic discontinuity in the Silverado water-bearing, zone (pls. 9-12). The fault probably transects all the deposits of Pleistocene age but does not cut the deposits of Recent age.

**FAULTS IN THE DOMINGUEZ HllL AREA**

So far as known, no faults are present in the surface or near-surface deposits in the Dominguez Hill area. Grinsfelder (1943, p. 318) states that the effects of faulting become evident below 4,000 feet, presumably in the Repetto formation of early Pliocene age. From snbsurface studies, Bravinder (1942, p. 390) reported two sets of faults: (1) high-angle faults striking obliquely across the long axis of the dome and (2) south-dipping lower angle thrust faults striking nearly parallel to the axis. Horizontal movement is evident in the oblique set, and the throw is greatest in the Miocene rocks. ·,

Although faults are not known in the Pleistocene deposits along the crest of Dominguez Hill, water levels in wells. tapping those deposits indicate a substantial hydraulic discontinuity across the axis" of the Dominguez anticline, because water levels on the southwest are from 20 to 40 feet lower than 'those on the northeast (pls. 9-12),' The position of this ground water barrier is only roughly defined by the water-level data. The inferred barrier may be caused by near-:­ surface effects of the faulting, ,which is known to have occurred at depth. These near-surface effects may be shear zones characterized either by many minor faults of small displacement, or by systems of tension and compression joints with little or no offset. In ei'ther case, it is believed that cementation along openings caused by these struc­ tures may have produced the ground-water barrier suggested by the differences in water levels. For a discussion of the mechanism of the formation of such cemented zones, the reader is referred to the report on the Long Beach-Santa Ana area (Poland, Piper, and others, 1956, p. 104 and 123).

**AVALON-COMPTON FAULT**

The land-surface trace of the Avalon-Compton fault is 2.25 miles long and extends northward from the *NW¼* sec. 33, T. 3 S., R. 13 W., on the north flank of Dominguez Hill, to the NW} sec. 20, T. 3 S.,

R. 13 W., 0.1 mile west of the intersection of Rosecrans Avenue and

Avalon Boulevard. The fault passes about 500 feet east of the inter­ section of Avalon Boulevard and Compton Avenue and is designated the Avalon-Compton fault in this report. The fault strikes N. 24° W.; the dip of the fault plane is not known. The trace of this fault has been taken along the topographic discontinuity shown on the Compton topographic sheet and is substantiated by hydrologic data. The average land-surface displacement is about 25 feet, with the dropped block on the southwest side. If this fault is similar to other faults

·along the Newport-Inglewood uplift, the throw ·at depth is con­ siderably greater than the vertical displacement at land surface. Well logs are not available, however, to indicate the amount of dis­ pJacement within the Silverado water-bearing zone, or at greater depth. As shown on plate 12, in November 1945 the water levels northeast of the fault were about at sea level, whereas those across the fault to the southwest were about 30 feet below sea level. This evidence demonstrates the effectiveness of the fault as a ground, water barrier.

**FAULTING** IN **THE CENTRAL PART OF THE ROSECRANS RILLS**

The central 4-mile reach of the Rosecrans Hills is beyond the inferred limits of the Avalon-Compton fault to the southeast and the Potrero fault to the northwest (pl. 2). This central reaeh has a relatively steep southwest flank, locally scarred by stream erosion. No rupture of the land surface can be noted. The Rosecrans oil field, which is about 3 miles in length, underlies the southern half of this central reach. The producing beds of the Rosecrans oil field are broken by a general northwestward-trending main shear zone and by many transverse faults, but none of these are known to pass upward into beds younger than the Repetto formation.

Although there is no geologic evidence of faults transecting the deposits· of Pleistocene· age, hydraulic continuity in these deposits is substantially impeded along the approximate position of the ground-water barrier shown on plate 2. So far as known, the most extensive measurements of depth to water in wells in the vicinity of this inferred barrier were made between 1930 and 1932.' In 1932, one or more nearby wells became inaccessible. Accordingly, measure­ ments of depth to water in• 1931 have furnished the .control for the position of ·the barrier as plotted. A straight line drawn to connect the extremities of the Avalon-Compton and the Potrero faults was

found to separate the higher water levels to the northeast from the­ lower water levels to the southwest. In November 1945, the water­ level displacement across this central barrier was about 30 feet (pl. 12). The cause of this barrier is thought to be similar to the one suggested for the Dominguez Hill area; namely, cementation of shear zones, which are believed to be near-surface reflections of major faulting at depth.

**POTRERO FAULT AND ASSOCIATED MINOR FAULTS**

The trace of the Potrero fault, as shown on plate 2, extends about 4 miles northwestward from the west part of sec. 2, T. 3 S., R. 14 W., to the middle of sec. 16, T. 2 S., R. 14 W., in the eastern part of the­ Baldwin Hills, and passes through the Centinela Park well field of the city of Inglewood. The fault is marked at the surface by an escarp­ ment about 50 feet high which extends along the west flank of the Rosecrans Hills for about 2.25 miles. At a depth of 3,000 feet, this fault bisects the dome on which the Potrero oil field is developed.

According to Willis and Ballantyne (1943, p. 310), at the Potrero oil field in sec. 34 the Potrero fault is a zone from 100 to 200 feet wide composed of several minor displacements. The general trend of the fault zone is N. 25° W.; the dip is about 82° to the west at depth, but lessens to about 77° at land surface. The throw at a depth of about 3,000 feet is about 270 feet, with the dropped block on the southwest; Willis states that the horizontal component of the displacement is the more important, because the axis of the dome southwest of the fault appears to have been shifted northwestward 1,200 feet relative to the axis northeast of the fault. At the base of the water-bearing zones of Pleistocene age a depth of about 300 feet below land surface, the throw is probably about 100 feet in the north half of 2/14-34 (pl. 2).

However, about a mile to the north in the Centinela Park well field of the city of Inglewood no vertical displacement across the Potrero fault is indicated by well logs. As discussed on page 139, the Potrero fault is a barrier to ground-water movement; therefore, the hori­ zontal component of the displacement in these younger rocks, although presumed to be considerably less than that which is ap­ parent at depth in the oil zones, must at least have been sufficient to produce fracturing and permit cementation. This barrier may be of a mechanical nature, caused by fracturing and pulverizing of the coarser material along the fault plane to form an impervious zone, or it may be a cemented zone similar to that indicated for other localities. Although it is likely that both processes have occurred, cementation is presumed to have caused the principal barrier features.

Between the Potrero fault on the east and the Inglewood fault on th west, in the 3.6-mile reach from Century Boulevard to Slauson A.venue, six transverse faults are shown on plate 2. The four southerly faults have been plotted about in the position indicated by Grant and Sheppard (1939, fig. 8, p. 321) as interpreted by W. S. W. Kew and Graham Moody, reportedly n topographic evidence (Driver, oral communication, January 1947 . The two northerly transverse faults, in secs. 21 and 16, T. 2 S., R. 14 W., have been plotted on plate 2 as shown by Graham Mood on an unpublished geologic map of the Baldwin Hills, which was m de available through the courtesy of the Standard Oil Co. of Califo nia. The three southerly faults are treated here, and the three to he north are discussed later with the Inglewood fault, which they ap ear to offset.

The most southerly of the inf rred transverse faults, near the

intersection of Crenshaw and Cent ry Boulevards, is indicated by a land-surface displacement of 10-2 feet, and by a creek channel passing westward along this small topographic offset. No substan­ tiating geologic evidence is known However, in well 3/14-3Al, a few hundred feet north of this t ansverse fault and between the Potrero and Inglewood faults, the ter level was about 60 feet below sea level in November 1945, whic was possibly 20 feet lower than water levels in sec. 3, south of the inferred fault (pl. 12). Thus, a hydrologic discontinuity is indicat d and the fault is inferred to be present chiefly on the basis of this ydrologic evidence.

The second inferred transverse fa t, near the north edge of sec. 34 (Manchester Avenue) and about 1 ile long, is suggested by a land­ surface displacement of about 25 fe t, east of the Potrero fault, with the dropped block on the south. owever, logs of wells 2/14-27Pl and 3401, north and south of the fault suggest no displacement at the base of the Silverado water-bea 'ng zone, 220 feet below sea level. Nevertheless, water-level measure ents taken in wells 2/14-27P2 and 3401 in November 1945 were a out 60 and 75 feet below sea level, respectively, suggesting a differen· al in water level across the in- ferred fault of about 15 feet. I

The third inferred fault, which ex ends westward almost across, the center of sec. 27, T. 2 S., R. 14 W., i indicated by a steep northward­ facing bluff and a land-surface displ!cement of about 50 feet, dropped to the north. Logs of water wells in icate a displacement of the water­ bearing zones of Pleistocene age, o about 30 to 50 feet in the same direction (pl. 3). Hydrologic data re not available to show whether a hydraulic discontinuity is present cross this fault.

**INGLEWOOD FAULT AND ASSOCIATED ?,IINOR FAULTS**

The Inglewood fault zone, as shown on plate 2, is about 9 miles long and extends northward from the northern part of the Rosecrans. Hills, across the Baldwin Hills, and beneath the Recent deposits in Ballona Gap. Topographic evidence and a hydraulic discontinuity indicate that the zone extends northward beyond the Beverly Hills. Its continuity is interrupted by many transverse faults and as shown on plate 2, it has seven distinct segments. Within the Baldwin Hills area, the fault pattern is plotted as shown on an unpublished map by Moody; 5 to simplify the structural detail, however, many minor faults are not shown.

The southern segment of the Inglewood fault extends northwest­ ward for about 2 miles to the center of sec. 28, T. 2 S., R. 14 W. In section 28 it is identical with the Townsite fault of Willis (1943,

p. 311-312). In the northern part of the Rosecrans Hills, from a quarter of a mile south to half a mile north of Century Boulevard, a local steepening of the land-surface profile indicates the inf erred surface trace of the Inglewood fault, trending about N. 30° W. How­ ever, subsurface and hydraulic evidence for this segment of the Inglewood fault is much more definitive. Logs of water wells in the central part of Inglewood indicate a vertical displacement of at least 100 feet at the base of the Pleistocene water-bearing zones, with the dropped block to the southwest (pl. 2). Also, in sec. 34,

T. 2 S., R. 14 W., water levels on the northeast side of the fault were about 20 feet lower in November 1945 than levels southwest of the fault (pl. 12).

At the north end of this southern segment, in the *SE!,* sec. 28, T. 2 S., R. 14 W., the trace ends abruptly against a transverse fault about a mile long, which strikes N. 60° E. along a former channel of Cen­ tinela Creek. The characteristics of this fault are not well known; logs of water wells indicate a displacement of about 50 feet between wells 2/14-28Ml and 28El (city of Inglewood, wells 26 and 23), both of which are west of the Inglewood fault. Here the water­ bearing beds are dropped to the south. These wells were drilled about 16 years after Kew (1923, p. 157) wrote that "no stratigraphic evidence is present indicating any faulting in this creek." Thus, the displacement suggested by the logs of these wells, although not con­ clusively demonstrated, constitutes presumed stratigraphic evidence for the existence of this fault. No hydrologic or chemical data are available for confirmation. The trace of the fault has been drawn along the former channel of upper Centinela Creek, according to information supplied by Kew and Moody (Grant and Sheppard,

**a** Moody, G. B., 1935, Surface geology of the Baldwin Hills, Los .Angeles Co unty 1 Calif.1 Report **for**

Standard Oil Co. of California.

1939, p. 321, fig. 8); but because it is believed to pass north of well 2/14-28Ml, the position of its western part has been shifted about 600 feet to the north.

The Inglewood fault, which at the surface is probably horizontally offset slightly to the west by the transverse fault just described, extends 4 miles northward from that fault across the Baldwin Hills. The fault is again horizontally offset, to a small extent, by two other transverse faults in the southern 1.5 miles of this stretch, and trends about N. 10° W. The northern part, about 3.5 miles long, extends over the Baldwin Hills, and trends about N. 25° W.

The fault pattern in the Baldwin Hills area shows that the Ingle­ wood fault is the more easterly of two faults forming a dropped block **or** graben along the crest of the hills (pl. 2). It is broken along this graben by several echelon faults which trend about N. 20° E. The Inglewood fault is marked here by a westward-facing escarpment with a land-surface vertical displacement or throw of about 275 feet (Driver, 1943, p. 308 and fig. 128). Locally in the NE¼ sec. 17,

T. 2 S., R. 14 W., at the top of the producing zones of the Inglewood

oil field, the throw is about 1,000 feet down on the west side, so that that zone is about 2,000 feet below the land surface in the graben and 1,000 feet below the surface east of the fault. Surface and sub­ surface data indicate that the horizontal component of the displace­ ment may be five times as great as the vertical component or throw. The fault dips about 80° west at the surface, and becomes less steep with depth.

About parallel to the Inglewood fault and nearly 1,000 feet to the west, another fault forms the west side of the graben. Like the Ingle­ wood fault, it trends about N. 25° W. and is broken by several echelon faults trending N. 10°-20° E.; it dips about 75° to the east. According to Driver, the throw is about 30 feet at the surface and 100 to 200 feet at a depth of about 2,000 feet. The echelon faults along the graben may have been the result of stresses which caused the large horizontal component of movement along the main Inglewood fault.

Bounding the northeast flank of the Baldwin Hills is an unnamed fault about 2 miles long, trending N. 70° W., which extends north­ westward and is offset by the Inglewood fault (Driver, 1943, p. 308). The dip of the fault plane is not known, but it is reported to be a normal fault with the downthrown block on the north. Data on a few wells south of the fault at its northwest end show that water levels at this point have been maintained about 90 feet above sea level; the underground drainage from the hills evidently has been trapped in the acute dihedral angle between this fault and the Inglewood **fault**

There is substantial evidence north of the Baldwin Hills that the Inglewood fault extends across Ballona Gap with a trend of about

N. 26° W. and is concealed beneath alluvial deposits of Recent age. It has already been indicated that (at the crest of the Baldwin Hills anticline) the Inglewood fault marks the eastern boundary of a graben; the strata at the fault are dropped on its west side. Also, information obtained from a study of well logs in Ballona Gap proves that the water-bearing deposits of Pleistocene age have been dropped on the east side of the fault. Therefore, movement along the Inglewood fault must have been pivotal, with a change from downward displace­ ment on the west in the Baldwin Hills, through a pivot of no displace­ ment, to downward displacement on the east in Ballona Gap. The dip of the fault plane in Ballona Gap is not known.

At the intersection of the Inglewood fault with section *D-D'* (pl. *3D),* the throw is inferred to be about 200 feet. Apparently no move­ ment has occurred along this fault since the beginning of Recent time because the "50-foot gravel" in Ballona Gap shows no evidence of offset.

Evidence that the Inglewood fault affords an effective barrier to ground-water movement through Ballona Gap is shown by the area of flowing wells that existed inland from the fault in 1904 (Men­ denhall, 1905b, pl. 6). More recent water-level data also indicate hydraulic discontinuity. For example, in November 1945 water levels east of the fault in secs. *5* and 6, T. 2 S., R. 14 W., near the Sentney plant of the Southern California Water Co., were as much as *50* to 70 feet below water levels west of the fault (pl. 12).

The trace of the Inglewood fault tentatively has been extended across the eastern part of the Beverly Hills on the basis of an eastward­ facing escarpment about 70 feet high, trending N. 25° W., and alined with the fault trace across the Baldwin Hills. If the assumption is correct that this escarpment marks the surface trace of the northward extension of the Inglewood fault, the fact that there is no displace­ ment of Recent beds, and that the strata of late Pleistocene (Palos Verdes) age are displaced, dates the last movement along this fault as occurring in latest Pleistocene time.

The northern limit of the Inglewood fault is not known. However, this shear zone does not extend to the older rocks in the Santa Monica Mountains.

**FAULTS IN BALLON.A. GAP**

Two faults in Ballona Gap that arenot associated with the Newport­ Inglewood uplift, but which have a strong influence on ground­ water circulation, are the Overland Avenue and the Charnock faults (pls. 2 and *3D).* Both faults have been located by well-log and water-

**GEOLOGIC STRUCTUR-E 77**

level data. They bound the east and west sides of a dropped block or graben. Both have been shown on the water-level contour maps of the Los Angeles County Flood Control District since 1938 (Bau­ mann and Laverty, 1940, map 9).

The Overland Avenue fault, so named in this report because its inferred trace nearly coincides with Overland Avenue in Culver City, is about 6 miles long and trends N. 30° W. It extends from the southwestern part of the Baldwin Hills northwestward across Ballona Gap, and across the southwest lobe of the Beverly Hills (pl. 2). Logs of wells indicate that where it crosses section *D-D'* (pl. *3D)* in sec. 12,

T. 2 S., R. 15 W., the vertical displacement is about 30 feet, with the dropped block on the west.

The well logs and water-level data indicate the fault extends 1.5 miles northwest of the Beverly Hills lobe over a part of the small alluvial plain, which is tributary on the north to Ballona Gap. Also, hydrologic evidence supported by subsurface data, indicate that the fault extended southeastward across sec. 19, T. 2 S., R. 14 W. Logs of wells 2/14-1901 and 1902 on the west side of the fault, and well 2/14-18F2 on the east side, indicate a displacement of several tens of feet at the base of.the water-bearing deposits.

Although the attitude of the Overland Avenue fault is shown to be vertical in plate *3D,* the true direction and magnitude of the dip of the fault plane are not known.

For the past 15 years the water levels on the east side of the Overland Avenue fault have remained 60 to 100 feet above those on the west side; this fact indicates the effectiveness of the fault as a ground-water barrier (pls. 9-12).

The Charnock fault has been so named in this report because it passes immediately west of the Charnock well fields of the city **of** Santa Monica and the Southern California Water Co., in the NW}i, sec. 11, T. 2 S., R. 15 W. The fault trace trends about N. 35° W. (nearly parallel to the Overland Avenue fault) and extends from the north border of the El Segundo sand hills 6 across Ballona Gap and through the alluvial narrows between the Ocean Park plain and the Beverly Hills. Water levels in wells and well-log data indicate that the north end of the fault trends in a more northerly direction (about N. 5° W.).

The attitude of the Charnock fault is not known; it is shown to be vertical in plate *3D* (as was done in the case of Overland Avenue and the Inglewood faults). The trace of the fault is concealed beneath deposits of Recent age for almost its full extent on plate 2, but the

* The California Division of Water Resources in its investigation for the adjudication concluded from additional information that the Chamoek fault extends south to Redondo Beach Boulevard in tbe vicinity **of** Gardena and so describe it in their report (1952, p. 93 and pl. 4).

throw is as much as 140 feet at the base of the San Pedro formation, with the dropped block to the east.

Hydraulic discontinuity is apparent across the Charnock fault, as shown by water-level contours on plates 9-12. For example, in November 1945, water levels east of the fault were as much as 50 feet below sea level, and were about 40 feet below those on the west.

The absence of land-surface displacement along the Charnock and Overland Avenue faults suggests that movement along these faults has not taken place during Recent time. The "50-foot gravel" of Ballona Gap is not known to be cut by either of these faults and thus it is believed that they have not produced any barriers to movement of water in this aquifer. As noted earlier in this report, all observable displacement along faults of the Newport-Inglewood structural zone occurred before Recent time, although movement is still taking place at depth.

The marked hydraulic discontinuities across the Charnock and Overland Avenue faults are caused in part by displacement of the water-bearing deposits against impermeable silt and clay beds. How­ ever, it is probably true that cementation within the fault zones has been responsible for much of the effectiveness of these ground-water barriers.

**GROUND-WATER HYDROLOGY**

**REGIONAL GROUND-WATER CONDITIONS**

The coastal plain in Los Angeles County is divided into two distinct ground-water basins by the Newport-Inglewood uplift, which extends from Beverly Hills southeastward to Signal Hill and beyond into Orange County. To the northeast the main (or central) coastal basin covers about 500 square miles in Los Angeles and Orange Coun­ ties and currently (1948) yields about a third of a million acre-feet of ground water annually-about four-fifths of the water pumped from the entire coastal plain. To the southwest of the uplift, the west basin currently (1948) yields about 90,000 acre-feet a year, or about one-fifth of the total pumpage of ground water from the coastal plain. At least three distinct bodies of ground water occur in these two basins. In downward succession they are: (1) a body of shallow unconfined and semiperched water which occurs in the upper part of the alluvial deposits of Recent age within the several gaps and inland beneath most of the Downey plain, also in the upper Pleistocene deposits beneath the Torrance plain and along the flanks of the uplift;

{2) the principal body of fresh ground water, which occurs chiefly in the lower division of the alluvial deposits of Recent age, in nearly all the deposits of Pleistocene age, and in the uppermost part of the

underlying Pliocene rocks; and (3) a body of saline connate water underlying the principal fresh-water body throughout the area.

Within the coastal plain in Los Angeles County, essentially all the water current]y withdrawn from wells is pumped from the principal water body. Accordingly, in following paragraphs a brief statement is presented to outline the occurrence and circulation of ground water in this body and to furnish a general background preliminary to the detailed discussion of ground-water occurrence in the west basin treated in following sections of the report.

The sediments in the main coastal basin in Los Angeles County consist chiefly of the coalescing alluvial fans of the Los Angeles River and the San Gabriel River (including the Rio Hondo) systems (pl. 1). The alluvial fans, which were laid down in a synclinal trough, com­ prise tongues and lenses of sand and gravel, interbedded with silt and clay. The lenses or tongues of gravel and coarse sand are largely the channel deposits of the major streams; the fine sand, silt, and clay **are** chiefly flood-plain deposits carried to the interstream areas during flood stage. Beneath most of the Downey plain the alluvial deposits are at least 1,000 feet thick, near the axis of the synclinal trough­ along a line through Huntington Park and Santa Ana-the deposits are as much as 3,000 feet thick. Most of the alluvium was deposited in early Pleistocene time, thus forming the San Pedro formation.

During most of the Pleistocene epoch, the shore of the alluvial plain in this central reach was nearly parallel to a line between Watts and Los Alamitos. Here the alluvial-fan deposits interfinger with lagoonal deposits of low water-yielding capacity. In effect, these lagoonal deposits produce a partial lithologic barrier to the free coast­ ward movement of the ground water. About a mile or two farther coastward, the lagoonal deposits merge with beach and shallow marine deposits--extensive, thick layers of sand and gravel that constitute the inland margin of the highly productive Silverado water-bearing zone. In the reach from the Baldwin Hills to Signal Hill, the Silverado water-bearing zone extends across the crest of the Newport-Inglewood uplift and southwest to the present coast thus underlying the greater part of the west basin.

Three highly permeable aquifers within the deposits of Recent age that overlie the Pleistocene deposits and locally extend to depths of as much as 100 to 150 feet below land surface are: (1) The Gaspur water-bearing zone, which extends from Whittier Narrows to Terminal Island; (2) the westerly arm of the Gaspur zone, which extends from the Los Angeles River Narrows to a juncture with the main Gaspur water-bearing zone at Compton; and (3) the "50-foot gravel," whose east end is in hydraulic continuity with the westerly arm of the Gaspur water-bearing zone, extends w stward through Ballona Gap to the

ocean. (See pl. 8 for extent of these water-bearing zones of Recent age within the Torrance-Santa Monica area.)

These extensively continuous and highly permeable aquifers are not typical alluvial-fan deposits. They are trains of gravel and sand laid down in valleys eroded in the Pleistocene deposits and were deposited contemporaneously with a rise in sea level. They form unbroken ground-water arteries or conduits from the intake areas to the ocean­ in fact, they extend inland beyond the intake areas of the coastal plain, and through the passes to the inland valleys. They range in width from 1 to 6 miles; the Gaspur water-bearing zone is at least 20 miles long.

The principal body of ground water is unconfined only within the intake areas, which extend a few miles coastward from the Whittier and Los Angeles Narrows. Most of the recharge to the principal body takes place in these areas of unconfined water, by- influent seepage from the major streams, by penetration of rain and irrigation water, and by underflow from the interior basins. .Also, since 1938 recharge has taken place by percolation from the spreading basins along the Rio Hondo and the San Gabriel River about 3 miles coast­ ward from Whittier Narrows.

Under native conditions of circulation the ground water moved generally oceanward from the intake areas, but chiefly under con­ finement. Coastward, beyond the intake areas, beds of silt and clay intervene between the successive water-bearing members and cause hydraulic discontinuity between those members. Such discon­ tinuities generally are slight within the intake areas but they become more extensive toward the Newport-Inglewood uplift. Movement of water is most rapid in the coarsest materials-such as the materials that constitute the Gaspur water-bearing zone of Recent age and the more permeable members of the San Pedro formation. Under the hydraulic gradients from 5 to 10 feet to a mile, which initially pre­ vailed throughout much of the coastal plain, movement is compara­ tively rapid in coarse deposits. However, the movement, probably is not more than a mile every few years. .Although movement is much slower through materials of finer texture, it probably takes place to some extent in all but the finest grained clay. Thus, the fresh water in the principal water body occupies and moves through a succession of water-bearing members that are contained in the vertical range **of** the alluvial deposits of Recent age and all the deposits of Pleistocene age. To a lesser extent, fresh water may move through the upper part of the Pico formation, but movement through these deposits presumably, is very slow.

The oceanward movement in the principal fresh-water body is

greatly impeded along the Newport-Inglewood uplift. There, owing

to substantial barrier features (cemented fault zones), -the impedance under native conditions was sufficiently effective to produce a belt of flowing wells (the artesian area of Mendenhall) extending inland to the intake areas and occupying nearly two-thirds of the main coastal basin (Mendenhall, 1905b, pl. 1). The hydrostatic head so developed· cause very high pressure in early wells. In the famous Bouton wells 2 miles north of Signal Hill (drilled about 1895), sufficient pressure heads were reached to raise the water level in casings 80 feet above the land surface or about 150 feet above sea level. These high pressures caused substantial leakage from the deeper water-bearing zones by upward movement in fracture-zone conduits adjacent to the master faults. At several places along the uplift, perennial springs occurred at the inland side of the master faults. For example, in Inglewood and immediately inland from the Potrero fault, a spring is reported to have discharged water perennially into the head of Centinela Creek. This spring ceased to flow about 1900. Also, in. Long Beach two perennial springs have been described (Brown, 1944,

p. 2), both associated with and immediately inland from the faults of the Signal Hill uplift. These springs ceased to flow after pres13ur levels in the main coastal basin were lowered below land surface by increasing withdrawals.

Under natural conditions of high7water level inland from the uplif , a substantial part of the repl uishment to the main coastal basin in Los Angeles County passed across the -uplift as underflow into the west basin. This underflow moved coastward in the confined aquifers, within the west basin, chlefly in .the Silverado water-bearing zonQ of. the Torrance-Inglewood subarea and in aquifers of correlative age to the north, but also in shallower Pleistocene:110.quifers, and in those **of** Recent ag the Gaspur water-bearing zone of Dominguez Gap and the "50-foot gravel" of Ballona Gap In addition to the underflow, recharge from rainfall contributed to the ground-water supply of the west basin.

The Los Angeles River and Ballona Creek did not furnish recharge directly to the west basin under native conditions because they were­ effiuent within its extent and hence functioned as channels for ground­ water discharge. Most of the discharge, however, was by direct escape from the aquifers extending beneath the ocean. Such· dis­ charge was into Santa Monica Bay along the west coast from Santa Monica to the Palos Verdes Hills, especially southward from Redondo - Beach; discharge also occurred into San Pedro Bay at the south end of Dominguez Gap, probably largely from the Gaspur water-bearing zone.

The pressure or piezometric surfaces of all aquifers in the west· basin under native conditions were below the land surface everywhere

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except (1) near the coast in Balloiia Gap, and (2) locally in and near Dominguez Gap, as registered in four wells that w re flowing in 1904. In Ballona Gap in 1904 the area of artesian flow as shown by Menden­ hall (1905b, pl. 5) extended over about 3 square miles, chiefly in secs.- 21, 22, 23, and 27, T. 2 S., R. 15 W. Within this area, almost the entire, land surface is less than 10 feet above sea level.

The decline in water level which has occurred in the main coastal basin within the past three decades, 'has been nearly matched by a similar decline on the coastal side of the uplift (within the west basin); therefore, the local pressure differential has remained almost equal. However, the decline along the crest o·f the uplift has been many tens of feet; it has dewatered a part of the water-bearing conduits and the over-all escape from the main :basin to the west basin has been decreased substantially. Thus, the changes in water level that occur within the main basin are critical in determining the quantity of replenishment that may be contributed to the west basin by under­ flow across the uplift.

For the main coastal basin and especially for the coastal reach from Dominguez Hill southeast to Newport Beach,· the interpretive reports of the Geological Survey on·the Long Beach-San ta Ana area have treated in some detail the occurrence and circulation of ground water, the increasing withdrawals, the drawdown of the water level that has developed, the nature and sources of saline contamination, and the character of the Newport-Inglewood uplift as a barrier to water movement. Other sections of this·report will treat elements of somewhat similar scope within the west basin.

**GROUND WATER** IN **THE WEST BASIN**

**SEMIPERCHED WATER BODY**

**OCCURRENCE**

The semiperched and unconfined water body occurs rather widely in the west basin in deposits less than 100 feet below the land surface. It is the first water reached by wells but is utilized only locally. In Dominguez Gap it is contained within the upper 20-50 feet of the Recent deposits in layers of fine sand and. silt of low permeability. In Ballona Gap it occurs in deposits of similar age and physical character, but here the semiperched body commonly does not extend more than 20 to 30 feet below the land surface. Beneath the Torrance plain, this body occurs very widely in the uppermost Pleistocene deposits. About in the south-central part of the Torrance plain, where it is tapped by nearly 100 wells, the semiperched body extends to depths of as much as 80-100 feet. Thus, here it is about twice as thick as within the two flanking gaps.

Although this water body has frequently been referred to as perched' water in local usage, in reality it is semiperched. According to. Meinzer (1923, p. 40-41),

ground water is said to be *perched* if it is separated from an underlying body of ground water by unsaturated rock [including unconsolidated materiall. Perched water belongs to a different zone of saturation from that occupied by the under­

lying ground water. \* \* \* Ground water may be said to be *semiperched* if it has

greater pressure head than an underlying body of ground water, from which it is, however, not separated by any unsaturated rock. Semiperched water belongs to the same zone of saturation as the underlying water, and therefore where it occurs there is only one water table, which may be called a *serniperched water table.* Semiperched water, like perched water, is underlain by a negative confining bed of either permeable or impermeable type. The underlying water has subnormal head.

Nearly everywhere within its extent in the west basin, the static level of the semiperched water body is higher than the pressure head of the underlying body of fresh ground water. Also, it is generally separated from the underlying water by more or less impermeable layers of silt and clay.

The semiperched water body beneath the Torrance plain is replen­ ished principally by infiltration of rain and of runoff temporarily ponded by overflow from Dominguez Channel and by infiltration of irrigation water. Under native conditions in Dominguez Gap the· semiperched body discharged to the Los Angeles River. For the last three decades, however, the water table has been at a lower altitude than the channel of the Los Angeles River, and the body is replenished in part by influent seepage from the river. Stream-gaging records are not adequate to define the small quantity of river loss involved· but measurements in shallow wells show a ground-water mound beneath the river channel. Also, a study of saline contamination in Dominguez Gap has suggested that since about 1930 the average contribution of saline water from the Los Angeles River passing through the semiperched body to the Gaspur water-bearing zone has been at least 90 acre-feet per year (Piper, Garrett, and others, 1953,

p. 190). Thus, it is inferred that the over-all annual recharge to the semiperched body has been substantially more than 90 acre-feet per year. In Ballona Gap under native conditions the ground-water body fed the creek along nearly the full reach of the gap. Within the west basin under the current conditions of depressed water level, the semi­ perched water doubtless has been and now is replenished in part by seepage from Ballona Creek. Immediately inland from the Ingle­ wood fault, however, even though the pressure head in the underlying San Pedro formation has been drawn down below sea level since the early thirties (pls. 9-12), the semiperched water body is known to

have discharged water to Ballona Creek as late as 1932, from a spring

in 2/14-5M (pl. 17, loc. 5).

**UTILITY**

Almost everywhere within its extent, the semiperched water was greatly inferior in chemical quality to the underlying fresh water under native conditions. Locally in Dominguez Gap, its quality has dete­ riorated substantially in the past two decades, either from landward movement of ocean water or by addition of industrial wastes and oil­ field brines. The changes in chemical quality of the semiperched water in Dominguez Gap have been discussed at length in an earlier report (Piper, Garrett, and others, 1953, p. 173-177); the chemical quality of the semiperched water elsewhere in the west basin is discussed on page 175 of this report.

Because of the general inferior quality of the semiperched water, and because wells of large capacity cannot be obtained, little water is withdrawn from it. In Dominguez and Ballona Gaps, few wells pro­ duce water from this body. However, beneath the Torrance plain in the Gardena area, the semiperched water in the uppermost Pleisto­ cene deposits is tapped by about 100 wells which range in depth from 25 to 100 feet. The area of this development is south of Rosecrans Avenue and north of 190th Street, and extends eastward from Haw­ thorne Avenue about 5 miles to Avalon Boulevard. From information obtained during the well canvass, it is concluded that about half of the wells, or about 50, are used chiefly for irrigation; of the remainder, some are used exclusively for domestic supply but most are used jointly for irrigation and domestic supply. Many of the wells are equipped with windmills. The yield of these wells commonly is only a few gallons per minute, and the irrigated gardens usuallydo not exceed half an acre in extent. Accordingly, it is estimated that the over-all draft from the 100-odd wells is about 50 acre-feet a year.

**DECLINE OF WATER LEVEL**

Throughout the known extent of the semiperched water body, its water table has declined 10 to 20 feet since 1904, the time of earliest. record. For example, in Dominguez Gap in 1903-4-essentially under. native conditions of head-the water table of the semiperched body ranged from 5 to 8 feet below land surface throughout the gap, and coincided closely with the pressure level of the underlying Gaspur water-bearing zone. In 1946· the depth to the water table ranged from 15 to 25 feet; and again it was about coincident with the pressure level in the Gaspur water-bearing zone. Thus, in about 40 years the water table of the semiperched body had declined as much as 10 to 15 feet in Dominguez Gap. Because a coincident decline occurred in the pressure level of the Gaspur water-bearing zone, it is concluded

that there is appreciable hydraulic continuity between the two water bodies. Because the pressure level in the G.aspur zone was drawn down by heavy withdrawals (especially in the twenties and early thirties), water percolated downward from the semiperched body and its level declined accordingly. This conclusion has been substantiated by study of the nature and development of saline contamination \_ within the Dominguez Gap (Piper, Garrett, and others, 1953, p. 167-169). ,

In the Gardena area in 1904 the semiperched water table ranged from 10 to 25 feet below land surface about 15 to 25 feet above sea level. Since 1929 periodic measurements have been made in a few wells tapping the semiperched body in this area. (See hydrographs for wells 3/14-25E2 and 25K3, fig. 5.) The water table at or near these wells was 22 feet above sea level in 1904 (from Mendenhall); 15 feet in 1929; 12 feet in 1936; and 14 feet in 1945 (high level for each respective year). Thus, this water table has had a net decline of about 8 feet in 40 years. In 1904 the pressure levels in nearby wells tapping the "200-foot sand" and the Silverado water-bearing zone, respectively, were nearly coincident with the semiperched water table, but they have been drawn down progressively until in 1946 they were about 30 and 50 feet below the semiperched water table (fig. 5). Presumably, the 8-foot lowering of the water table in 3/14-25E has occurred in part by slow percolation from the semiperched body to the underlying aquifers. However, this change in storage in the semi­ perched body has been distributed over many years, and the contain­ ing deposits have a low specific yield.7 Also, some part of the lowering may represent drawdown by withdrawals from the sha1low wells of the Gardena area., For these reasons, change in storage in the semi­ perched body is considered to have been negligible in its relation to problems of replenishment to the principal water body.

**PRINCIPAL WATER BODY**

**OCCURRENCE**

**EXTENT AND THI KNESS**

The principal body of fresh ground water underlies almost all the Torrance-Santa Monica area, and occurs beneath all of the west basin except the crestal part of the Baldwin Hills and certain con­ taminated areas along the coast. It extends downward from the base of the semiperched water body to 'the top of the body of saline connate water. This fresh-water body occupies: (1) the lower division of the deposits of Recent age-that is, the G spur water-bearing zone

7 The specific yield of a water-bearing deposit is de'i.ned as the ratio *Qf* (1) the volume of water which the saturated mRterial will yield by gravity to (2) its own voluma, This httio ls st'ated as a per<:entage.

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and the "50-foot gravel" where these are uncontaminated; (2) the unnamed upper Pleistocene deposits, in which the principal aquifer is the "200-foot sand"; (3) the San Pedro formation of ear]y Pleistocene age which, in the Torrance-Inglewood subarea, contains (a) an inex­ tensive upper aquifer, the "400-foot gravel", and (b) the underlying thick and very extensive Silverado water-bearing zone; and (4) most of the upper division of the Pico formation of late Pliocene age, except in the Culver City area where the sand members in the upper division of the Pico either are absent or, if present, commonly contain brackish to saline waters.

The depth to the base of the principal fresh-water body has been shown on plate 8. Its over-all thickness is indicated generally by the contours of that map because its top is within a few tens of feet of sea level in almost all of the west basin except along the crest of the Newport-Inglewood uplift and along the flank of the Santa Monica Mountains where its top rises to as much as 200 to 300 feet above sea level.

The upper division of the Pico formation is not tapped by water wells at the present time. Hence, the thickness of the principal water body now utilized is indicated by the contours drawn on the base of the water-bearing deposits of Pleistocene age (pl. 2). In the Tor­ rance-Inglewood subarea, these contours define the base of the Sil­ verado water-bearing zone; in the Culver City subarea, they define the base of the essential correlative of the Silverado water-bearing zone-that is, the main water-bearing zone within the San Pedro formation. As shown by that map, throughout much of the west basin the thickness ranges from 200 to 700 feet but it reaches a maxi­ mum of about 1,200 feet near the intersection of Alameda and Carson Streets in Dominguez Gap, at the deepest part of the syncline.

Along the crest of the Newport-Inglewood uplift the thickness of the water-bearing deposits *now* tapped by wells varies widely. As shown by plate *3A,* the thickress ranges from a feather edge on the crest of the Baldwin Hills to 700 feet in Dominguez Gap. Specifically, along the line of section *A-A'* (pl. *3A),* these water-bearing deposits are about 330 feet thick in Inglewood, thin to 250 feet at the north end of the Rosecrans Hills, thicken irregularly southeastward to about 600 feet at the south edge of the Rosecrans Hills and beneath the crest of Dominguez Hill, attain a maximum thickness of 700 feet in Dominguez Gap, and thin to about 200 feet beneath Signal Hill.

Along the coast the thickness of the water-bearing deposits tapped by wells is somewhat more uniform although it increases substantially from north to south (p1. 30). These deposits are from 200 to 250 feet thick from Santa Monica to Playa del Rey, thicken to as much as 350 feet at El Segundo, thin to 200 feet at Manhattan Beach, thicken

to 500 feet in the Redondo Beach area, and then thin to a featheredge along the north flank of the Palos Verdes Hills. The thicknesses here cited do not include the deposits of dune and beach sand that blanket the coast from Playa del Rey to the Palos Verdes Hills and extend from a few tens of feet above sea level to altitudes as much as 244 feet. For the several water-bearing zones within the principal water body, general physical character, water-bearing character, extent, thickness, and depth below land surface have been discussed in the geologic section of this report. The quantity of water withdrawn

from them is discussed on pages 99-111.

**CONFINED AND WATER-TABLE CONDITIONS**

Within most of the west basin, the water-bearing zones within the principal water body are separated by substantial thicknesses of relatively impermeable silt or clay. These features have been shown on the gelologic sections previously introduced. The beds of silt or clay confine the water in the several aquifers and prevent free circula­ tion from one to another. For example, between Hawthorne and Gardena, near the axis of the syncline, along the line of section *B-B'* (pl. *3B),* the "200-foot sand" is separated from the "400-foot gravel" by 50 to 100 feet of silt or clay; and a similar thickness of silt or clay separates the "400-foot gravel" from the Silverado water-bearing zone beneath.

In the Torrance-Inglewood subarea, the water in the several aquifers is almost wholly confined by impermeable d posits, except to the south of Playa del Rey and near Redondo Beach (pl. 11), where a water table occurs. Near Playa del Rey, the water table is in the main water-bearing zone of the San Pedro formation; the top of this water­ bearing zone here rises as high as 30 feet above sea level and the con­ fining beds feather out westward in the vicinity of Lincoln Boulevard. West of Lincoln Boulevard and south nearly to Imperial Highway, the main water-bearing zone is directly overlain by permeable beach and dune deposits. Hydrographs introduced later in this report.sug­ gest that rainfall passes through these overlying permeable beds directly into the main water-bearing zone (p. 124).

In the Redondo Beach area, south of 190th Street (boundary be­ tween Tps. 3 and 4 S.) and west of the center of the city of Torrance, the confining beds that separate the Silverado water-bearing zone and the "200-foot sand" to the east and north are not present (pl. 5). In this area the permeable deposits of Pleistocene age rise above sea level and a water table occurs in what is inferred to be the Silverado water­ bearing zone, although its upper part may represent the westward extension of the "200-foot sand."

. In the area south of Sepulveda Boulevard and east of Narbonne Avenue, water-table conditions exist in the "200-foot sand," extend eastward about to Alameda Street and beneath much of the Wilming­ ton area. Here, however, the "200-foot sand" is separated from the Silverado water-bearing zone by relatively impervious deposits and from west to east the water table in the "200-foot sand" stands progressively higher than the pressure surface of the Silverado zone. Elsewhere within the Torrance-Inglewood subarea, the ground water in the Silverado water-bearing zone is wholly confined and in the "200-foot sand" it usually occurs under confined conditions. In the Culver City subarea the water in the main water-bearing zone of the San Pedro formation commonly is confined, except locally along the north edge of Ballona Gap from the Charnock fault west to the coast in the Charnock subbasin north of the Charnock well fields, and from the Overland Avenue fault east at least to and

beyond the wells in 2/15-lC (pl. 2).

**SOURCE AND MOVEMENT METHOD OF INVESTIGATION**

The source of ground water commonly is indicated by the direc­ tion of movement. Water generally moves from areas of recharge to areas of discharge. If the water-bearing deposits are homogene­ ous, the altitude of water level in a number of wells measured within a short span of time can be utilized to construct a map showing contours on the water table or the piezometric surface. Such a map shows conditions of head from place to place. Movement is at right angles to the contours, which connect points of equal altitude on the water table or the piezometric surface. The rate of movement is proportional to the hydraulic gradient and the permeability of the deposits.

As already discussed, the water-bearing deposits in the west basin do not occur as a homogeneous permeable mass but are stratified in several fairly distinct aquifers which are separated at most places by confining layers. Initially the pressure levels in all the water­ bearing zones were at about the same altitude. Through the period;' of use, and largely because of inequalities in draft and replenishment, differences have developed in the pressure levels of the several aquifers. At some places, the maximum differential in water level in shallow and deep aquifers in 1946 was as much as 70 feet. Thus, in order · to draw contours on the piezometric surface or water table for a single aquifer, only levels for wells tapping that aquifer can be uti­ lized. A water-level contour map drawn from levels in random wells tapping more than one aquifer would be misleading and inac,-

curate and could not be used to determine direction of movement, or source of water.

Within the west basin, the Silverado water-bearing zone south of the Ballona escarpment and its essential correlative to the north currently yield about 90 percent of the ground-water withdrawal, including nearly all the pumpage for industrial use and about 90 percent of the pumpage for domestic use. Thus, with respect to conditions of replenishment and saline contamination, the changes in the form and position of the piezometric surface in these composite water-bearing zones of the San Pedro formation are critical, and the changes in water level in overlying aquifers are of minor importance. Water-level contour maps showing conditions in 1903-4 and in March 1933 (pl. 9), in April 1941 (pls. 10, 11), and in November 1945 (pl. 12), have been included in this report. Each of these water-level contour maps has been drawn from water-level altitudes in wells tapping the San Pedro formation-that is, the water-bearing zones most intensively utilized. Within almost all the Torrance­ Inglewood subarea, the water levels utilized for the maps were those in wells tapping the Silverado water-bearing zone; in the Culver City subarea the water-level data were from wells tapping the main water­ bearing zone of the San Pedro formation, the essential correlative of the Silverado water-bearing zone; and inland from the west basin, water levels were from the deeper wells tapping the Silverado or

equivalent water-bearing zones of Pleistocene age.

In preparing the water-level contour maps, measurements of depth to water were utilized from all possible sources. For the maps of 1933 and 1941, measurements were made chiefly by the Los Angeles County Flood Control District and by the Los Angeles Department of Water and Power; for the map of 1945, most of the measurements were made by the Flood Control District and by the Geological Survey. All measurements made by the Geological Survey during the cooperative investigation are being published in the annual reports on water levels and artesian pressure in the United States for the years 1944, 1945, and 1946 (U. S. Geol. Survey). The scope of the measurements is discussed on page 112.

Altitudes of measuring points for most of the observation wells in the Torrance-Santa Monica area have been determined by instru­ mental leveling. For the area immediately west of Long Beach, in

T. 4 S., **R.** 13 **W.,** altitudes for many of the wells were determined by the Geological Survey in 1941-42 through a third-order level net anchored to bench mark "tidal 8" in the Los Angeles Outer Harbor, and by additional levels with transit and stadia or with alidade and level rod, tied to the third-order net (Meinzer, Wenzel, and others, 1944, p. 87-88). In the remainder of the area, altitudes of measur-

ing points for most of the observation wells have been determined by levels of the Los Angeles Department of Water and Power, and these were utilized wherever available. For a few wells, altitudes of measuring points have not been determined instrumentally; how­ ever, these altitudes have been interpolated from topographic maps o(the Geological Survey having a 5-foot contour interval.

**MOVEMENT IN THE TORRANCE-INGLEWOOD SUBAREA**

*Conditions in* 1903-4.-Water-level contours for 1903-4 are plotted on plate 9 for the southern two-thirds of the project area-essentially the Torrance-Inglewood subarea. These contours were constructed from data obtained by Mendenhall and show substantial modifica­ tion from his water-level contours (Mendenhall, 1905b, pl. 5). The revision has developed for two reasons: (1) The altitude of land sur­ face at the wells measured during the Mendenhall field canvass has been re-interpolated because of recent Geological Survey topographic

. maps with a land-surface contour interval of 5 feet; in the Torrance area especially, the topography on the later map (1934 edition) differs considerably from that shown by the survey of 1894, which was published with a land-surface contour interval of 25 feet and was the basis for the well altitudes interpolated by Mendenhall.

1. Insofar as possible, only water levels in wells tapping the Silverado water-bearing zone have been utilized in redrawing the water-level contours, whereas the contours of Mendenhall were generalized from all available water levels, including many levels for wells tapping shallower zones.

The reconstructed water-level contours of 1903-4 show coastward movement of ground water across the Newport-Inglewood uplift and a hydraulic discontinuity from about 40 to 50 feet across the inland boundary of the west basin along the 14-mile reach from the Baldwin Hills to Long Beach. Within the west basin movement was also generally coastward. East of Manhattan Beach the 20-foot contour bulges seaward, indicating a flattening of the hydraulic gradient and a diversion of part of the ground-water flow to the northwest and to the south. This configuration of the pressure surface suggests that the known thinning of the Silverado water-bearing zone near the coast at Manhattan Beach (fig. 2) retarded discharge of ground water to the ocean. However, in the vicinity of Manhattan Beach, the dune topography is rough and hilly; and the locations of the wells shown by Mendenhall can be plotted only approximately on the revised topo­ graphic map of the Torrance quadrangle. Hence, the computed alti­ tude of the water surface is subject to possible errors of several feet and the contours based on these altitudes are only approximations and are not suitable for exact interpretations.

From Manhattan Beach northward to Playa del Rey, the movement of ground water was westward; inland from Sepulveda Boulevard the coastward gradient was from 6 to 8 feet per mile. Near the coast, however, the gradient was only about 3 feet per mile.

Southward from Manhattan Beach to the Palos Verdes Hills, the movement was generally westward to the coast; from the Palos Verdes Hills to Long Beach the movement was southward. The coastward gradient in 1903-4, both westward toward Redondo Beach and southward toward San Pedro Bay, was about 4 feet per mile.

Thus, the contours of 1903-4 suggest escape of ground water beneath the ocean offshore from Redondo Beach and beneath San Pedro Bay. Although fresh-water springs were reported in San Pedro Bay, under native conditions, these are believed to have developed by escape of water from the ocean-bottom outcrop of the Gaspur water-bearing zone (Poland, Piper, and others, 1956, p. 50). However, escape f,rom the Silverado water-bearing zone under native conditions by upward movement into San Pedro Bay cannot be substantiated by such direct evidence. The writer has heard reports of former fresh-water springs offshore from Redondo Beach but these have not been verified. If such springs did occur, they must have been fed by discharge from the

.Silverado zone.

From the geologic relations, it would seem that escape could have occurred with much greater facility in the vicinity of Redondo Beach than beneath San Pedro Bay (pls. 5 and 6). If the permeability of the Silverado water-bearing zone is assumed to be about 1,300 gpd per square foot (about two-thirds as great as in the area east of Torrance, as indicated by comparison of yield factors from table 5), the ocean­ ward discharge in the Redondo Beach area under native conditions can be estimated by use of the equation ·

*Q- -P1 X I X A ,*

where *Q* is gallons per day; *P1* is the field coefficient of permeability defined as the number of gallons of water per day that would be con­ ducted through each mile width of the water-bearing bed for each foot of thickness of the bed and for each foot per mile of hydraulic gradient; *I* is the hydraulic gradient in feet per mile; and *A* is the cross­ sectional area of the water-bearing material in foot-miles. The average thickness of the Silverado water-bearing z·one between Her­ mosa Beach and the Palos Verdes Hills is about 400 feet and the dis­ tance about 3.5 miles; thus the estimated discharge Q-1,300X4X 400X3.5, or about 7.3 mgd, equivalent to about 11 cfs. The presumed gradient of 4 feet to the mile at Redondo Beach is conservative; coast­ ward from the 10-foot water-level contour, a steeper gradient is

suggested by the altitudes of water level in random wells. Because the local control is poor, however, the regional coastward gradient of about 4 feet per mile was .utilized in computing the estimate for seaward escape in the Redondo Beach area as of 1903-4. Thus, the annual discharge to the ocean between Hermosa Beach and the Palos Verdes Hills in 1904 is estimated to have been about 8,000 acre-feet per year.

North from Hermosa Beach to Playa del Rey and along San Pedro Bay the data on gradient near the coast in 1903-4 are fragmentary but a rough estimate of oceanward discharge is given on page 147.

*Conditions in 1933.-The* withdrawals of ground water from the Torrance-Inglewood subarea increased from an estimated 10,000 acre-feet per year in 1904 to about 50,000 acre-feet per year in the early thirties (p. 99-100). The water-level contours for March 1933 (pl. 9) show the changes in position of the water level and in direction of movement that had developed since 1904 as a result of increasing withdrawals from the west basin and from the main coastal basin to the northeast. These changes can be summarized as follows:

1. Immediately inland from the west basin boundary, in the reach from the Baldwin Hills to Long Beach, the water levels had declined about 40 feet in the 29 years but the direction of movement was still coastward into the west basin. The local gradient had been steepened to a small degree. (See also **pl.** 4 showing water-level profiles for 1904 and 1930.)
2. The pressure differential across the fault boundary ranged from about 30 feet at Inglewood and Dominguez Gap to about 50 feet in the central part of the Rosecrans Hills.
3. Within the area south of Inglewood the pressure level-and, locally, the water table--was below sea level. Everywhere westward from the axis of the pressure trough, about two-thirds of the Torrance-Inglewood subarea, the direction of movement of the water within the Silverado zone had been reversed and was landward-generally southeastward or eastward toward the area of greatest pressure lowering in Dominguez Gap.

*Conditions in 1941 and in 1945.-Plate* 11 shows water-level con­ tours for April 1941 and plate 10 indicates the rise or fall in water level that had occurred since March 1933 (pl. 9). The general pattern of the contours is similar to that for March 1933. However, attention is directed to four features:

1. The maximum drawdown of water levels in the 8-year period occurred im­ mediately inland from the west basin boundary, east of Inglewood and within the Rosecrans Hills, and was about 30 feet. This drawdown, indicating local over­ draft, was noteworthy because almost everywhere else within the main coastal basin (central basin), except in the Huntington Park area, water levels were higher in 1941 than in 1933.
2. In the west basin, north of 190th Street, nearly all water levels were drawn down, but the maximum decline of 16 feet, which developed between Inglewood and Hawthorne, was only about half as great as the drawdown inland beyond the west basin boundary.
3. South of 190th Street, water levels changed only a few feet between 1933 and 1941. In the Wilmington area, a small net rise resulted from the virtual cessation of pumping at the Wilmington and Lomita well fields of the city of Los Angeles (table 7).
4. The axis of the pressure trough moved inland as much as 3 miles between Hawthorne and Gardena, but it was almost stable from 190th Street into Do­ minguez Gap. This axis marks the boundary between coastward and landward movement of ground water in the Silverado water-bearing zone.

Largely because of demands caused by industrial expansion during the war years, withdrawal of ground water from the Torrance-Ingle­ wood subarea increased about 50 percent between 1941 and 1945 (table 8). The water-level contours of plate 12 indicate conditions in November 1945, essentially at the end of the period of acceleration in draft induced by the war expansion, in relation to distribution of pumping draft.

The contours represent approximate low-water levels for the year, whereas the contours for 1933 and 1941 represent the high-water levels in those years. As is shown on representative hydrographs intro­ duced later in this report, the yearly fluctuation in the Silverado water­ bearing zone within the west basin ranges from about a foot near the coast to as much as 30 feet in areas of heavy pumping near the inland boundary. For example, the center of the depression in the piezo­ metric surface immediately north of Hawthorne was 62 feet below sea level in November 1945, but it was only 38 feet below sea level in March 1945 (pl. 13, well 3/14-4Nl). Thus, although the contours for November 1945 indicate a maximum decline of more than 30 feet below the contours for April 1941 (pl. 11), much of this is due to seasonal fluctuations. The contours of November 1945 were drawn to show the lowest water levels for the Silverado water-bearing zone that had occurred in the Torrance-Inglewood subarea to the end of 1945. With respect to saline encroachment from the ocean, the average con­ trolling hydraulic gradient is about halfway between the seasonal high and low levels. However, the maximum rate of landward advance of the saline front occurs at the time of autumn low water. In Novem­ ber 1945, the landward gradient from the coast to the minus 20-foot contour was steepest between El Segundo and Hermosa Beach, as much as 20 feet per mile; in the vicinity of Redondo Beach it was only about a third as steep, from 5 to 6 feet per mile.

The axis of the pressure trough did not move appreciably from 1941 to 1945, even though pressure levels along that axis were drawn down locally as much as 30 feet. In November 1945, the greatest differ­ ential pressure across the inland boundary of the west basin was about 60 to 70 feet. Differential pressures of this magnitude occurred east of Inglewood across the southern part of the Potrero fault, also in Dominguez Gap across the Cherry-Hill fault.

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MOVEMENT IN THE CULVER CITY SUBAREA

*Summary of geologicjeatures.-Ballona* Gap, a broad trench cut into the Pleistocene deposits by an ancestral Los Angeles River, is floored by deposits of Recent age to a depth of 40 to 80 feet below land sur­ face. These deposits consist of an upper and a lower division. The upper division consists chiefly of clay, silt, and fine sand; it is from 10 to 40 feet thick and of low permeability. The lower division, the "50-foot gravel," is composed almost wholly of gravel, but locally contains lenses of coarse sand. Its thickness ranges from 10 to 40 feet and its average base is about 50 feet below land surface. The "50-foot gravel" blankets most of the gap (pl. 8) and furnishes a thin but permeable ground-water artery from the main coastal basin to the ocean.

Everywhere within the gap, the "50-foot gravel" is presumed to be underlain by the San Pedro formation. Near the coast, the San Pedro largely consists of sand and gravel; but inland beyond the Inglewood fault more than half the formation is made up of layers of silt and clay, which separate and confine the layers of sand and gravel (pl. *3D).* Within and adjacent to Ballona Gap, three faults divide the San Pedro formation into distinct blocks which are critical with respect to water circulation and to movement of contaminated waters. These three faults are subparallel and trend about north-northwest. So far as known, they do not transect the deposits of Recent age and presumably do not interrupt hydraulic continuity in the "50-foot gravel." (Seep. 76 and 78.)

Of the three faults, the Inglewood fault, the farthest inland, passes across the gap about 6 miles from the coast and forms the inland boundary of the west basin in this area. The Sentney plant of the Southern California Water Co. (in 2/14-5D) is a short distance east of this fault and within the main coastal basin. Logs of wells at this plant show that three distinct aquifers in the San Pedro formation yield water to wells and that the three are separated by impervious strata.

The Overland Avenue fault is about 2 miles coastward from the Inglewood fault. Between these two faults, an upthrown block of the San Pedro formation contains water-bearing beds whose thickness ranges from 50 to 100 feet. The subbasin within this block is termed the crestal subbasin.

The Charnock fault is about 1.2 miles west of the Overland Avenue fault and 3 miles from the coast. Between these two faults the San Pedro formation has been dropped and the main water-bearing zone is as much as 350 feet thick. In subsequent discussion, the subbasin within this block will be referred to as the Charnock subbasin. Coast­ ward from the Charnock fault the San Pedro formation is gently

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folded and its water-bearing deposits range from 100 to 250 feet in thickness.

Logs of wells indicate that the "50-foot gravel" and the underlying water-bearing deposits of the San Pedro formation are in direct con­ tact locally within each of the blocks here described, and thus, some hydraulic continuity occurs. The complex structure of the San Pedro formation makes it difficult to trace the extent of hydraulic continuity, except where logs of closely spaced wells are available. However, the hydraulic continuity is known to be most free coastward from the Charnock fault, and is very poor to absent inland from the Overland Avenue fault.

North of Ballona Gap, logs of wells show a general southerly dip of the water-bearing beds of Pleistocene age, but the sand and gravel layers are irregular in thickness and position and cannot be correlated from well to well. Only within the dropped Charnock subbasin (to the north), are the water-bearing deposits thick and extensive. The main water-bearing zone extends continuously at least 2 miles north from the gap, to the vicinity of Pico Boulevard, where its top is about 50 feet above sea level and its thickness about 250 feet.

*Circulation of ground water.-The* Culver City subarea has been defined as including the part of the west basin north of the Ballona escarpment. The ground-water contour maps of the west basin for the selected times between 1904 and 1945, inclusive, indicate that exchange of ground water between the Culver City subarea and the Torrance-Inglewood subarea-that is, across the Ballona escarpment­ has been small. Also, in the Culver City subarea, movement has been controlled very largely by fault barriers, which appear to parti­ tion the subarea into three essentially separate subbasins.. Within these subbasins, movrment has been-chiefly in response to concentra­ tions of draft at several heavily pumped well fields (pl. 12).

Water-level contours for the Culver City subarea for 1903-4 were reconstructed from basic data by Mendenhall but it was impracticable to reproduce them on plate 9, because of the complexity of the hy­ drologic pattern for 1933. However, a brief summary of salient features is presented. These contours indicate that in 1903-4 there was a general southward movement of ground water toward Ballona Gap from the upland area flanking the Santa Monica Mountains. In Ballona Gap the contours were drawn chiefly from water levels in shallow wells tapping the "50-foot gravel" because in 1904 very few wells had been drilled to the San Pedro formation below. Rere the movement of water was southwestward and essentially parallel with the slope of the land surface. In Ballona Gap, a short distance west of the Inglewood fault, the water-level contours bulge coast-­ ward, indicating that water in the "50-foot gravel" was moving coast-

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ward from the main basin into the west basin, over the top of the Inglewood fault. Throughout its 6-mile reach within the west basin Ballona Creek was an effluent stream draining water from the Recent deposits of the gap. The reach of effluent seepage extended inland at least half a mile beyond the Inglewood fault and into the area of artesian flow that still existed in 1904 in the main coastal basin. The water-level contours for March 1933 (pl. 9), April 1941 (pl. 11), and November 1945 (pl. 12), show general similarity in direction of ground-water movement; and all show substantial change from the water-level contours of 1903-4. This change was brought about by (1) heavy draft from well fields in or adjacent to the two sub­ basins, and (2) the barrier action of the three major faults, which

bound those subbasins.

In the main coastal basin, immediately inland from the Inglewood fault and adjacent to Washington Boulevard, heavy withdrawals from the wells at the Sentney plant of the Southern California Water Co. in sec. 5, T. 2 S., R. 14 W., and from nearby wells of the city of Beverly Hills (Cadillac and Castle plants) had developed a substantial cone of pressure relief by the early thirties. In March 1933, the pres­ sure level at the center of this cone as represented by the hydrograph for well 2/14-5D5 tpl. 14), was about 10 feet above sea level; but by April 1941 it had been drawn down as much as 60 feeet below sea level. By 1945 local draft by the city of Beverly Hills had decreased and the water level in the spring of that year at well 2/14-5D5 had re­ covered substantially; but it was still 30 feet below sea level. Thus the pressure levels at these well fields have been maintained many tens of feet below sea level continuously for the past decade and water in the aquifers of the San Pedro formation has been moving into this cone of depression from the south, east, and north.

*Crestal subbasin.-In* the crestal subbasin, between the Inglewood

and Overland Avenue faults, the movement of water in the San Pedro formation has been consistently southward from the Beverly Hills through 1945. Within this subbasin pumping draft is largely from wells at the Manning plant of the Southern California Water Co. in 2/15-10 and from well 2/15-12Bl of the Metro-Goldwyn-Mayer Corp. (pl. 2). Total draft from this subbasin is believed not to have exceeded 1,600 acre-feet per year. Under native conditions and continuously through the period of withdrawal, replenishment to the San Pedro formation in the crestal subbasin apparently has been supplied almost entirely by runoff from the south flank of the Santa Monica Mountains and by rainfall from the Santa Monica plain. However, in Ballona Gap north of Washington Boulevard, the water­ bearing beds of the San Pedro formation are believed to be in direct contact locally with the overlying "50-foot gravel." Hence, ground

water passing westward across the Inglewood fault in the "50-foot gravel" may contribute some replenishment to the underlying San Pedro beds in the crestal subbasin. Within this subbasin, the position of water level in the "50-foot gravel" is not known, except at well 2/15-1P2 near the western boundary; here the water level in this aquifer has been about 30 feet lower than the pressure level of the San Pedro formation for the past 15 years. (See hydrograph for well 2/15-1P2 on fig. 4; pressure levels for San Pedro formation, pls. 9-12.) Thus, near this well, for many years the pressure differential between the two aquifers would not have permitted downward movement from the "50-foot gravel" to the San Pedro formation-if hydraulic continuity exists at all, movement would have been upward.

*Charnock subbasin.-In* the Charnock subbasin, during the past

two decades at least, pumping has been concentrated at the Charnock plant of the city of Santa Monica (2/15-110), and at the Charnock plant (2/15-llD, E, F) and the Sepulveda plant (2/15-llJ) of the Southern California Water Co. The joint withdrawal from these three plants was 7,352 acre-feet in 1933, reached a maximum of 10,448 acre-feet in 1940, and was 7,258 acre-feet in 1941 and 5,005 acre-feet in 1945. The decrease in withdrawal was caused by the gradual decrease in the rate of pumping at the Charnock plant of the city of Santa Monica following 1940 and the complete cessation of pumping by the city late in 1944.

As a result of the concentrated withdrawal at the Charnock well fields and at the nearby Sepulveda well field, the water level in the San Pedro formation has been depressed several tens of feet below sea level since the late twenties. As shown by the water-level contours for the years 1933, 1941, and 1945 (pls. 9-12), and by other data, movement of ground water throughout the subbasin has been toward this focus of withdrawal for the past two decades. To the north (nearly to Pico Boulevard), water levels have been below sea level consistently since 1933, and the steep southward gradient induced by this draft has been as much as 50 feet to the mile (pl. 11). To the south (to and beyond the Ballona escarpment), water levels have been below sea level consistently since 1933, and the average northward gradient has been as much as 25 feet per mile (pl. 11). Thus, at least since 1933, about two-thirds of the water withdrawn from these well fields has come from the north and about one-third from the south. The water-level contours for the San Pedro forma­ tion indicate that very little water enters the Charnock subbasin from the east (across the Overland Avenue fault), or from the west (across the Charnock fault), even though the pressure differentials across the two faults have been as much as 110 feet and 90 feet (pl. 11).

The "50-foot gravel" may conduct some water into the Charnock subbasin, from both the east and the west. As shown by geologic section *D-D'* (pl. *3D),* the "50-foot gravel" is in contact (at least locally) with the water-bearing · beds of the San Pedro formation within the Charnock subbasin, and presumably some downward percolation of water occurs. However, fragmentary records of water levels in shallow wells indicate that in the part of the subbasin north of Ballona Creek, the "50-foot gravel" has been essentially dewatered for the past two decades. Southward from Ballona Creek, the base of the "50-foot gravel" locally is as much as 60 feet below sea level, and this water-bearing zone still must be almost wholly saturated.

*Coastal* area.-Between the Charnock fault and the coast, the "50-

foot gravel" of Ballona Gap and the underlying main water-bearing zone of the San Pedro formation are in contact at many places, as shown by logs of wells. Thus, these water-bearing zones may have fair hydraulic continuity (p. 127). The water-level contours of 1903-4 indicate a general oceanward movement of water through these deposits, with a coastward hydraulic gradient of about 10 feet per mile. North of the gap, the water-level gradient was southward, indicating some replenishment from the Santa Monica upland area. By the late twenties water levels in this coastal part of Ballona Gap had been drawn down as much as 10 to 30 feet and were from 5 to 15 feet below sea level (see pl. 9 for levels in 1933). The water-level contours of March 1933 indicate some continuing contribution from the north, but the underflow to the gap from beneath the Ocean Park and Santa Monica plains must be small because: (1) the water­ bearing deposits are thin, and (2) southward movement is impeded by the ground-water barrier about at the north edge of T. 2 S., which is inferred to be a fault zone. Water levels in the gap had recovered to sea level by 1941, probably in part because of the heavy rainfall of that year but chiefly owing to a general decrease of draft for irriga­ tion and cessation of pumping by the Marine plant of the city of Santa Monica in 2/15-9N; both actions were caused by saline en­ croachment. However, from the early thirties to date, the water level in this coastal part of the gap has been essentially flat and move­ ment of water apparently has been largely in response to local draft. Except for withdrawals from the Marine plant to which reference has been made, that draft has been moderate and widely distributed. Because water levels were below sea level from the middle twenties through the thirties, sea water has advanced inland beyond Lincoln Boulevard and about half the distance from the coast to the Charnock

fault (p. 197).

**WITHDRAWAL OF GROUND WATER**

**HISTORY OF DEVELOPMENT**

Development of ground water in the coastal plain began about 1870. As of 1904, Mendenhall (1905a, 1905b, 1905c) canvassed and described about 8,200 wells within the coastal plain, of which about 2,500 wer flowing in the spring of 1904. Mendenhall estimated that in 1904,· the average discharge of all flowing and pumped wells within the coas­ tal plain was about 250 cfs, equivalent to a yearly withdrawal of about 180,000 acre-feet. He did not evaluate withdrawals from the west basin specifically. However, in 1904 there were 134 wells with pumping plants in the west basin, as compared to 282 wells with pumping plants in the Santa Monica and Redondo quadrangles (Mendenhall, 1905b, pls. 5 and 6). The average annual yield of all pumped and flowing wells in these two quadrangles was estimated as about 30,000 acre-feet. If the estimated yield is distributed in proportion to the number of wells with pumping plants, the with­ drawals in 1904 were about 14,000 acre-feet per year for all the west basin, and about 10,000 acre-feet per year from the part of the west basin south of Ballona Gap-the Torrance-Inglewood subarea of this report. Because the lands irrigated by ground water within the Santa Monica and Redondo quadrangles amounted to only 12,250 acres in 1904, Mendenhall's over-all figure of 30,000 acre-feet probably is liberal (about 2.5 acre-feet per acre); thus, the estimate of 14,000 acre-feet just derived for the west basin likewise is also believed to be liberal.

During the quarter century following the canvass by Mendenhall, the rate of withdrawal from the west basin increased several fold, owing to: (1) increased demand for water for irrigation, industrial, and domestic use, (2) lack of surface-water sources, and (3) improve­ ment and widespread use of deep-well turbine pumps. Information is not available to indicate the rate at which the withdrawal increased from 1904 to 1930. However, extensive industrial development commenced in the twenties, and water levels in wells tapping the Silverado water-bearing zone began to decline noticeably in the early to middle twenties. Also, a period of low rainfall began about 1919 (table 2), causing an increase in the use of water for irrigation. Thus, it is inferred that the over-all increase in draft was most rapid after 1919. Furthermore, the figures for electrical energy sold on the "agricultural-rate" schedule in the Redondo and Inglewood operating districts of the Southern California Edison Co. are available for the period beginning in 1923. In comparison with the amount of energy sold in 1932, as a base year (p. 104), the amount of energy sold an­ nually in these two operating districts of the Edison Co. from 1923

through 1930 was higher in all years except 1927. The average use in the 8 years was 112 percent of the use in 1932; the peak was in 1923-about 140 percent of the 1932 base. Although water levels in the west basin declined nominally in the twenties, it is believed that pump efficiencies were improved sufficiently to nearly compen­ sate for the increased lift, and that the amount of electrical energy required to raise an acre-foot of water remained nearly constant. Thus, it is concluded that the draft for irrigation in the Torrance­ Inglewood subarea was slightly greater from 1923 through 1930 than in 1932 and following years (table 8). Accordingly, the main increase in irrigation draft must have occurred prior to 1923.

As indicated in table 8, by 1931 the withdrawal from the Torrance­ Inglewood subarea was about 53,000 acre-feet per year, which inci­ cates an increase of nearly 400 percent in the 26-year period since 1904. Records of withdrawal by the larger plants since 1931 are reasonably complete, and the withdrawal for irrigation and miscel­ laneous uses can be approximated with fair accuracy. Methods of evaluating this withdrawal are discussed in following pages, and estimates for the yearly over-all draft from the Torrance-Inglewood subarea beginning in 1931 are summarized in table 8.

**PUMPAGE FROM MUNICIPAL WELL FIELDS**

In 1945, eight cities operated municipal water systems within the Torrance-Santa Monica area. The well fields of the cities of El Segundo, Hawthorne, Manhattan Beach, Santa ]\fonica, and Torrance are located within the west basin. The city of Santa Monica, how­ ever, purchased most of its water supply from the Metropolitan Water District, beginning in 1941, and reportedly discontinued the use of its well fields entirely in 1945. The city of Inglewood operated several well fields within the west basin and one (the Centinela Park well field) that was almost entirely in the main coastal basin. The city of Los Angeles operated its Lomita and Wilmington plants, which were within the west basin, and its Manhattan, 99th Street, and Figueroa Street plants in the main coastal basin. In 1945, the city of Beverly Hills pumped all of its water from well fields outside the west basin, partly from the main coastal basin and partly from the Hollywood basin of Eckis (1934, pl. *E).* In addition to these eight municipal systems, Los Angeles County Water Works Districts 13 and 22 withdrew water from plants wholly within the west basin. The distribution of plants producing more than 200 acre-feet of water for public supply or for industrial use in 1945 is shown on plate 12 (also see table 10).

Pumpa.ge records for all these systems except that of Beverly Hills

were collected by the Geo]ogical Survey from officials of the water

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departments or from the city engineers. In some cases these records were extended to earlier years by utilizing estimates made by other agencies, chiefly the Metropolitan Water District (Vail, 1942, table 2). Records of pumpage by the city of Beverly Hills were obtained through the California Division of Water Resources. Available records of the yearly pumpage by each of the eight cities are given in. table 7. In this table each record is carried back as far as available data will permit. Except as noted, records are for the calendar year. Total yearly withdrawals from the municipal and county water works district fields within the Torrance-Inglewood subarea from 1931

through 1945 are summarized in table 8,-column 2.

TABLE 7.- *Yearly withdrawal of ground water by municipalities in the Torrance­ Santa Monica area*

Year I Acr feet 11 Year I Acr feet II Year I Acre-feet

**Beverly Hills, 1929 45**

[For year ending September 30; records obtained from California Division of Water Resources]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1929 --- - -----------  1930 --- \_ ----------  1931\_ --------------  1932 ------- --------  1933 ---------------  1934 --------------- | 14,920  1 6 900  16'.960  1 6 290  16' 480  6'.139 | 1935 - -- -- --- \_ ---- \_  1937 -- - \_ -----\_-- \_  1938 ------------ \_  1939 -----------  1940 - -- -- -- - . ----. | 5,654  6,635  6,778  6,801  7,958  7,742 | 194L .  1942\_ ----\_-- -- --\_-- --  1943 ---------------  1944 ---------- ---  1945 --- ------- | 25,874  34,977  2 4 703  25,030  24,824 |

**El Segundo,** 1931-45

1931\_ --------

1932 -- ----

1933 - \_ -- ------

1934 --

1935 -- - ------------

s 412 1936 \_

a 540620 1l993387 --\_

697 1939 \_

706 1940 \_

726 1941 \_

966 1942 \_

942 1943

680 1944-----------------··

709 194L-·····-·-···-·-·-

808

1,027

1,098

1,269

1,156

**Hawthorne, 1931-45**

[Estimates by Metropolitan Water District through 1941; records from city engineer beginning in 1942]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1931\_ ··- -·-·-···-···  1932 . \_......··-\_·-. \_  1933--···-····-···-·-·-  1934-·--··--··--·----··  1935 . - - ·-. - . - .. ·- ... | 410  560  500  550  600 | 1936--·--····-···-····-  1937....·-············-  1938--····--······-····  1939.. --···-······-····  1940 ········--······- | 690  700  800  850  900 | 194L\_····-············  1942-·-··-·-···········  1943.--•···········-·--  1944\_·······-·-·-·-··-·  1945--······-·-········ | 1,120  1,900  1,980  2,302  1,852 |

**Inglewood, 1923-45**

[Record for years 1923-28 from Los Angles County Flood Control District; for years 1931-36 from Metro­ politan Water District; for years 1937-45 fr-0m city engineer]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Hl23--····-··-·····-··- 870  1924•• ·--·-····--····-- 2,280  1925-·---·-·-·-·--····· 1,400  1926.. ·-·--·-------···- 1,320  1927-·--········---·--- 2,010  1928---·-···-·---····-· 2,240  1929 . \_. \_··-.··-·\_.. ....\_....    1930···········---···-· ·------··· | 193L-... ······-·····-·  1932\_ .. \_. \_·- .......·-.\_  1933---·-···... . ·-···  1934---····-·--··----··  1935\_··-·-··-···--·-·-·  1936 ···-····-······-  1937 . ····-··-·--···-  1938-··-···-··-··-·-·-- | 2,170  2,560  2,440  2,650  2,350  2,670  2,810  3,060 | 1939·-·-·... -·-· ---- ...  1940 ·--···-·-······-  194L.\_.....-.-·-·---·-  1942\_.. -········-·-  1943 .\_ - ·-- -··-·-· -·-  1944\_.\_ ···-·-.·----·\_·-  1945.·--·-····--·-·-··- | 3,360  3,610  3,840  4,190  4,776  4,939  5,297 |

I Metered consumption plus 10 percent to cover estimated losses.

2 Additional water taken from Metropolitan Water District.

3 Estimate by Metropolitan Water District.

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TABLE *7.-Yearly withdrawal of ground water by municipalities in the Torrance­ Santa Monica* area-Continued

Year I Acre-feet II Year I Acre-feet 11 Year I Acre-feet

**Los Angeles, 1918-45**

[Total withdrawal from Lomita and Wilmington pumping plants] *4*

1919 -----

1920 --------------

1921\_ -----------

192<) \_ -- -- -- -- -- -

1923 -- --- --- -- --- --

4,272

4,561

5,285

5,937

7,385

6,950

6,805

7,023

7,312

1928 ---------\_-- ---

1929 --- --- \_

1930 -- -- \_ --- \_

1931 -- -- -- --

7,892 1937 -- -- - -- \_ -- \_ -- \_

9,774 1938 - ---------------

3,207 1939 ---------- ------

1932 -- -- ----------

1940 ---

1941\_ -- ----

1942 ---

1925 -----

1926 -- \_ --- -- \_

1927 ----------------

1924 --------------

1933 ---------

1934 --------

1935 -- --------------

8,615

8,073

8,434

8,000

1943 -- --- -- -- -- - --- -

7,211 1944 --------------

1936 --------- 0 1945 -- -- -- --- --

0

111

48

0

105

92

651

794

2,058

**Manhattan Beach, 1931-45**

[Estimates by city engineer, based on rated capacity of booster pumps; rounded off by Geological Survey]

1931\_ - ------------

1932 --- \_ ---- --

1933 ------

1934 -- - -- - -- --- - -- -

1935 --- - ----------

550 1936 \_

550 1937 \_

600 193g \_

600 1939 \_

650 1940 \_

650 194L \_

700 1942 \_

750 1943 \_

900 1944 \_

950 1945 \_

1,000

1,050

1,300

1,300

1,300

**Santa Monica, 1931-45**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1931 -------------  1932 ----- ----- \_  1933 -- ----------\_--  1934 ----------------  1935 ---- \_ -- \_ -- -- \_ | 62,496  4,288  5,117  5,727  5,812 | 1936 ----------  1937------ - --- -- --- --  1938 ---------------  1939 ---------------  1940 -------- | 6,790  7,147  7,939  8,525  8,925 | 194L \_  1942 ------------ \_  1943 ----- --- \_  1944 ----------  1945 -- ------ | 64,469  238  33  38  19 |

**Torrance, 1931-45**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 193L -- - -  1932 ------ | **7 800** 1936 \_  7 800 1937 \_  7 760 1938-------------------  7 890 1939 \_  7 875 1940 ---- | 71,070  1,115 | 1941\_ -----------  1942 -- \_ -- -- ---- \_ -- | 1,178  1,500 |
| 1933 ---------------- | 1,350 | 1943 -- -- - -- --- - --- -- | 1,757 |
| 1934 -- ------------- | 1,328 | 1944 -- --------\_ | 1,786 |
| 1935 ------------- | 1,376 | 1945 -- - \_ --- - - -- -- - - | 1,748 |

*4* For withdrawal from all well fields of the city of Los Angeles within the coastal plain from 1918 through 1944, see Poland, J. F., Sinnott, Allen, and others (report on withdrawals of ground water from the Long Beach-Santa Ana area), table 4, p. 39.

*Ii* Pumpage for April through December.

6 Water supply chiefly from Metropolitan Water District beginning in 1941.

7 Records from Metropolitan Water District.

**WITHDRAWAL FROM THE TORRANCE-INGLEWOOD SUBAREA, 1931-45**

**:METHODS OF EVALUATING WITHDRAWAL**

*Industrial consumption.-ln* the southern and central parts of the Torrance-Inglewood subarea, south of El Segundo Boulevard, 20 industrial plants currently obtain their water from wells. The largest use is by petroleum refineries, of which eight are in this area. Most of the records of withdrawal of ground water by each of these industrial plants was obtained from plant representatives. Meter records were available for all plants using large quantities of water. However, estimates that were supplied for several of the smaller plants were based on well performance and hours of operation.

In the central part of the west basin, between El Segundo Boulevard

and the Ballona escarpment, there are a number of industrial plants,

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but, as far as known, all of these plants purchase their water from municipalities or water companies.

*Pumpage by large water companies.-Within* the Torrance-Inglewood subarea about 25 private water companies supply water for domestic, irrigation, and industrial uses. Meter records of production are avail­ able for several of the larger companies. In connection with its field canvass of wells, the Geological Survey collected meter records from the California Water Service Co., the Dominguez Water Corp., the Palos Verdes Water Co., the Palisades Del Rey Water Co., and the Southern California Water Co. In addition, the pumpage of the Moneta Water Co. has been interpolated from estimates by other agencies in 1931 and 1944. With the exception of the part of the withdrawal by the Dominguez Water Corp. that is sold to industrial plants, total draft by these six companies is given in table 8, column 4.

*Pumpage for irrigation and miscellaneous uses*.-Withdrawal of ground water by private irrigators and by many small water companies is substantial. However, neither meter records nor estimates are available for most of this use. In its appraisal of withdrawal in the Long Beach-Santa Ana area, the Geological Survey estimated pump­ age for agricultural purposes by deriving yearly mean energy factors (energy expended in raising a unit quantity of water) and applying these factors to the quantity of electrical energy expended in pumping from wells. In appraising pumpage for irrigation from the west basin, however, it was found that this method was not readily applicable because: (1) three operating districts of the Southern California Edison Co. extend from the west basin into the main coastal basin,

1. pump-efficiency tests were not sufficiently comprehensive in distribution to define satisfactory yearly energy factors, and (3) many of the smaller water companies are not supplied with energy under the agricultural-rate schedule of the Edison Co.

Because the energy-factor method could not be readily applied, the pumpage for irrigation and for miscellaneous uses in the Torrance­ Inglewood subarea was estimated from figures of irrigated acreage, considered together with a plot of electrical energy purchased yearly on the agricultural-rate schedule. Specifically, in 1932 and in 1941, the California Division of Water Resources made crop surveys of the lands in the west basin. Unpublished data in the files of the Division, compiled from these surveys and from maps showing service areas of municipal systems and public utilities, have been utilized by the Geological Survey to estimate the acreage supplied from wells with meter record estimate of pumpage. For the Torrance-Inglewood subarea, it has been estimated from these data that in 1932 an area of about 13,200 acres was so supplied (about 90 percent classified by the Division as irrigated lands and about 10 percent classified as

domestic and industrial areas). Water use on the 13,200 acres in 1932, a year of nearly average rainfall (table 2), is estimated to have been about 13,200 acre-feet, an average use of 1 acre-foot per acre. This figure agrees with estimates made by the Los Angeles County Flood Control District from a field survey in 1931 (Dockweiler, 1932, pl. 11), which indicated that private irrigation and miscellaneous plants in the part of the Torrance-Inglewood subarea west of Vermont Avenue pumped about 9,200 acre-feet in that year. That figure did not include withdrawal from similar plants east of Vermont Avenue but it is estimated that these plants pumped about 4,000 acre-feet in 1932.

Furthermore, from the crop survey of the California Division of Water Resources made in 1941, it has been estimated that the lands in the Torrance-Inglewood subarea supplied with water from wells for which neither meter records nor estimates are available was about 16,000 acres in that year. About three-quarters of this area-or about the same acreage as in 1932-was classified by the Division as irrigated lands and about one-quarter of the area was classified as domestic and industrial sections. Thus, it is apparent that an increase of about 3,000 acres in lands used for domestic and industrial development supplied with water by noncanvassed withdrawals had occurred since 1932. Data are not available to indicate the rate at which this increase in domestic use took place. Therefore, it is assumed to have been uniform, or about 330 acres per year, and to have required a duty of 1 acre-foot per acre.

To obtain yearly figures for the unmetered irrigation and domestic uses through 1941, it has been assumed that the annual sales of elec­ trical energy under the agricultural-rate classification in the Redondo and Inglewood operating districts of the Southern California Edison Co. furnish an approximate index of water pumped for agricultural use from 1931 through 1941. In that 11-year period the average de­ cline of water level within the Torrance-Inglewood subarea was about 4 feet for the Silverado water-bearing zone, the principal aquifer. The small increase in lift may have been more than offset by improvement in pumping-plant efficiencies. The year 1932, with an estimated with­ drawal of 13,200 acre-feet for unmetered agricultural and domestic uses, has been taken as the base year. Thus, for 1931 and the years 1933 through 1941, estimates of withdrawal for unmetered irrigation use in each year have been obtained by multiplying 13,200 by the percentage of electrical energy used in that year in comparison to the 1932 base use. To the figure so obtained has been added the estimated increase in uncanvassed domestic use, prorated as described above. The sum of these two elements has been entered in table 8, column 6.

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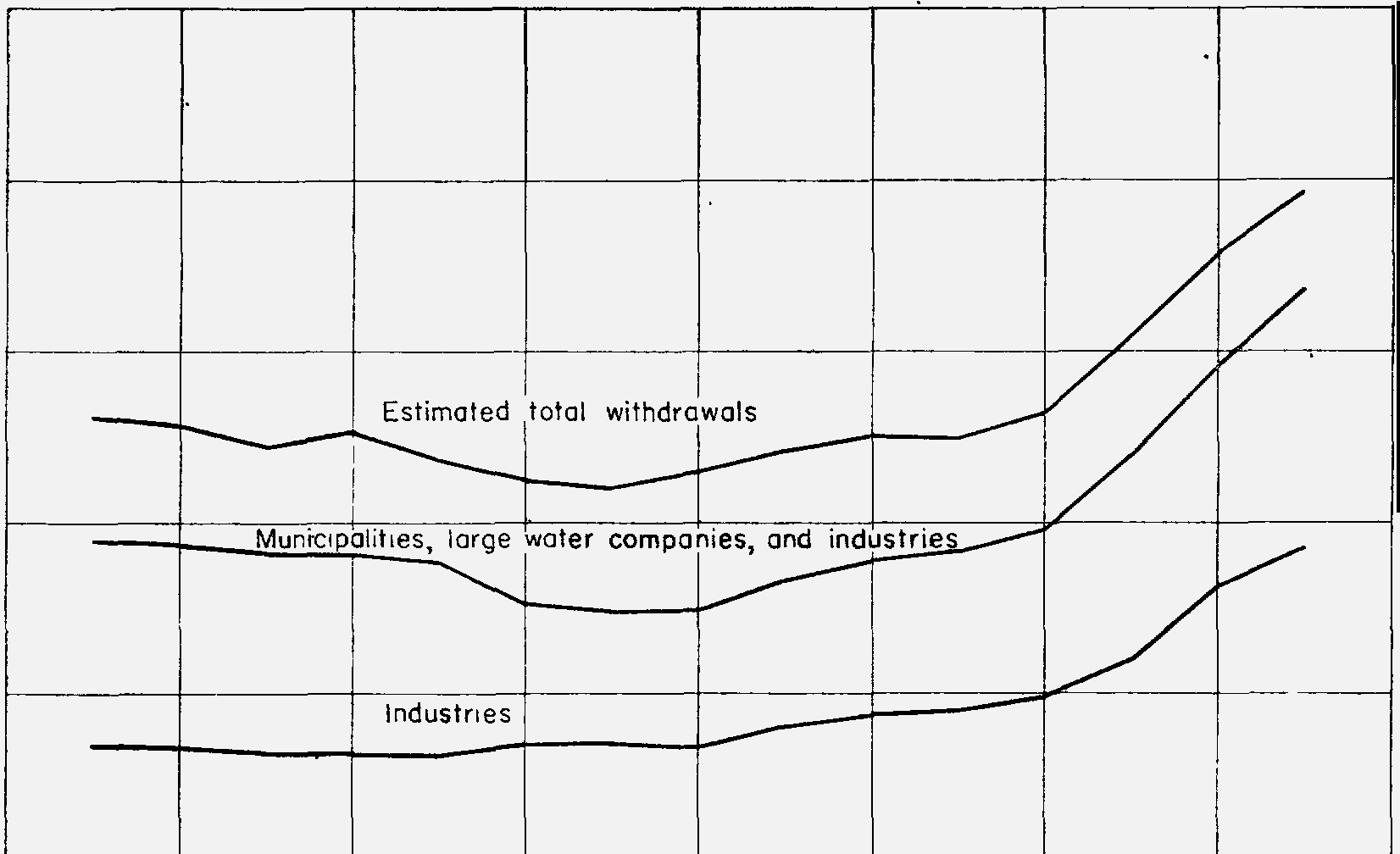
For the war years 1942-45, agricultural withdrawals decreased sub­ stantially but domestic expansion was greatly accelerated, and a con­ siderable part of this increased domestic use of water was met by the smaller water companies. Data are not available to indicate the pro­ portionate changes in area. Therefore, water used for irrigation and for miscellaneous purposes in these 4 years is assumed to have been constant at about 13,000 acre-feet per year.

The estimates entered in table 8 for yearly withdrawals by private irrigators and for miscellaneous use are only approximate. However, these figures constitute less than one-quarter of the total pumpage from the Torrance-Inglewood subarea. Extensive work would have been required to derive a more accurate estimate. In 1948 the Cali­ fornia Division of Water Resources began a detailed study of the quantity of ground water drawn from each of the wells or well fields of this subarea, in connection with the pending adjudication of water rights. Accordingly, duplication of work, which the Division must carry out for legal reasons, was not believed to be warranted.

**ESTIMATE OF TOTAL PUMPAGE**

Table 8 and figure 3 summarize the yearly withdrawal from the Torrance-Inglewood subarea for the 15 years from 1931 through 1945. The estimated over-all draft from this area decreased from 52,600 acre-feet in 1931 to 44,500 acre-feet in 1937, rose to 52,700 acre-feet in 1942, and then increased sharply during the war years to about 78,000 acre-feet in 1945. As shown by the table, most of this expan­ sion was caused by increased industrial demand. Withdrawals for

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0

:i: 1---

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1930 1932 1934 1936 1938 1940 1942 1944 1946

FrnURE 3.-Estimated withdrawals of ground water from the Torrance-Inglewood subarea, 1931-45.

industrial use were nearly constant ·at 14,000 acre-feet per year from 1931 through 1938, or about 30 percent of the total use; and increased to 19,640 acre-feet in 1942; and to 37,420 acre-feet in 1945, or about 48 percent of the total use. Most of the increase in industrial use of water during the war years was due to the expanded requirements of the oil refineries; in 1945, these refineries accounted for about 88 percent of the industrial demand.

TABLE *8.-Estimated yearly withdrawal of ground water from the Torrance-Inglewood subarea, 1 in acre-feet, 1931-45*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Municipal systems 2 | Industries a | Large water companies | Subtotal | r i ?  cellaneous | Total' |
| 1931 -- --- -- \_--- \_-- | 12,720 | 14,720 | 11,210 | 38,650 | 13,900 | 52,600 |
| 1932 -------\_-- ------------ | 12,460 | 14,710 | 10,690 | 37,860 | 13,200 | 51,100 |
| 1933 -------\_ --- --- - - - - -- | 12,900 | 13,100 | 10,200 | 36,200 | 13,000 | 49,200 |
| 1934 --- -- --- ---- -- | 12,830 | 13,340 | 10,230 | 36,400 | 14,400 | 50,800 |
| 1935 --- ---------- | 12,030 | 13,510 | 10,250 | 35,790 | 12,100 | 47,900 |
| 1936 --- --- -- --- --- - --- -- - | 5,300 | 14,520 | 10,940 | 30,760 | 14,600 | 45,400 |
| 1937 --- ---------- | 5,580 | 14,830 | 9,830 | 30,240 | 14,300 | 44,500 |
| 1938 -------------- | 6,250 | 13,670 | 10,250 | 30,170 | 16,000 | 46,200 |
| 1939 --- --------- -- | 6,020 | 16,470 | 11,220 | 33,710 | 14,900 | 48,600 |
| 1940 ----------- \_ -- | 6,670 | 17,380 | 11,280 | 35,330 | 15,200 | 50,500 |
| 1941 --------------------- | 7,010 | 18,520 | 11,200 | 36,730 | 13,600 | 50,800 |
| 1942 ------------ | 8,660 | 19,640 | 11,360 | 39,660 | 113,000 | 52,700 |
| 1943 ------- \_ --- -- - - | 10,640 | 24,740 | 12,770 | 48,150 | 113,000 | 61,200 |
| 1944 -------------- --- | 12,000 | 33,680 | 13,020 | 58,700 | 113,000 | 71,700 |
| 1945 --- \_ --- --- --- --- -- | 13,220 | 37,420 | 14,770 | 65,410 | 113,000 | 78,400, |

1 For purposes **of** this report, the part **of** the west basin south **of** the Ballona escarpment is called the- Torrance-Inglewood subaraa.

**2** Includes water pumped by County Water Works Districts 13 and 22.

3 Includes water sold to industrial plants by the Dominguez Water Corp. ' Rounded off to three figures.

**1** Flat estimate only.

The municipal systems accounted for nearly 25 percent of the total draft in 1931 and about 17 percent in 1945. The decrease in use by municipal systems from about 12,000 acre-feet in 1935 to 5,300 acre­ feet in 1936 was a result of cessation of withdrawal at the Lomita and Wilmington well fields of the city of Los Angeles, these fields had withdrawn about 8,000 acre-feet per year in the early thirties. Since 1936 the yield from these two well fields has been small.

**WITHDRAWAL FROM THE CULVER CITY SUBAREA**

Withdrawal of ground water from the Culver City subarea (the part of the west basin north of the Ballona escarpment) has not been appraised in detail. The field canvass of wells was carried only from 1 to 2 miles north of Ba.Ilona Gap and collection of records of pumpage from privately owned wells was not attempted for any part of the

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Culver City subarea. However, the most heavily pumped well fields have been those of the city of Santa Monica and those of the Southern California Water Co. Table 9 gives the draft from the Culver City subarea by these two agencies yearly from 1931 through 1945.

TABLE **9.-** *Withdrawal of ground water, in acre-feet, from the Culver City subarea. by the city of Santa Monica and by the Southern California Water Co., 1931-45*

[Sum of pumpage from the Marine, Charnock, and Arcadia plants of the city of Santa Monica, and from the Pacific, Chamock, Sepulveda, and Manning plants of the Southern California Water Co.]

|  |  |  |  |
| --- | --- | --- | --- |
| Year Acre-feet | Year | Acre-feet | Year Acre-feet |
| 1931 7, 111  1932 --------------- 8,066  1933 8,607  1934 9,238  1935 9,312 | 1936 - ---  1937  1938 ----------------  1939 -------\_-- --\_--  1940 --- ------------ | 10,461  10,956  11,773  12,567  12,933 | 1941 8, 705  1942 4,405  1943 5,622'  1944 6, 125  1945 6, 10& |

In addition to the withdrawal from the principal well fields, shown in table 9, water from private plants was used to irrigate about 3,300 acres of land in 1932 and about 3,000 acres in 1941 (unpublished data from California Division of Water Resources), chiefly along the south edge of Ballona Gap and in secs. 2 and 3, T. 2. S., R. 15 W. (pl. 2). These irrigated areas were supplied almost exclusively from private wells, although possibly as much as 200 acres of this land have been irrigated with water pumped directly from Ballona Creek (C. E. Bollinger, Los Angeles County Flood Control District, oral communication). About two-thirds of the over-all acreage is planted in garden and field crops and one-third is in irrigated grass. The quantity of ground water pumped to irrigate these lands probably is about 4,000 acre-feet a year.

The privately owned wells yielding water for irrigation in the Culver City subarea in 1945 (excluding the area north of the north boundary of T. 2 S.) were distributed as follows: in the coastal area, 30 wells; in the Charnock subbasin, 24 wells; in the crestal subbasin, 2 wells. If the annual well yields are assumed to be proportional to the distributio.n, the estimated draft for irrigation (4,000 acre-feet) would be about 2,100 acre-feet from the coastal area, 1,700 acre-feet from the Charnock subarea, and 200 acre-feet from the crestal sub­ basin. Actually, because yields of wells in the Charnock subbasin are larger than those of wells nearer the coast and bec.ause slightly more than half of the irrigated acreage is supplied by water pumped from the Charnock subbasin, it is inferred that the division of draft as of 1945 was about 1,800 acre-feet from the coastal area, 2,000 acre-feet from the Charnock subbasin, and 200 acre-feet from the crestal subbasin.

The larger part of the withdrawal from the Charnock subbasin has been for public supply and has been obtained from the Charnock

well field of the city of Santa Monica and the Charnock well field of the Southern California Water Co.; both fields are in the *NW¼* sec. 11, T. 2 S., R. 15 W. (pl. 2). The yearly withdrawal records from these two well fields for the 15 years are graphed on plate 14. The Sepulveda plant of the Southern California Water Co. (well 2/15-llJ) also is in this subbasin. The over-all draft from the Char­ nock subbasin from these three well fields, and from the private

irrigation wells previously discussed, is estimated to have been approximately 9,000 acre-feet in 1931, 10,000 acre-feet in 1935,

12,500 acre-feet in 1940 (the peak year), and 7,000 acre-feet in 1945. In the crestal subbasin, perennial draft has been chiefly by: (1) the Manning plant of the Southern California Water Co. from well 2/15-10, beginning in the middle twenties; (2) the Metro-Goldwyn­ Mayer Corp., from wells 2/15-12Bl and 2/14-7Pl, beginning in 1932; (3) the LAC Chemical Co., from well 2/14-6Hl, beginning in 1942; and (4) the Holy Cross Cemetery from well 2/14-lSQl, and irrigation wells 2/14-lSFl and F2. The over-all draft from this subbasin did not exceed a few hundred acre-feet per year until the middle thirties; it was about 1,100 acre-feet in 1935 and in 1940,

and had increased to about 1,600 acre-feet in 1945.

For the Culver City subarea as a whole, it is estimated that the withdrawal in 1931 was about 13,000 acre-feet. Withdrawal increased to about 20,000 acre-feet in 1940, the peak year of pumpage by the city of Santa Monica. In that year withdrawal was approximately two-fifths as large as it was in the Torrance-Inglewood subarea to the south. In 1945, when draft by the city of Santa Monica had ceased, the withdrawal had decreased to about 12,000 acre-feet per year, or only about one-sixth of that in the Torrance-Inglewood subarea. The over-all use of water in the Culver City subarea is many times greater than the ground-water draft. Current importa­ tions (1948) consist chiefly of surface water from the Los Angeles municipal supply, the Colorado River and ground water from the Sentney plant of the Southern California Water Co.

**WITHDRAWAL INLAND FROM THE WEST BASIN**

About 90 square miles of the Torrance-Santa Monica area is inland from the west basin and almost entirely within the main coastal basin. The over-all withdrawal of ground water from the 90 square miles was not evaluated in this investigation.

Except for the area within the city of Beverly Hills, nearly all of the territory north of Imperial Highway is within the city of Los Angeles and is supplied chiefly by water from the Los Angeles munic­ ipal system. Most of the Los Angeles municipal supply to the coastal

plain is imported from the Owens Valley or from the San Fernando Valley, but in this inland area the city currently obtains a minor auxiliary supply of ground water from its Manhattan and 99th Street plants. Some of the area north of Imperial Highway is served by the Sentney, South Los Angeles, and Normandie systems of the Southern California Water Co. The distribution and magnitude of draft from the larger well fields for public supply, as of 1945, are shown on plate 12.

Inland from the west basin, the position and slope of the pressure level are critical with respect to the rate of replenishment by under­ flow across the west basin boundary. Both the position and slope of the pressure level between Slauson and Rosecrans Avenues are believed to be affected to a major extent by the very heavy withdrawal in the Huntington Park area, a short distance to the east of the east boundary of the Torrance-Santa Monica area. However, the position and slope of the pressure level are affected also by the intensity of local with­ drawal. Thus, it is of interest to note that the combined withdrawal from the pumping plants of the city of Los Angeles and of the Southern California Water Co., between Slauson and Rosecrans Avenues, was 4,030 acre-feet in 1931, 3,130 acre-feet in 1938, \_and 6,440 acre-feet in

1945.

**DISTIUBUT.ION OF DR.AFT AS OF 1940**

By 1945 most of the withdrawal of ground water from the Torrance­ Santa Monica area was concentrated at a number of intensively pumped well fields operated almost entirely for public supply or indus­ trial use. To show the nature of this concentration and its effect on the water levels in the Silverado water-bearing zone and in the cor­ relative aquifers within the San Pedro formation beyond the extent of the Silverado, the magnitude of draft at such plants within the coastal zone of the Torrance-Santa Monica area has been indicated on plate 12 by means of circles whose areas are proportional to the draft. The centers of these circles are plotted at the centers of pumping. For closely grouped wells, the circle commonly encom­ passes the entire well field; for groups of widely scattered wells which supply a single system, such as the South Los Angeles system of the Southern California Water Co., the circle is plotted approximately at the geographic center of pumping. The circles so plotted on plate 12 are numbered and table 10 identifies the agency withdrawing the water; numbers in this table correspond with those of the plate.

As shown on plate 12, the area of most intensive draft in 1945 was between Dominguez Hill and State Street, approximately along Alameda Street.

TABLE *10.-Agencies withdrawing ground water from the coastal zone of the Torrance­*

*Santa Monica area in 1945 for public supply or industrial use*

[Numbers identify location and magnitude of draft as indicated on plate12; well fields withdrawing less than 200 acre-feet not listed]

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|  |  |  |  |
| --- | --- | --- | --- |
| Number on plate 12 | Agency | Number on plate 12 | **Agency** |
| 2La --\_  2b \_  2c \_  2d \_  2e \_  23a½------------ | City of Beverly Hills.  Southern California Water Co.: Sentney plant.  Manning plant. Charnock plant. Sepulveda plant. Pacific plant.  Metro-Goldwyn-Mayer Corp. City of Inglewood:  Plants in main basin. | 1. General Chemical Co. 2. City of Manhattan Beach.   t ::::::::::} California Water Service Co. 14a Dominguez Water Corp.: 14b \_ Redondo plant.   1. **\_** Main plant. 2. \_ General Petroleum Corp. 3. **\_** Moneta Water Co. 4. \_ City of Torrance. 5. Columbia Steel Co. 6. **\_** Quandt pumping plant. 7. **\_** County Water Works District 13. 8. **\_** Palos Verdes Water Co.   City of Los Angeles:   1. Uni 1gff' t. 2. The Texas Co.   25a Shell Oil Co., Inc.:  Wilmington plant. 25b Dominguez plant. 26 Richfield Oil Corp.  27 Tidewater Associated Oil Co. 28 Johns-Manville Products Corp. 29 Stauffer Chemical Co. | |
| i -------------} Plants in west basin.  4a City of Los Angeles:  Manhattan plant. 4b 99th Street plant.  5a Southern California Water **Co.:**  5b \_ South Los Angeles system.  -fia Normandie system.  6b Lennox system.  6c \_ Gardena system.  Lawndale system.  City of Hawthorne.  '**8**I**.**L**•** ---------\_--- Airways Water Co.  **10 \_** City of **El** Segundo.  Standard Oil Co. of California. | |

**PRINCIPAL SOURCES OF GROUND WATER**

**SOURCES** IN **THE TORRANCE-INGLEWOOD SUBAREA.**

In the Torrance-Inglewood subarea, the principal sources of the ground water, in order of increasing age, are: (1) the Gaspur water­ bearing zone in the deposits of Recent age (in Dominguez Gap); (2) the "200-foot sand" in the unnamed upper Pleistocene deposits;

1. the "400-foot gravel" in the upper part of the San Pedro formation of Pleistocene age; and (4) the Silverado water-bearing zone in the middle and lower parts of the San Pedro formation. In relation to draft, the Silverado water-bearing zone is of primary importance, and the "200-foot sand," the "400-foot gravel," and the Gaspur water-bearing zone are of secondary importance, and probably in the order listed.

In 1945, the Silverado water-bearing zone was the source of water for: (1) all withdrawals by industries, with the exception of one small plant; (2) essentially all withdrawals from the municipal well fields of Hawthorne, El Segundo, Manhattan Beach, and Torrance, and about one-third of the withdrawal from the well fields of the city of Inglewood within the west basin; (3) all withdrawals by County Water Works Districts 13 and 22; (4) all withdrawals by the California Water Service Co., the Dominguez Water Corp., and the Palos Verdes Water Co., and about 90 percent of the withdrawal by the Lennox, Lawndale, and Gardena syste.ms of the Southern California Water Co.; and (5) at least half of the withdrawals by private irrigators and the

smaller water companies. **Of** the total withdrawal from the Torrance­ Inglewood subarea in 1945-approximately 78,000 acre-feet-about 68,000 acre-feet or 87 percent was taken from the Silverado water­ hearing zone.

Of the remaining 13 percent-approximately 10,000 acre-feet­ about 8 percent was drawn from the "200-foot sand" and associated aquifers in the unnamed upper Pleistocene deposits, about 3 percent from the "400-foot gravel," and about 2 percent from the Gaspur water-bearing zone in Dominguez Gap.

**SOURCES** IN **THE CULVER CITY SUB.A.REA**

In the Culver City subarea the two principal sources of ground water, in order of increasing age, are (1) the "50-foot gravel" in the

-deposits of Recent age (in Ballona Gap); and (2) the main water­ bearing zone of the San Pedro formation of Pleistocene age--believed to be the essential correlative of the Silverado water-bearing zone to the south. The main water-bearing zone of the San Pedro forma­ tion underlies all of Ballona Gap within the west basin and, at least in the Charnock subbasin, extends northward nearly 2 miles beyond the north edge of the Gap, or about to Pico Boulevard. No uniform water-bearing zone seems to exist north of Pico Boulevard. As shown by well logs, the aquifers are thin and discontinuous; as might be expected for alluvial deposits laid down by streams trans­

:porting debris from the Santa Monica Mountains.

The main water-bearing zone in the San Pedro formation has been the source of supply for: (1) almost all of the water pumped from the three well fields of the city of Santa Monica; (2) all of the with­ drawal from the four well fields of the Southern California Water Co.;

(3) nearly all of the withdrawal used for irrigation in the area north of Washington Boulevard, south of Pico Boulevard 1 and east of Centinela Avenue (pl. 2); and probably more than half of the water pumped for irrigation along the south side of the Ballona Gap. Thus, of the total withdrawal in the Culver City subarea in 1945-some 12,000 acre-feet-it is estimated that about 90 percent was drawn from the main water-bearing zone and associated aquifers within the San Pedro formation; most of the remaining 10 percent was drawn from the "50-foot gravel" in the deposits of Recent age in Ballona Gap.

**SOURCES** INLAND **FROM THE WEST BASIN**

As explained on page 108, the withdrawal from the 90 square miles of the Torrance-Santa Monica area inland from the west basin was not evaluated as a whole. However, all of the larger pumping plants draw water almost entirely from deposits of Pleistocene age and from aquifers within the San Pedro formation. These same

aquifers supply a substantial part of the replenishment to the west basin across the crest of the Newport-Inglewood uplift.

**WATER-LEVEL FLUCTUATIONS**

**SCOPE .AND UTILITY OF THE RECORDS**

In 1903-4 Mendenhall made single measurements of depth to water or of artesian pressure head in several thousand wells on the coastal plain. To extend these data, water-level measurements were made in 41 representative wells at irregular intervals during the next two decades by the Geological Survey. Twenty-six of these wells were within the coastal and inland zones of the present investigation. The records through 1920 have been published by the Geological Survey (Ebert, 1921, p. 13-29); records for three wells for the years 1921-26 have been published by the California Division of Water Resources (Gleason, 1932, p. 62, 77, 104).

In connection with its investigation of water resources **of** the San Gabriel Valley, the Division of Water Rights in the California Depart­

ment of Public Works, in cooperation with Los Angeles County and the city of Pasadena, measured depths to ground water periodically from 1923 until 1928 (Conkling, 1927, 1929, p. 171-200). This program superseded the earlier program of the Geological Survey but included only a few wells in the Torrance-Santa Monica area, all of which were in the territory east of Main Street-that is,in thevicinity of Compton and of Dominguez Gap.

The program of water-level measurements by the California Divi­ sion of Water Rights was accompanied or followed by continuing programs of several agencies, which together extended over all the area of the present cooperative investigation. The two principal programs of periodic water-level measurement in the Torrance-Santa Monica area have been that of the Los Angeles Department of Water and Power, beginning in 1923 and terminating in 1941; and that of the Los Angeles County Flood Control District, beginning in 1928 and continuing to date. These programs have been supplemented by those of many other agencies, especially the following: The San Gabriel Valley Protective Association, beginning in 1928; the city of Pasadena, from 1928 to 1933; the city of Long Beach, beginning in 1929; the city of Beverly Hills, beginning in 1930; the Southern California Water Co., beginning about in 1929; and the California Water Service Co., beginning about in 1933. Periodic measurements have also been made by several other municipalities and water companies, by several industrial plants, and by a few individuals.

Nearly all the water-level records by the agencies listed above have been deposited with the Division of Water Resources in the Cali-

fornia Department of Public Works and are available to the public. Representative records from selected observation wells have been published (Gleason, 1932).

Beginning in 1943, single measurements of depth to water were made by the Geological Survey in several scores of wells in connection with the field canvass of water wells in the Torrance-Santa Monica area. Measurements were continued semiannually until December 1945 in about 60 of these wells. Measurements were made at weekly or biweekly intervals from 1944 to November 1946 in 20 other wells. Water-level recorders were also operated on six wells for periods of a month to 2 years. All the periodic water-level measurements made by the Geological Survey have been published in water-supply papers (see p. 89). Table 11 shows the scope of water-level data available from all agencies, including data taken by the Geological Survey for the coastal zone of the Torrance-Santa Monica area.

TABLE *11.-Scope of water-level records available from wells in the coastal zone of the Torrance-Santa Monica area, as of July 1946*

|  |  |  |  |
| --- | --- | --- | --- |
| Type of record | Number of wells measured | | |
| Active | Discon- tinned | Total |
| Nonperiodic and miscellaneous measurements Semiannual measurements Monthly measurements Weekly measurements  Water-level recorder operated  Total | --------  111  125  16  4 | --------  140  350  4  27 | 266  251  475  20  31 |
| 256 | 521 | 1,043 |

These records of depth to water in wells are of inestimable value for the interpretation of the past and present hydrologic conditions, and they reveal the changes in pressure level or water table that have developed as a result of increasing draft. Hydrographs plotted from periodic measurements in single wells show the nature of .fluctuations and changes in head within the tapped aquifers. Thus, hydrographs for wells tapping separate aquifers at one place reveal the degree or the lack of hydraulic continuity between those aquifers. Water-level contour maps drawn from data for one or more aquifers known to be hydraulically continuous present the water-level conditions at selected times; discontinuities in the water-level contours define basin bound­ aries or barrier features. Also, the regional changes in water level shown by comparing maps for separate times can be utilized to obtain · estimates of change in storage if the specific yield or storage coefficient is known.

Hydrographs for wells in the Torrance-Santa Monica area show several types of fluctuations, related chiefly to recharge and discharge. Specifically these fluctuations are caused by: (1) recharge from streams,

(2) recharge by penetration of rainfall, (3) recharge by underflow, (4) discharge by pumping, and (5) tidal oscillations. Typical fluctuations are illustrated and discussed in following pages.

The water-level contour maps previously introduced (pls. 9-12) show four positions of the water level and directions of water move­ ment in the aquifers of principal draft between 1904 and 1945. Hydrographs for 59 selected wells in the Torrance-Santa Monica area are presented on figures 4 and 5 and plates 13 and 14. The locations of the wells are shown on plate 11; the tapped zones are identified on the individual hydrographs and by symbols on plate 11. Pertinent hydrologic data are given in table 12.

**FLUCTUATIONS IN THE TORRANCE-INGLEWOOD SUBAREA**

Selected hydrographs assembled on figures 4 and 5 and plates 13 and 14, illustrate the rate of change in pressure head in the several aquifers in the Torrance-Inglewood subarea. Most of the hydro­ graphs concern wells that tap the Silverado water-bearing zone, which supplied about 87 percent of the draft in 1945. Other hydrographs are presented, however, to compare pressure heads in overlying aquifers with that in the Silverado water-bearing zone. These paired hydrographs are of particular interest for three reasons: (1) they furnish proof that the aquifers have substantial hydraulic separation;

(2) they indicate the effect of and furnish a clue to the magnitude of draft from each of the aquifers; and (3) they show the differentials in pressure head that have been developed between the several aquifers in the period of most intensive use and are of considerable interest in connection with possible downward migration of contamination, either now or in the future, and with the feasibility of artificial recharge

**DIFFERENCE** IN **HEAD DEVELOPED BETWEEN THE SEVERAL AQUIFERS**

**VICINITY OF DOMINGUEZ GAP**

The Gaspur water-bearing zone of Recent age in Dominguez Gap occurs from about 60 to 140 feet below the land surface and is sepa­ rated from the underlying Silverado water-bearing zone of Pleistocene age by several hundred feet of silt and fine sand of low permeability (pl. 6). On figure *50,* the composite hydrograph for wells 4/13-14Kl and 4/13-14Ll represents the pressure level in the Gaspur water­ bearing zone from 1924 through 1946, and the hydrograph for wells 4/13-21H3 and 4/13-2302 represents the pressure head in the Silver­ ado water-bearing zone for the same period. Data from the Menden­ hall well canvass of 1904 indicate that pressure levels in the **two**

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MEASUREMENTS DISCONTINUED

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1904 1906 1908 1910 1912 1914 1916 1913 19.20 1922 1924 1926 192B 1930 1932

B. WELLS INLAND FROM WEST BASIN

1934 1936 193B 1940 1942 1944 1946

FIGURE 4.-Hydrographs of longest record for wells in and near the west basin.

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FwtTRE 5.-Hydrographs for selected wells in the southern part of the west basin.

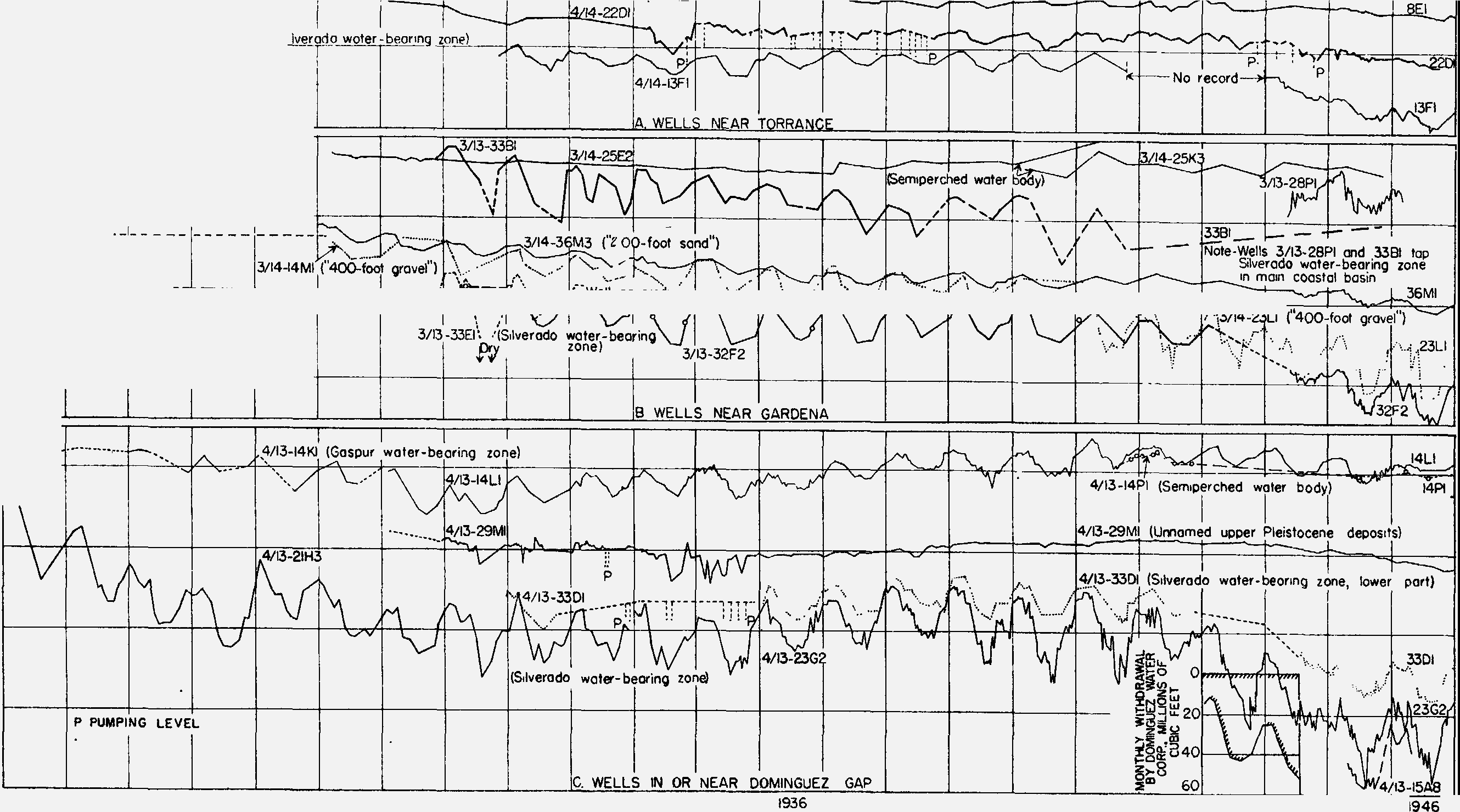


TABLE *12.-Wells in or near the west basin for which hydrographs are plotted on figures 4 and 5 and plates 13 and 14*

Well

Owner's name and well

Water-yielding zone or zones

I Feet

Agency supplying principal record a

USGS

Loca­ tion 1

Dept 2 below (feet) land

Stratigraphic correlation

-----i---, 1-+-sur-face ,

--1--------

2/14-3HL --------

3QL 2667

5D5 2626D

5D9 \_

Artesian Land and Water Co.

City of Los Angeles.

Southern Cali­ fornia Water Co.:

Sentney plant, well 5.

----+- (?) USGS

1 ---------- San Pedro for- LADWP,

mation. LACFCD.

1,1 - ,.. -----••--·- scwc

Sentney plant, well

I 23-54 "50-foot gravel" SCWC

5F2 2627

9.

Shell Oil Co., Inc.

?.AA San Pedro for-

mation.

-r

LADWP

7ML 2609A

18FL 2619A

27DL 1352

27Fl, 2, 3. 1363

Mrs.J. D.

Machado. Lewis A. Crank.•.

City of Ingle­ wood, well 7.

Inglewood Park Cemetery Assn., wells 7,

2, 11.

do LAD WP

26+ 90-312 do Lt, icD

300 135-266 do LACFCD, USGS

------!I -- Sllverado zone LADWP, USGS

32CL 1324

34CL •••• 1364

Formerly by Bowler.

Inglewood

1!/I ()

4r

264-362

"200-foot sand" LADWP,

LACFCD

Silverado zone LADWP

36BL •••. 1404

36HL

Country Club. Southern Cali­

fornia Water Co., Man­ chester Heights plant, well 1.

Formerly by Mrs. Bedell.

i

320

I

1iI o

I

do SCWC

Unnamed upper USGS Pleistocene

deposits.

36KL

1404B

Olivita Mutual

Water Co.

5f, 5

Silverado zone

LADWP

2/15-1P2

1P3

2598

2597B

Guy Beringhely.•• {f85 i

Formerly by 66

}--------- "50-1'00t gravel"--- {LALCAFDCWDP,

do\_ USGS

llE3

2578P

sofo!frngiaieW:ia:t1er. Co.:

Cbarnock

1

5 196-376 San Pedro for­

scwc

11F4

2578C

plant, well L

Cbarnock plant

j

168-346

mdaotion.

SCWC

16FL 1240

well 4.

J. H. Evans o

"50-foot gravel"... LACFCD,

LADWP

22B4\_ 1261A

Clarence MicheL \_ ...,7

63-205 San Pedro for­

LACFD,

23FL 1271M

Los Angeles County Flood Control Dis­ trict, test bole

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t

Semmaiptieornc.hed water body.

LADWP LACFCD

24Cl

34HL.

1291

12640

1.

Mesmer City Corp., Ltd.

Formerly by Barnard.

170-395 San Pedro for­

mation.

do

13o-250 ••••.

LADWP LADWP,

LACFCD

34KL

1264

Palisades del Rey

Water Co., well 1.

208

91-133

do.

LADWP, owner,

See footnotes at end of table, p. 119.

460508-59--9

TABLE *12.-Wells in or near the west basin for which hydrogr.aphs are plotted on figures 4 and 5 and plates 13 and* 1,4-Continued

Well

USGS Loca- tion 1

Owner's name and well

Water-yielding zone or zones

Feet

Depth 2 below Stratigraphic (feet) land correlation

surface

Agency supplying principal record a

3/13---7NL. 1418

Formerly General .,

Petroleum Corp.

---------- Silverado(?) zone•.

**LADWP**

8L2... --- 1437G

H. N. Edison, formerly by

254 ----------

Silverado zone LADWP, USGS

17QL...

1802

1439A

Mrs. Bushby.

H. Hellmers

341

119--330

do ... **LADWP**

1418F

20CL

Union Oil Co

384.0 ---------- \_ do .. LADWP, USGS

1439F

G. L. Douglas.\_.\_

403 183-243 do.\_ **LADWP**

28PL.•.. --------

32F2

Gardena Syndi- cate.

401.0

284--340

do.- . ----

USGS

833A

33BL

John Larronde

750 ---------- ~~\_~~ do .. ----------

**LADWP, USGS**

853.A,

33EL

I. W. Hellman Estate.

375 ----------

do • ---

**LADWP**

3/14-4NL --------

1346B

Union Oil Co

Southern Cali- fornia Water Co., Truro plant, well 1.

**700**

636

272-480

318-636

do ,---

**LADWP**

scwc

llMl 1377

Formerly by

200 ----------

"200-foot sand"\_.\_ USGS, **LACFCD**

l3J2 1409A

;·,

Johnson Ranch. Southern Cali-

. fornia Water Co., Southern plant, well 2.

582 236--556

Silverado zone scwc

14ML 1379

0. 'l'. Johnson Ranch, well 5.

Southern Cali- fornia Water

440 332-380

"400-foot gravel" **LADWP**

21BL 1349

Co.:

Rosecrans plant, well

468 ----------

Silverado zone scwc

23Ll\_ 770D

1.

Compton plant, well

397

334-353

"400-foot gravel"

scwc

25E2 791

Baust\_1.

38 ----------

Semiperched

**LADWP**

25K3

802B

A. J. Walter

30 -------- --

wadtoer body.

**LACFCD**

2603 781A

C. G. Pursche, formerly by

C. C. Jorgen- sen.

205 ----------

"200-foot sand" USGS, LADWP

35RL 794

Southern Cali- fornia Edison Co., Ltd., (Torrance sub- station).

{W. H. Seward,

550 470-548

} 315

Silverado zone. Owner, LACFCD

"200-foot sand" **tALDAWCFPC, D,**

36M3

793B

formerly by Luckensmeyer.

City of El

Segundo:

193.0 }---------

USGS

3/15-12LL **1297**

WellL

355

236--355

"200-foot sand" and Silverado

**LADWP**

12L5

1297G

Well g

380

207-312 \_

zodnoe..

Owner.

12L6 1297F

Well7 City of Man-

350

222-320

\_ do.\_.

Do.

**25AL**

25H2

**701A**

7010

haWttaenll3Beach:

Well4

547

395.0

204-280

239--265

Silverado zone.

\_ do.\_-

**LADWP,** LACFCD, USGS

LADWP

4/13-14KL 897

H. E. Dickson. -------- ----------

Gaspur zone. **JBL, DWR**

14LL 887F

14PL --------

**15A8** 876E

do-\_.

City of Long Beach.

Dominguez Water Corp., well 5.

114. 3

29. 5

980

86--114

25-30

744-980

\_ do .---------

Semiperched water body.

Silverado zone

LB,LACFCD USGS

Owner.

See footnotes at end of table, p. 119.

TABLE 12.-*Wells in or near the west basin for which hydrographs are plotte( on figures 4 and 5 and plates 13 and* 14 Continued

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Well | | | Owner's name and well | Water-yielding zone or zones | | | Agency supplying principal record a |
| USGS | | Loca- ti-On I | Depth 2  (feet) | Feet below land surface | Stratigraphic correlation |
| 21H3 | | 858B | Richfield Oil Corp., well 3.  City of Long Beach, Silverado well **1.**  Robert Tracy  City of Los Angeles, Wilmington plant, well 14.  California Water Service Co., station 3, well 4.  David E. Crutcher.  Standard Oil Co., producing and pipeline dept., well 1. | 800 | 430-788 | Silverado zone  do ----------  Unnamed upper Pleistocene deposits.  Silverado zone, lower part.  Silverado zonl:'. \_. \_  do  do | LADWP, owner. |
| 2302 | | 888H | 1,074 | 596-1,066 | **LB** |
| 29ML | | 320 | 68.5 | ---------- | **LACFCD** |
| 33Dl | | 341D | **888. 2** | 669-800 | LADWP, USGS. |
| 4/14-8EL | | 725 | 440. 5 | 14(}-373 | LADWP, owner, USGS |
| 13FL | | 797 | 697.0 | 24lHl60 | **LADWP,** USGS |
| 22DL\_ | | 768 | 404 | 206-404 | LACFCD,USGS |
|  |  |

1 Number assigned by California Division of Water Resources.

2 Depths below land-surface datum indicated in whole feet are reported; those to a tenth of a foot are meas­ ured by Geological Survey.

3 Names of agencies used in this table are identified as follows: DWR, Division of Water Resources, State or California; JBL, J. B. Lippincott; LACFCD, Los Angeles County Flood Control District; LADWP, Los Angeles Department of Water and Power; LB, city of Long Beach; SCWC, Southern California Water Water Co.; USGS, U. S. Geological Survey.

water-bearing zones were about equal and were about 20 feet above sea level in 4/13-23D. By 1924, levels for both zones had been drawn down but the level of the Silverado water-bearing zone at well 21H3 was about 20 feet below sea level and some 25 feet below the pressure head in the Gaspur zone (fig. 50). The differential increased to about 40 feet by 1930, remained nearly constant to 1941, and increased to about 60 feet by 1946 (high levels for the year for hydrographs 4/13-14Ll and 4/13-23G2). This increasing differential in pressure levels for the two water-bearing zones is indicative of the lack of hydraulic continuity between them. The Gaspur zone here is highly contaminated by oil-field brine, however (p. 258 to 260), and with this pressure differential, which currently is equivalent to some 25 pounds per square inch, the contamination poses a serious threat to the pure water of the Silverado water-bearing zone. Because the two zones are separated by beds of low permeability, contaminated water is more- likely to move downward through wells whose casings are either perforated or rusted through in both zones.

The history of changes in the regimen of the Gaspur water-bearing zone both within and inland from the Dominguez Gap have been treated in some detail in another report (Poland, 1959).

For the semiperched water table in Dominguez Gap, the hydrograph of well 4/13-14Pl, from 1941 through 1946 (also plotted on fig. 5C) shows that the position of the water table in recent years has been essentially equal to that of the pressure level in the Gaspur zone beneath.

Wells 4/13-29Ml and 33Dl, in Wilmington and about 3 miles southwest of well 4/13-23G2, tap the unnamed upper Pleistocene deposits and the lower part of the Silverado zone (table 12). Hydro­ graphs for these wells (fig. *5CJ* illustrate the trends and increasing differential between the water levels in these two aquifers at that place since 1931.

In 1904, under essentially native conditions of head, the water level in both aquifers was about 13 feet above sea level. In the upper Pleistocene deposits the water level had been drawn down to about 20 feet below sea level by 1931, was about constant into 1938, re­ covered to 17 feet below sea level by 1942, and then d clined to 22 feet below sea level by 1946. The pressure level for the lower part of the Silverado water-bearing zone (well 33D1) had been drawn down to 31 feet below sea level by 1932, was about constant to 1942, and then was drawn down to 47 feet below sea level by 1946. Thus, the head differential between these two aquifers increased from noth­ ing in 1904 to about 11 feet in 1932, and to 25 feet in 1946 (high level for the year).

At the WilIDlngton well field of the city *of* Los Angeles, a 240-foot section *of* fine sand and silt separates the upper and lower parts of the Silverado water-bearing zone; this section occurs from about 460 to 700 feet below land surface. Water-level measurements for well 4/13-33E6, not plotted on figure 5, indicate that the pressure level in the upper part of the Silverado water-bearing zone was about 21 feet below sea level in 1927, 24 feet in 1930, and 32 feet in 1946 (high levels for the year). Thus, by 1946, the pressure level for the upper part of the Silverado was about 10 feet below that of the unnamed upper Pleistocene deposits and about 15 feet above that of the lower part *of* the Silverado water-bearing zone (well 33Dl).

**GARDENA AREA**

Four distinct and separate water-bearing zones in the Gardena area are tapped by wells. These zones and their approximate depths below land surface are as follows: (1) The semiperched water body to about 80 feet; (2) the "200-foot sand" in the unnamed upper Pleistocene deposits from 140 to 260 feet; (3) the "400-foot gravel" in the upper part of the San Pedro formation, from 320 to 400 feet;

:and (4) the Silverado water-bearing zone in the lower part *of* the San Pedro formation, from 500 to 700 feet (pl. 3B).

On figure *5B,* hydrographs for wells 3/14-25E2 and 25K3 show the position of the water table in the semiperched water body from 1929 through 1945; the hydrograph for well 3/14-36M3 shows the pressure level in the "200-foot sand" from 1929 through 1946; hydrographs for wells 3/14-14Ml and 23Ll show the pressure level in the "400-foot gravel" for the same period; and hydrographs for wells 3/14-35Rl and 3/14-32F2 show the pressure level of the Silverado water-bearing zone from 1924 through 1946.

The record for the "200-foot sand" is extended back to 1904 by the hydrographs for wells 3/14-llMl and 2603 (fig. *4A).* For the "400- foot gravel," although wells 3/14-14Ml and 3/14-23Ll are a mile apart, and although the hydrograph for well 3/14-23Ll indicates a pressure head about 5 feet below that of well 3/14-14Ml early in 1941 when well 3/14-23Ll was completed and placed in service, the two hydrographs are believed to represent the changes in pressure sur­ faceduringthe periodofrecord. In confirmation, well3/14-10Cl, which also taps the "400-foot gravel" is 2.5 miles northwest of well 23Ll; in 1945 the pressure level in well 1001 (not shown on fig. 5) was only about 2 feet above that for well 3/14-23Ll in March and identical with it in December.

For the Silverado water-bearing zone, well 3/13-32F2 is 2.6 miles east of well 3/14-35Rl and only about a mile from the east boundary of the west basin. Nevertheless, from mid-1944 to the end of 1946, frequent measurements (at least biweekly) of depth to water in each of these wells indicated essentially an identical position of water level throughout the yearly range. In fact, the pressure level of these years in well 3/14-35Rl was not plotted on figure *5B* because the graph would have been confused with that for well 3/13-32F2. For earlier years also, the levels for both can be considered coequal, as is shown by the position of the random measurements in well 35Rl as related to the hydrograph for well 3/13-32F2.

For the four water-bearing zones in the Gardena area, the changes in water levels that have occurred since 1904 can be summarized as follows, utilizing high level for the year if known:

1. In 1904, Mendenhall's data show that the water levels in the several water­ bearing zones were about equal but increased slightly in altitude with depth of zone. For example, the water table of the semiperched zone and the pressure surface of the "200-foot sand" were both from about 15 to 25 feet above sea level, but the pressure surface of the Silverado water-bearing zone was from 25 to 30 feet above sea level.
2. By 1920, the water level in the "200-foot sand" had been drawn down to about 10 feet above sea level (well 3/14-26C3, fig. 4A) and that of the Silverado water-bearing zone had been drawn down to sea level (measurement by the Southern California Edison Co. in well 3/14-: 5Rl).
3. In 1929, the water table of the semiperched body was 16 feet above sea level; and the pressure surfaces for the "200-foot sand," the "400-foot gravel," and the

Silverado water-bearing zone were respectively **2,** 5, and 18 feet below sea level (fig. *5B).*

1. By 1941, levels in the four zones were respectively 19 feet above sea level (25E2); 14 feet below sea level (36M3); 15 feet below sea level (14Ml); and **22** feet below sea level (32F2).
2. As of 1946, levels were respectively 12 feet above sea level (extrapolated), and 18 feet, 29 feet, and 38 feet below sea level. Thus, as of 1946, and with respect to high levels for the year, the pressure level in the Silverado water-bearing zone was 50 feet below the semiperched water table, 20 feet below the pressure level of the "200-foot sand," and about 9 feet below that of the "400-foot gravel."

**VICINITY OF INGLEWOOD**

In the vicinity of Inglewood, the hydrographs for wells 2/14-3201 and 3/14-4Nl, shown on plate 13, indicate conditions of change in head in the "200-foot sand" (3201) and in the Silverado water-bearing zone (4Nl) from the early thirties through 1945. These wells are about 2 miles apart. Several hundred acre-feet of water is withdrawn each year from well 3/14-4Nl, whereas well 2/14-3201 is used solely as an observation well. Thus, their hydrographs do not furnish an absolute comparison of static water levels at one place. However, they do indicate the increasing differential in head between the two zones in a general way.

In 1904, water levels in both the "200-foot sand" and the Silverado water-bearing zone near the sites of these wells were about 25 feet above sea level. By 1933, the head in the "200-foot sand" was at sea level and that of the Silverado was about 8 feet below sea level. The pressure heads of both aquifers declined continuously from 1933 to 1945; by 1945, the head in the "200-foot sand" at well 2/14-32O1 was about 17 feet below sea level and the head in the Silverado at well 4Nl was about 40 feet below sea level. Thus, the head differential between the two aquifers, which was zero in 1904 increased by 1945 to 23 feet (high for the year) and about 50 feet (low for the year).

**FLUCTUATIONS AND CHANGE** IN **HEAD IN THE SILVERADO WATER-BEARING ZONE**

Figure 5 and plate 13 include hydrographs for 20 wells or groups of wells in the Torrance-Inglewood subarea that tap the Silverado water-bearing zone or correlative aquifers in the San Pedro formation. These wells were selected to give a wide and representative geographic distribution (pl. 11).

**AREA SOUTH OF REDONDO BEACH BOULEVARD**

With regard to the southern part of the area, figure 5 shows hydro­ graphs for two wells in the water-table reach between Torrance and Redondo Beach-for well 4/14-SEl, 0.9 mile from the coast, and well 4/14-22Dl, 2.3 miles from the coast; also for eight wells in the confined or pressure area between Torrance and Long Beach wells 4/14-13Fl,

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3/14-35Rl, 3/13-33El, 3/13-32F2, and 4/13-15A8, 21H3, 23G2, and

33D1. From west to east, these hydrographs show great differences in (1) the character and amplitude of the seasonal fluctuations, and

1. the rate and amount of decline in pressure head.

The seasonal fluctuations have been small in the water-table area west of Torrance and have become progressively greater to the east in the confined or pressure area. For example, in water-table well 4/14- SEl the seasonal fluctuation has ranged from 1 to 3 feet, and since 1943, when pumping at this well ceased, the fluctuation has been about 1.5 feet per year. The graph from a water-level recorder operated on this well by the Geological Survey showed a daily fluctuation of as much as 0.1 foot, which was correlated with the tidal fluctuation at Los Angeles Outer Harbor. This correlation indicated a tidal effi­ ciency of about 1.4 percent but with an 8-hour lag in registration. Well 4/14-22Dl is 2 miles farther from the coast and only about 200 feet from a pumped well. Even though the hydrograph shows the effect of the nearby pumping, the seasonal range commonly has not exceeded 4 feet.

Within the pressure area, the seasonal fluctuation has ranged from about 5 feet at well 4/14-13Fl in Torrance to as much as 20 to 25 feet at well 4/13-23G2 (city of Long Beach, Silverado well) in Do­ minguez Gap. Well 4/13-23G2 is an unused observation well a mile from the nearest active well tapping the Silverado water-bearing zone (4/13-22Kl, used for irrigation); also 1.2 and 1.7 miles from the well field of the Dominguez Water Corp. (in 4/13-15A), and the Richfield Oil Corp. (in 4/13-21H). Each of these well fields is a locus of heavy draft (pl. 12, plants 14b and 26). The seasonal range shown by the hydrograph for well 4/13-23G2 was only about 13 feet from 1933 to 1938 but has nearly doubled with the accelerated withdrawal during the forties.

Most of the draft in the vicinity of Dominguez Gap is caused by continuous demands of industrial plants; the draft is about as heavy in winter as in summer. Therefore, the hydrograph for well 4/13- 2302 might be expected to show little, if any, seasonal fluctuation. However, the draft by the Dominguez Water Corp., which is the largest single draft of the area, does vary substantially from winter to summer, because part of the withdrawal is for irrigation and do­ mestic use. The monthly draft by this corporation from January 1943 to June 1944, inclusive, has been plotted on figure *50* to show its relation to the seasonal fluctuation in pressure level in well 4/13- 2302. The correspondence is reasonably good, although the pressure level of well 4/13-2302 is affected by other nearby pumping; it is possibly most strongly affected by the intermittent pumping of irrigation well 4/13-22Kl.

The decline in the presslli'e head of the Silverado water-bearing zone in the southern part of the Torrance-Inglewood subarea has ranged from an average of about half a foot per year near Redondo Beach to as much as 2 feet per year in Dominguez Gap. At well 4/14-8El (in Redondo Beach), the water table has declined 10 feet from 1928 to 1946-an average yearly rate of 0.55 foot. In Domin­ guez Gap, some 10 miles to the east, the decline in the pressure head from 1924 to 1946, shown by the composite hydrograph for wells 4/13-21H3-23G2, has been 46 feet, and has occurred veiy largely in two widely separate periods. From 1924 to 1927 the decline was 20 feet, or about 7 feet per year; and from 1941 into 1946, dming the war period, it was 26 feet, or about 5 feet per year.

**AREA BETWEEN GARDENA AND THE BALLONA ESCARPMENT**

For the central part of the west basin south of the Ballona escarp­ ment, plate 13 shows hydrographs for eight wells or groups of wells which tap the confined reach of the Silverado, as follows: 3/15-12Ll, L6, and L5, at El Segundo; 3/15-25H2 and Al at Manhattan Beach; 3/14-21Bl, 3/14-13J2, 3/13-1802, and 3/13-2001, all near Rose­ crans Avenue; and 3/14-4Nl and 2/14-3401 near Inglewood. Wells 2/15-34Hl and 34Kl, whose hydrographs also are shown, tap the main aquifer of the San Pedro formation (believed correlative with the Silverado water-bearing zone) in the water-table reach near Playa del Rey (pl. 11).

In the confined reach of the Silverado water-bearing zone, near the coast at the municipal well field of El Segundo, hydrographs for wells 3/15-12Ll, L6, and L5 suggest a seasonal fluctuation of about 2 feet if pumping effects are disregarded. Three miles inland and south of Hawthorne, the pressure level at well 3/14-21Bl varied about 10 feet per year in the middle thirties and the annual range increased to about 15 feet by the early forties. The joint discharge of wells 21Bl and 21B2 has ranged between 350 and 711 acre-feet per year since 1940. At the east margin of the west basin, the pressure level in well 3/13-1802 fluctuated about 10 feet per year in 1945 and 1946, but the range in pumped well 3/14-13J2 has been as much as 23 feet (in 1945).

Throughout the central part of the west basin most of the water is pumped for domestic and irrigation use. Thus, the draft is heaviest late in the summer and it is lightest from December to March. The pressure levels in wells fluctuate in direct ratio to draft demands. This general seasonal fluctuation, which is greatest far within the confined reach of the Silverado water-bearing zone and near the cen­ ters of heaviest pumping, may be accompanied by a seasonal com­ pression of the aquifer and the confining beds deve1oped by the re-

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duction of artesian pressure in the summer, when pumping is most inten ive, and expansion of the beds caused by the gradual increase of pressure as water moves into the compressed parts of the forma­ tion during winter months. Such an explanation has been suggested by Fiedler (1944, p. 244-245) for similar fluctuation in the Roswell artesian basin. The subject of compressibility of artesian aquifers has been treated in more detail by Meinzer (Meinzer and Hard, 1925, p. 73-95; Meinzer, 1928, p. 263-291).

As in the water-table area near Redondo Beach, the seasonal fluc­ tuations of the water table near Playa del Rey, at wells 2/15-34Hl and 34Kl, have been very small-in most years the range in level has not exceeded 0.5 foot. The nearest heavy draft is at El Segundo, about 2.7 miles southeast from these wells as shown by plate 12. The only local withdrawal is from wells 2/15-34Al and Kl (wells 3 and 1 of the Palisades del Rey Water Co.). In 1945 their joint draft was about 170 acre-feet.

The drawdown of about 1 foot in the water table at well 2/15- 34Hl, w:hich persisted from February 1935 to April 1937, was induced by a temporary increase in draft from wells of the Palisades del Rey Water Company, as follows: 89 acre-feet in 1933; 87 acre-feet in 1934; 328 acre-feet in 1935; 147 acre-feet in 1936; 102 acre-feet in 1937; and 99 acre-feet in 1938. An active but temporary drilling program in 1935 in the so-called Del Rey Hills segment of the Playa del Rey oil field received most of its water supply from the wells of this company.

The water table in well 2/15-34Kl consistently stood about 2 feet above sea level in the thirties, but from the end of 1940 to the end of 1941 the level rose from 2.6 to 3.8 feet above sea level. Rainfall was very heavy in the water year 1940-41; at Los Angeles it was about 210 percent of the 68-year average (table 2), and the greatest since 1889-90. The unique rise in water level in well 34Kl was caused by recharge from this rainfall. The peak rainfall was in Feb­ ruary and March (12.42 and 8.14 inches at Los Angeles); the water­ table peak was in November-December, indicating a 9-month lag in maximum rate of recharge at the water table. The water froru rain­ fall here must pass through about 80 feet of dune sand to reach the water table.

The average rate of downward movement of water from rainfall at well 34Kl in 1941 apparently was about 9 feet per month, only about 3 percent as rapid as the rate of 10 feet per day cited by Sopp (1929,

p. 2227) for penetration through 150 feet of Recent alluvium near Pasadena, Calif. Possibly the slow rate of movement was caused by the restraining effect of two beds of clay (7 and 9 feet thick) reported in the log for this well to be present within the dune sand. It is not

known why the water table at well 2/15-34Hl, 2,900 feet northeast of well 34Kl, did not show a similar response, although a rise and decline may have occurred between the May and October measure­ ments of 1941.

· As shown by the hydrographs of plate 13, the decline in the pressure head of the Silverado water-bearing zone in the central part of the west basin (between Gardena and the Ballona escarpment) has differed widely from place to place.

Within the confined reach, about 1.2 miles from the ocean at the main well field of El Segundo, water levels were about 3 feet below sea level in the early thirties and about 4 feet below sea level in 1941 (wells 3/15-12Ll-12L6); thus, these levels declined about a foot in 10 years. From 1942 through 1946 the decline was 8 feet, or nearly 2 feet per year. Wells at the main well field of Manhattan Beach (3/15-25Al) have shown about the same character and rate of pressure decline.

On the other hand, near the central synclinal axis of the west basin at well 3/14-4Nl (north of Hawthorne) the decline in pressure head was nearly uniform from 1933 to 1940 at about 2 feet per year, and then increased to more than 3 feet per year to 1946; at well 3/14-21Bl, south of Hawthorne, the rate of decline was about 1.3 feet per year from 1930 to 1941 and about 3 feet per year from 1941 to 1946.

In the water-table reach near Playa del Rey (wells 2/15-34Hl and

**Kl),** water levels were essentialy stable from 1930 through 1944 but declined about 2 feet in 1945-46. Because water levels to the north, east, and south were below sea level as early as 1933 (pl. 9), the water table of the Playa del Rey area must have been maintained at or above sea level since the early thirties by recharge from rainfall. Thus, the recharge from rainfall in this area is shown to have been more than sufficient to supply the draft from the wells of the Palisades del Rey Water Co. However, in 1945 the regional cone of water­ level lowering reached wells 34Hl and 34Kl and caused a steady if slow decline. It is interesting to note that the chloride concentration of water from well 34Kl has increased sharply since January 1945 (fig. 15), coincident with the decline in water level.

**FLUCTUATIONS** IN **THE CULVER CITY SUBAREA**

As discussed previously, the part of the west basin in and north of Ballona Gap includes three semi-independent subbasins formed by the partitioning effect of the Overland Avenue and Charnock faults. Water levels in the three subbasins have fluctuated in widely differing fashion. The hydrographs of plate 14 bring out some of the most marked differences

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**COASTAL AREA**

Wells 2/15-16Fl and 2/15-22B4, respectively, tap the "50-foot gravel" and the San Pedro formation in the coastal area west of the Charnock fault. Hydrographs for these wells (pl. 14) indicate that spring water levels in the two aquifers were essentially equal; in the thirties, the pressure head in the San Pedro formation at well 22B4 had a greater seasonal range than did that of the "50-foot gravel" at well 16Fl, but this fluctuation was induced by nearby pumping for irrigation.

In 1904, water levels were about 5 feet above sea level near well 16Fl and 8 feet above sea level near well 22B4. By 1930 the levels had been drawn down about 10 feet below sea level at both wells. Records are not available to define when this drawdown developed; but presumably, most of it occurred in the twenties, when pumping for irrigation was most intensive. By 1930, the front of saline con­ tamination had passed inland beyond both wells (pl. 16), and local draft was decreasing.

The hydrographs show a slow and relatively uniform recovery of water level from 1931 to 1941 in well 16Fl, and a similar but irregular recovery in well 22B4; this recovery was caused by a decrease in irrigation draft as saline encroachment became more extensive (pl. 16). In the spring of 1941 the levels rose several feet, coincident with cessation of pumping at the Marine plant of the city of Santa Monica (in 2/15-9N); in 1940 this draft had been 944 acre-feet. Also the recovery of water level in 1941 probably was partly due to the increased replenishment during the wet winter of 1940-41. At well 16Fl the recovery continued until 1944, when the level stood a foot above sea level, and the "ground-water hole" of the early thirties had completely disappeared (pls. 9-12).

Well 2/15-23Fl, about 4,000 feet east of well 22B4, taps the semi­ perched water body overlying the "50-foot gravel." The hydrograph (pl. 14) suggests that, the water table of the semiperched body generally stood a few feet above the water level of the underlying aquifers in the late thirties, but has been essentially coincident since 1941.

**CHARNOCK SUBBASIN**

Very few of the wells in the Charnock subbasin for which water­ level records are available tap only the "50-foot gravel." Many small wells which formerly tapped this aquifer have gone dry and have been abandoned, such as well 2/15-1P3 (fig. 4). The hydro­ graph for this well indicates that the water level in the "50-foot gravel" declined fairly uniformly from 1904 to 1911 and from 1918 to 1926; the hydrograph for well 2/15-1P2 continues the record of the decline to 1946. Both wells are close to the Overland Avenue fault

which, however, does not interrupt hydraulic continuity within the "50-foot gravel." The hydrographs indicate that this aquifer does not have hydraulic continuity with the main aquifer of the San Pedro formation beneath, because the pressure levels of the latter aquifer have followed an entirely different trend. Hydrographs for wells 2/15-11F4 and 2/15-11E3 at the Charnock plant of the Southern California Water Co. and for well 2/15-24O1, about 2 miles southeast, illustrate the fluctuations since 1930 in the San Pedro formation (pl. 14).

In 1904 the water level in 2/15-1lC was from 30 to 35 feet above sea level and in 2/15-240 it was about 16 feet above sea level. In 1925 the level at well 2/15-24O1 was 11 feet above sea level, thus indicating a decline in head of only about *5* feet since 1904.

In 1925 the city of Santa Monica completed its first well at the Charnock municipal field in 2/15-llC; about 1927 the Southern California Water Co. began taking water from its Charnock well field in 2/15-llE and 2/15-llF, and the draft became very heavy before 1930. This concentrated withdrawal from the NW} sec. 11 has been the controlling factor in the fluctuation of the pressure level in the main aquifer of the San Pedro formation throughout the Charnock subbasin since 1926. The heavy draft at these fields was supple­ mented by pumping at the Sepulveda plant of the Southern California Water Co. in well 2/15-llJ, which also commenced in 1926. To­ gether, these withdrawals produced a cone of perennial drawdown which rapidly extended to the north and south but was terminated abruptly on the west by the Charnock fault barrier, and was limited on the east by the more distant Overland Avenue fault. A water­ level contour map of the high level for 1930 (not included in this report) shows that pressure levels at the Charnock well fields then were 20 to 30 feet below sea level; in addition, the map shows that water levels had been drawn down below sea level southward about 2 miles, or to Ballona Creek (see hydrograph for well 2401), and northward about three-quarters of a mile, or about halfway to Pico Boulevard.

The hydrographs for wells 2/15-11F4 and 11E3 illustrate the great drawdown of water level that occurred at this center of pumping from 1931 to 1940, inclusive. The combined yearly draft from the Charnock well fields by the city of Santa Monica and by the Southern California Water Co., also illustrated on plate 14, increased from 6,070 acre-feet in 1931 to 9,190 acre-feet in 1940. Withdrawal by Santa Monica decreased about one-half in 1941 and was negligible by 1942 (the total draft from the Charnock fields was 2,505 acre-feet at this time). In response to this variation in concentrated draft, the water level in well 11E3 was drawn down to 100 feet below sea level by 1940 but

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recovered about 45 feet by 1945 and became temporarily stabilized about 55 feet below sea level. It should be noted that this well is pumped and is in the midst of other pumped wells; hence the level for this well illustrated on plate 14 represents a "recovery" level observed while well 11E3 was idle but while other wells were pumped. Thus, it shows the over-all drawdown at the well field.

Water levels in other wells tapping the San Pedro formation in the Charnock subbasin have fluctuated primarily in response to the draft at the Charnock well fields. For example, well 2/15-2401 is 2 miles southeast from the Charnock fields and has not been pumped since 1935. Its pressure-level graph is a reduced replica of the hydrographs for wells 11F4 and 11E3 and shows the same downward trend from 1930 (1925) through 1940 and a gentle recovery of about 4 feet from

1941 to 1945, inclusive.

**CRESTAL SUBBASIN**

The crestal subbasin occupies the narrow upthrown block between the Inglewood fault to the east and the Charnock fault to the west. In the San Pedro formation within this subbasin, movement of water is southward and the pressure levels now stand far above the drawn­ down levels to the west and east.

Records of water level by Mendenhall in 1904 and periodic measure­ ments beginning in 1930 show that there was no change in the pressure head of the San Pedro formation in the crestal subbasin from 1904 to 1930. For example, measurements made by the Geological Survey in well 2/15-lFl (Ebert, 1921, well 16) between 1904 and 1910 indicate that its pressure level then was 60 to 62 feet above sea level; it was still about 62 feet above sea level in 1930, as shown by a water­ level contour map for the spring of 1930 prepared as a part of the present investigation. Also, about 2 miles to the south in 2/14-7M, the pressure level was 40 feet above sea level in 1904 and in 1930.

The hydrographs for wells 2/14-7Ml and 18Fl (pl. 14) show the change in pressure head that has occurred from 1930 to 1945, nclusive. The seasonal fluctuation has been less than a foot (a icharacteristic of wells in this subbasin). Decline of head began in 1931, was very gentle until 1936, increased in 1937, and then continued until 1945 at a fairly uniform rate-about 1 foot per year in well 7Ml and 2 feet per year in 18Fl. Compared with the great range in water levels to the east and west, the change in pressure head in this subbasin has been suprisingly uniform and completely independent-attesting to a lack of hydraulic continuity within the San Pedro formation across the Inglewood and Charnock faults. The fluctuations of water level have been in response to change in draft within the subbasin. Perennial withdrawal has been chiefly by the Southern California Water Co. at its Manning plant in 2/15-10,

beginning in the middle twenties; and by the Metro-Goldwyn-Mayer Corp. from wells 2/15-12Bl and 2/14-7Pl, beginning in 1932. As described earlier (p. 108), the over-all draft did not exceed a few hundred acre-feet per year until the middle thirties; it was about 1,100 acre-feet in 1935 and in 1940, and about 1,600 acre-feet in 1945. Water levels in wells at the Manning plant of the Southern California Water Co. show a seasonal fluctuation of as much as 10 feet, but their long-term trend has been in agreement with that of the hydrograph for well 2/14-7Ml; water levels at the Manning plant are about 25

feet higher than at well 7Ml.

Water levels in the "50-foot gravel" in the crestal subbasin have fluctuated in a different manner from those in the San Pedro formation, presumably because the "50-foot gravel" is hydraulically continuous across the barrier faults that are so effective in damming the older aquifer. Hydrographs for wells 2/15-1P2 and 1P3 (fig. 4) show the long-term decline in head in this aquifer. For the past two decades, draft from the "50-foot gravel" within the crestal subbasin has been negligible; hence the decline has been caused largely by decrease of inflow, and by continued outflow.

**FLUCTUATIONS INDUCED BY PUMPING**

Seasonal fluctuations related to pumping are discernible in most of the hydrographs for wells measured monthly or more frequently. Pumping draft for irrigation and other uses fluctuates not only with the season but also from day to day. Even wells supplying water to satisfy a reasonably constant industrial demand may be subject to momentary and frequent changes in rate of discharge if the system is operated with an automatic control and substantial storage facilities. These fluctuations of the water level in observation wells induced by such changes in the rate of withdrawal can be determined only by taking a continuous record of water level.

In connection with the operation of water-level recorders in wells, the Geological Survey has obtained many examples of these short­ term fluctuations. Two records of particular interest are illustrated

in figure 6.

Well 4/13-33Dl (city of Los Angeles, Wilmington plant, well 14) in Wilmington taps the lower part of the Silverado water-bearing zone from 669 to 800 feet below the land surface. The wells of the Texas Co. in 4/13-27M, 6,000 feet to the northeast, tap the full thickness of the Silverado water-bearing zone from 400 to 800 feet below the surface. In December 1941 well 4/13-27M4 (owner's well 6) was being pumped continuously at 850 gpm and well 27M3

{owner's well 5) was on automatic control, pumping intermittently at 3,000 gpm. Thus, the over-all discharge was at the base rate of 850

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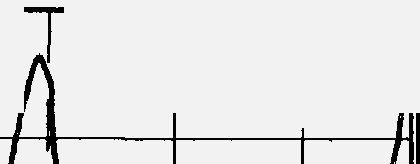
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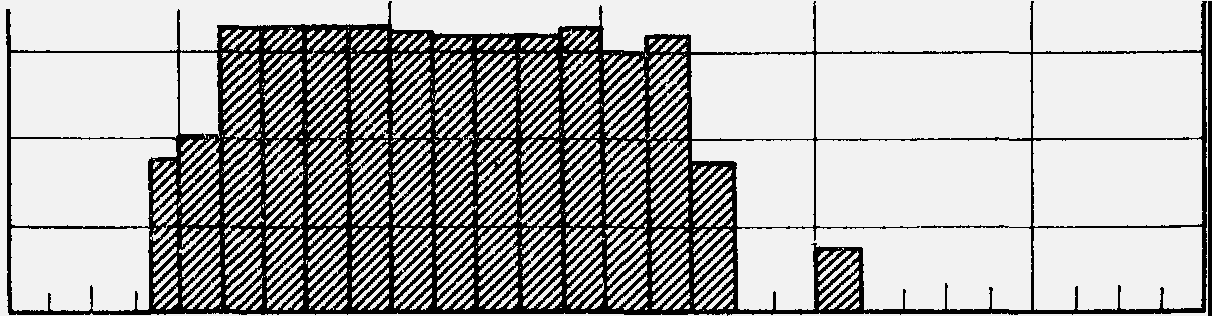
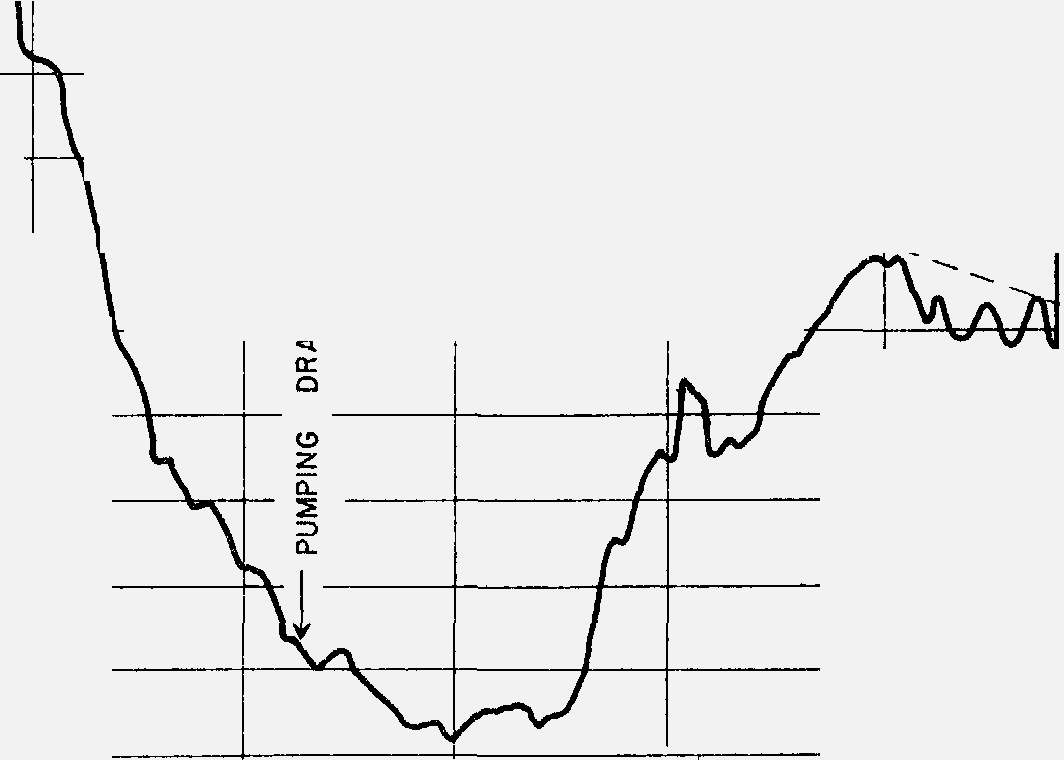
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FIGURE 6.-Graphs showing fluctuations of water level in wells 4/13-33Dl and 4/14--13Fl induced by pumping of distant wells.

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HYDROGRAPH FOR WELL 4/I4-13FI, 1 2, 000 FEET NORTHWEST OF LOMITA PLANT WELLS

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gpm with intermittent increase to 3,850 gpm (fig. 6). The plot of pressure head in well 4/13-33Dl indicates an immediate response to the pumping of well 27M3. During the time here graphed, the average length of each pumping period for well 27M3 was about 1 hour and the average drawdown in pressure level at well 33D1 induced by this pumping was about 0.08 foot. The drawdown at the pumped well was about 15 feet in 1941. The precise amount of time required for the transmission of the pressure effect through the 6,000-foot distance is not known but the graph indicates registration at well 33D1 within a very few minutes. Before the cause of the fluctuations was identified, the recorder had to be removed from the well and thus an expanded-time graph was not obtained.

Well 4/14-13Fl, near Torrance, taps the full thickness of the Sil­ verado water-bearing zone. The fluctuation of pressure head at this well from April 16 to May 13, 1944 is shown on figure 6 together with the combined daily draft from wells 4/13-3001 and Kl (city of Los Angeles, Lomita plant, wells 6 and 7). The Lomita plant wells, located 12,000 feet southeast from well 4/14-13Fl, also tap the Silverado. Their pumps had been idle for about 3 weeks before the beginning of pumping at 9:20 a. m. April 19. In the following 14 days (ending May 2), about 82,620,000 gallons (254 acre-feet) of water was withdrawn from the Silverado water-bearing zone through these wells, at an average discharge rate of 4,340 gpm. The hydro­ graph for well 13Fl shows that the drawdown of the pressure head caused by this pumping was superimposed on a general declining trend of about 0.04 foot per day. Before, during, and after the opera­ tion of the wells at the Lomita plant, the hydrograph for well 4/14- 13Fl showed a diurnal fluctuation of about 0.1 foot; its cause is not known. As nearly as can be determined from the recorder graph for well 13Fl, the pressure level at this well began to decline about 30 minutes after the pumps were turned on at the Lomita plant, about

* 1. miles distant. Considering the general trend, the drawdown in

pressure level induced by the continuous operation of the Lomita plant was 1.1 feet after 4 days and 1.5 feet after 10 days.

Both the rate of response and the magnitude of drawdown at well 4/14-13Fl attest to the complete confinement of the Silverado water­ bearing zone between Wilmington and Torrance. If this aquifer were unconfined in that area, it is doubtful if the effect of pumping at a distance of 12,000 feet could be detected from a recorder graph. Certainly a cone of water-table depression of appreciable depth would take many weeks to extend 12,000 feet from the origin.

By plotting on semilogarithmic coordinates the drawdown at well 4/14-13Fl against the time since the pumps at the Lomita plant were started (log scale), the graphical method developed by Cooper and

**GROUND WATER HYDROLOGY** 133

Jacob (1946, p. 526-534) can be used to determine transmissibility, permeability, and storage coefficient. As discussed on page 54, the transmissibility determined from these data is about 813,000 gpd per foot, and the indicated coefficient of permeability is about 2,000 gpd per square foot. The storage coefficient can be calculated by use of the equation:

8=2.25 *T t0 /r2*

where Sis the storage coefficient (volume of water that a unit decline of head releases from storage in a vertical prism of the aquifer of unit cross section), Tis the transmissibility, *t0* is the value of time at the drawdown intercept 0, and *r* is the distance of the observation well from the pumped well. The storage coefficient so derived from the semilogarithmic plot for drawdown in well 4/14-13Fl is 0.0012.

Figures 7 and 8-discussed in detail in the section on barrier features (p. 137 to 141)-also show drawdown fluctuations induced by pump­ ing of nearby wells.

**HYDROLOGIO EVIDENCE RELATING TO BOUNDARIES OF THE WEST BASIN**

**WATER LEVELS ACROSS THE BARRIER FEATURES OF THE NEWPORT­ INGLEWOOD UPLIFT**

Thefaults of the Newport-Inglewood uplift produce discontinuities in the pressure surfaces of the aquifers of Pleistocene age. Thus, the location of the fault barriers commonly can best be determined by constructing water-level contour maps and by relating hydraulic discontinuities to geologic or physiographic evidence of faulting. In places where the latter types of evidence are lacking or unknown, the hydraulic discontinuity may furnish the only proof of a fault barrier, and the accuracy of location then depends wholly on the water-level control. The inferred fault barrier passing southeastward along the Rosecrans Hills from the Potrero fault to the Avalon-Compton fault and the similar feature along the crest of Dominguez Hill both have been defined purely from hydrologic data as revealed on plates 9-12, and on hydrographs to be discussed.

The effectiveness of the faults as barriers to water movement can be evaluated in part from the magnitude of the hydraulic discontinu­ ities across them, and by the gradients developed immediately inland and coastward. Both features are shown by the water-level contour maps. The effectiveness can be appraised also from simultaneous water-level fluctuations in two or more wells on opposite sides of such barrier features. In a recent report (Poland, 1959) such an appraisal has been made for the 22-mile reach of the Newport-Inglewood uplift from Dominguez Hill southeast to Newport Mesa.

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From that appraisal and with respect to the reach within Los Angeles County-that is, from Dominguez Hill to the Orange County line near Seal Beach-it has been concluded (Poland, 1959) that:

In Dominguez Gap there is no barrier to movement through the Gaspur water-bearing zone of Recent age. In the underlying Silverado zone a substantial barrier has been developed but presumably it is not wholly watertight. Along the Signal Hill uplift the barrier features form a reasonably effective barrier to water movement but available evidence suggests that they are not wholly water­ tight against differential heads of several tens of feet. In Alamitos Gap, no barrier exists within the deposits of Recent age which extend to about 90 feet below land surface. However, the barrier across the underlying San Pedro formation is believed to be essentially watertight.

For the demonstration of the hydrologic evidence from which these conclusions were derived, the reader is referred to that report. In particular, attention is directed to the analysis of hydraulic conditions across the inferred extension of the Cherry-Hill fault in Dominguez Gap, (1) in the semiperched water body, (2) in the Gaspur water­ bearing zone, and (3) in the Silverado water-bearing zone (Poland, 1959).

**DOMINGUEZ HILL TO THE BALDWIN HILLS**

To show hydraulic discontinuities across the 12-mile reach of the Newport-Inglewood uplift from Dominguez Hill northwesterly to the Baldwin Hills, selected data collected or assembled as a part of the present investigation are presented on five pairs or sets of hydrographs, as fo1lows:

* + 1. Across the ground-water barrier on the northwest flank of Dominguez Hill, hydrographs for well 3/13-33Bl (inland side) and well 3/13-33El (coastal side). (See fig. 5B.)
    2. Across the south end of the Avalon-Compton fault, hydrographs for well 3/13-28Pl (inland side) and well 3/13-32F2 (coastal side). (See fig. *5B.)*
    3. Across the north end of the Avalon-Compton fault, hydrographs for well 3/13-17Ql (inland side) and well 3/13-2001 (coastal side). (See pl. 130.)
    4. Across the ground-water barrier along the central part of the Rosecrans Hills, hydrographs for wells 3/13-8L2 and 7Nl (inland side) and wells 3/13-18G2 and 3/14-13J2 (coastal side). (See pl. 130.)
    5. Across the Potrero fault east of the center of Inglewood, hydrographs for wells 2/14-27Fl, 2, and 3 (inland side), and well 2/14-3401 (coastal side). (See pl. 13D.)

All these wells tap the Silverado water-bearing zone, therefore the hydrologic data are common to this aquifer. The locations of these wells are shown on plate 11.

On the northwest flank of Dominguez Hill, wells 3/13-33Bl and 3/13-33El are about 2,700 feet apart (about 2,300 feet measured normal to the water-level contours). The record for well 3/13-33El spans only the years 1931-32. For these years seasonal fluctuation was about the same in both wells, but the pressure head in well 33El

consistently stood 30 feet lower than that of well 33Bl. Thus, the discontinuity shown on plate 9 (March 1933) is known to be an all-year feature. With reference to plate 9, if the approach gradient (inland side) and the escape gradient (coastal side) are projected to the inferred barrier a hydraulic discontinuity of about 25 feet is obtained. Although the measurements at well 33El ceased in 1933, the water-level contours of November 1945 (pl. 12) suggest that the actual discontinuity at the barrier had increased in the 12 years to nearly 40 feet.

The hydrographs for wells 3/13-28Pl and 32F2 also span a joint record of about 2 years, from 1944 to 1946. Well 3/13-28Pl is about 700 feet inland from the Avalon-Compton fault, and well 3/13-32F2 is about 4,500 feet coastward. The general character and amplitude of seasonal fluctuation are similar for the two wells. The differential in pressure head, which is about 50 feet, remained about equal through­ out the 2 years. Hydrographs for wells 3/13-33Bl and 32F2 furnish a 15-year comparison of the fluctuation in wells which are 6,500 feet apart and on opposite sides of the barrier. They show that the difference between the pressure heads at the two wells has increased from 50 feet in 1931 to 66 feet in 1945.

Wells 3/13-17Ql and 3/13-2001, at the northwest end of the Avalon-Compton fault, are only 1,500 feet apart and nearly equi­ distant from the fault. The hydrographs for these wells, which extend from 1930 to 1945 (pl. 130), show a striking difference in amplitude of seasonal fluctuation; the average for welI 17Ql is about 19 feet and the average for 2001 is about 6 feet. The greater range in pressure head at well 17Ql doubtless is caused by more intensive local pumping; however, the pressure effects are not transmitted to well 2001 because of the fault barrier. The pressure differential at these wells was greatest in the early thirties-about 48 feet in February and 32 feet in August. In 1945 the differential had decreased to about 24 feet for both spring and autumn; this was due almost entirely to decline in head at well 17Q2 (successor to 17Ql and tapping the same water-bearing beds).

On plate 130, the hydrographs for wells 3/13-8L2 and 7Nl inland from the ground-water barrier along the Rosecrans Hills and those for wells 3/13-1802 and 3/14-13J2 coastward from the barrier show a striking change during the 17-year period of record. Well 3/14-13J2 is one of the heavily pumped wells in the Gardena system of the Southern California Water Co. Well 3/13-1802 was pumped by the Union Oil Co. until about 1942. So far as known the two inland wells have not been pumped during the period of record. From 1931 into 1937, the pressure-head differential between wells 3/13-8L2 and 18G2 decreased from 40 feet to 25 feet. In that same period

the head difference between wells 3/13-1802 and 3/14-13J2 was constant at about 30 feet. From 1937 into 1941, the pressure head in well 3/13-1802 declined about 30 feet; therefore, in 1941 a pressure differential of 52 feet had developed with respect to well 3/13-8L2. It is inferred that this drawdown of head in well 18G2 was caused by accelerated draft at the Southern plant of the Southern California Water Co. in :J/14-13J. By 1945 the high level for the year in well 18G2 was only about 4 feet above that for 3/14-13J2 and 57 feet below that for well 8L2. The record here discussed is considered to furnish indisputable evidence that weH 3/13-1802 is within the west basin and that it is hydraulically separated from the wells to the northeast by a ground-water barrier.

Hydrographs for wells 2/14-27Fl, 2, 3, and 2/14-3401 compare conditions across the Potrero fault at the north edge of the Rosecrans Hills (pl. *13D).* Although the hydrograph for well 27Fl is shown here only from 1932, earlier measurements indicate a decline of head from 50 feet above sea level in 1930. The amplitude of seasonal fluctuation in well 27Fl has ranged from 5 to 7 feet; that in well 3401 has ranged from 10 to 35 feet. From 1930 to 1939 the pressure head at well 27Fl was drawn down 49 feet, and the head in well 3401 declined only 29 feet. On the other hand, from 1940 to 1945 the head in wells 27F2 and F3 (which tap the Silverado water-bearing zone also) declined only 2 feet, whereas the head in well 3401 was drawn down 27 feet. This greatly accelerated drawdown of pressure head in well 3401 is believed to reflect the increase in draft on the small subbasin in section 34 which was caused by the pumping of wells 34Fl and L2 (Hollywood Turf Club) beginning about 1941.

For the several pairs of hydrographs here discussed, the evidence indicates a substantial ground-water barrier at each place. The information gained from an appraisal of replenishment, however, indicates that the barrier features are by no means watertight through­ out their extent under the range of differential heads that have pre­ vailed across them in the past (see p. 159 to 161).

**BALLONA GAP**

Across the Inglewood fault in Ballona Gap, a striking hydraulic discontinuity has developed in the pressure head of the San Pedro formation through drawdown of head east of the fault by the joint draft of the Sentney plant of the Southern California Water Co. and the Castle plant of the city of Beverly Hills. Hydrographs are shown on plate 14 for wells 2/14-5D5 and 5F2 at and near the Sentney plant, respectively, inland from the fault, and for wells 2/14-7Ml and 18Fl in the crestal subbasin coastward from the fault. Although the latter two wells are more than a mile from the Inglewood fault and nearly 2

miles from the Sentney plant, their hydrographs represent fluctuation in the crestal subbasin. The contrast in the seasonal pattern and in the long-term trend needs no verbal emphasis. It is concluded from these graphs and from the shape of the water-level contours on plates 9-12 that between the Baldwin Hills and the Beverly Hills, the Ingle­ wood fault presents an essentially water-tight barrier to movement in the San Padro formation.

The water level in the "50-foot gravel" inland from the Inglewood fault was about 62 feet above sea level in 1946 (well 2/14-5D9)-about 90 feet above the pressure level in the San Pedro formation beneath (well 5D5). In the crestal subbasin coastward from the fault, the water level in the "50-foot gravel" as of 1946 was known only for well 2/15-1P2 (fig. 4), and was about 12 feet above sea level. Although the suggested gradient from well 5D9 to well 1P2 in 1946 was 25 feet per mile, it is inferred that no hydraulic barrier transects the "50-foot gravel" at the Inglewood fault. It is of interest to note that the gradient between these two places was 25 feet per mile in 1904 also, although the water level was about 30 feet higher at that time.

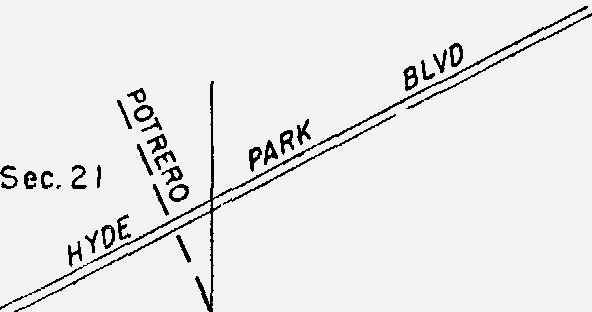
**PUMPING TEST AT INGLEWOOD WELL FIELD**

From January 3 to April 30, 1945, the Geological Survey operated a water-level recorder on well 2/14-27Dl (city of Inglewood, well 7), in the Centinela Park well field of the city of Inglewood, and 200 feet east of the Potrero fault. During the early part of the period of operation, it was noted that the water level in this well was drawn down several feet by the pumping of certain nearby wells in the Centinela Park field. With the cooperation of the Inglewood Water Department, a pumping schedule was arranged for the active wells in the Centinela Park field to determine the effectiveness of the Potrero fault as a barrier to water movement. The Inglewood Water Department kept a careful record of the pumping periods for the active wells in the field. The results of this pumping test are shown on figure 7.

As indicated by the plan of wells in the Centinela Park field (fig. 7), 9 of the 11 active wells in the field are east of the Potrero fault (in the main coastal basin) and 2 are west of the fault (in the west basin). All of the wells tap aquifers in the San Pedro formation, which is correlative with the Silvera.do water-bearing zone.

Figure 7 shows the drawdown in water level at well 27Dl caused by the pumping of well 22N2, 300 feet to the north. At the time, all other well pumps at the field were idle except those for wells 22Pl and 22P2, which were operated continuously through the period of record on the graph (March 5-12). The drawdown induced by pumping of well 22N2 was 3.8 feet after 46 hours of pumping. Obviously there is free hydraulic movement between these wells. As explained on page

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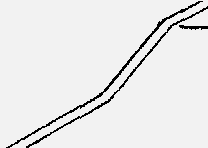
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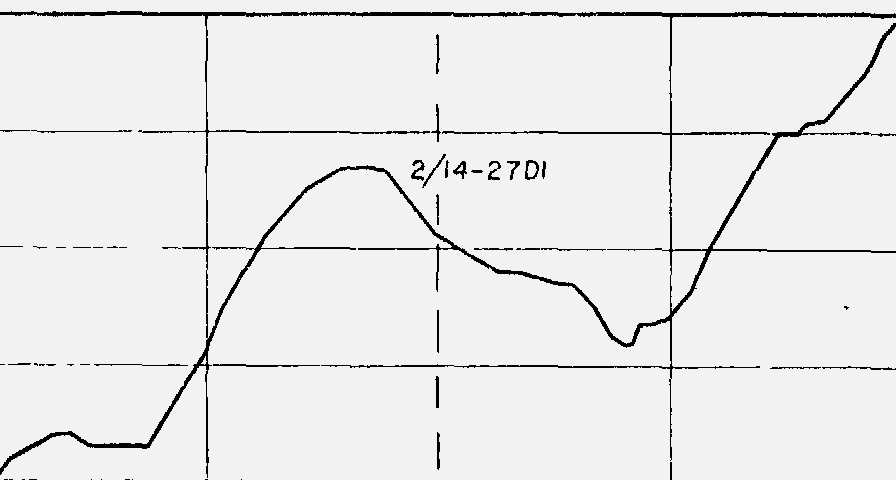
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1. EFFECT FROM PUMPING OF WELL ON SAME SIDE OF FAULT

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| -22N3 | II | -27DI | 7 |
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1. LACK OF EFFECT FROM PUMPING OF WELLS ACROSS FAULT

FtoURlll 7.-Ma:p of wells, and gruphs showing fluctuations of water level in well 2/14-27Dl in Inglewood as related to pumping of nearby wells tHl

opposite sides of Potrero fault.

**GROUND,\_WATER HYDROLOGY** 139

55, this drawdmn1 of water level in well 27D1 resulting from the­ pumping of well 22N2 was utilized in computing transmissibility and permeability of the water-bearing beds.

Figures 7 and 8 show the hydrograph for well 27D1 during the­ intermittent operation of the pumps in wells 27D2 and 27D3 (city of Inglewood, wells 10 and 14); both of these wells are west of the Potrero fault and are 325 and 725 feet, respectively, from well 27D1. For the period here graphed (6 a. m. April 25 to noon, April 27), two of the wells east of the fault 22Pl and 22P2 were operated continuously and all others were idle. Although the hydrograph for well 27DI indicates drawdown and recovery of the water level in response to pumping, the fluctuations are not related to operation of the pumps in wells 27D2 and 27D3. For example, on April 25 the pumps in these two wells were started at 11:10 and 11:05 p. m., respectively, but the recovering water level in well 27Dl was not affected in the leasL Clearly, the Potrero fault is an effective ground-water barrier within the head differentials imposed by this test. The drawdown in well 27D2 at the time of the test is not known. In November 1944 its level was drawn down to 30.7 feet below sea level after pumping for 15 minutes, or about 26 feet below the level in well 27D1. Presumably *r* the differential of April 25-27 was similar.

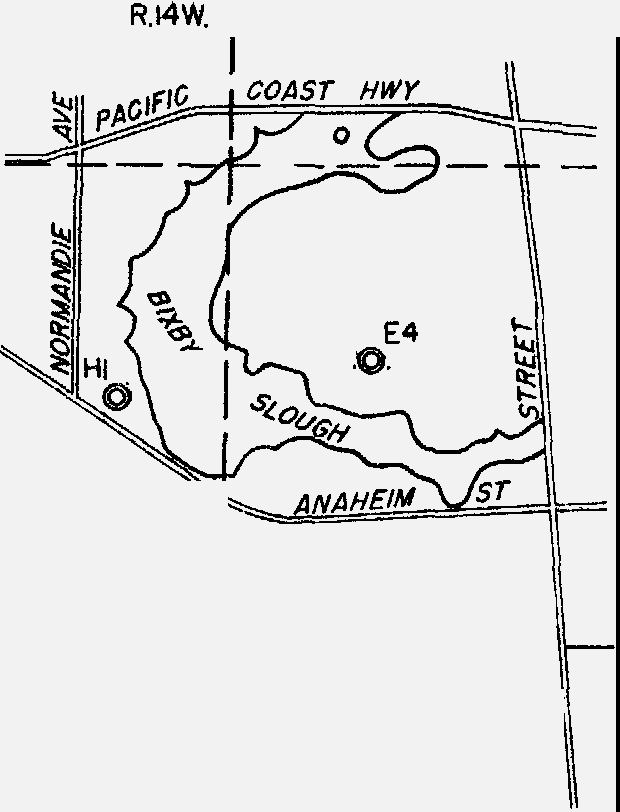
**PUMPING TEST NEAR WILMINGTON**

In September 1946, with the cooperation of the Union Oil Co., the Palos Verdes Water Co., and the Department of Water and Power of the city of Los Angeles, the Geological Survey made a pumping test near Bixby Slough, in Wilmington. This pumping test was made chiefly to determine whether a barrier to ground-water movement existed between the wells of the Union Oil Co. (4/13-31Pl and 5/13- 6D2) and nearby wells at (1) the Lomita plant of the city of Los Angeles, in 4/13-31E, and (2) the Palos Verdes Water Co. property, in 4/14-36H. Figure 8 shows the relative locations of the wells, and graphs the results of the pumping test. All of the wells involved in the pumping test tap the Silverado water-bearing zone. Because the wells of the Union Oil Co., beginning with well 5/13-6D1 in 1922, always have yielded water of markedly different chemical quality from that yielded by the wells north of Anaheim Street (fig. 34), it had long been suspected that the Union Oil Co. wells might be sepa­ rated from the west basin by a hydraulic barrier. For example, from the beginning of 1931 to the end of 1945 about 14,616 acre-feet of water was withdrawn from the Silverado water-bearing zone through the wells of the Union Oil Co. In 1931, the water yielded by well 5/13-6D1 contained about 500 ppm of chloride and 1,200 ppm of dis­ solved solids; as of 1945, the water from well 5/13-6D2 contained

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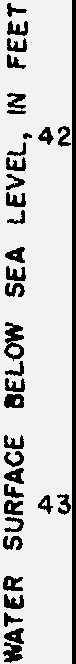
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| WELL | OWNER |
| USGS |
| 4/I3·3IE4 | CITY Of LOS ANGELES |
|  | LOMITA PLANT, WELL NO. 4 |
| 4/13·3IPI | UNION OIL CO. |
| 5/13·6D2 | UNION OIL CO. |
| 4/14·36HI | PALOS VERDES WATER co. |
|  | WELL NO. I |

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SEPTEMBER 28, 1946

FIGURE 8.-Map of wells, and graph showing results of pumping tests to determine presence or absence of barrier features near Bixby Slough.

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about 380 ppm of chloride and about 1,000 ppm of dissolved solids.. On the other hand, the water withdrawn from the wells in 4/13-31E north of Anaheim Street, has ranged from 42 to 108 ppm of chloride and from 350 to 500 ppm of dissolved solids.

On September 28, 1946, the pumps at the Lomita plant of the city of Los Angeles were idle and had been shut down for several days. The wells of the Union **Oil** Co. had been pumped continuously for· several months before the test, and the wells of the Palos Verdes­ Water Co. had been pumped intermittently during previous days.. During the day, wells 4/13-31Pl and 5/13-6D2 (Union Oil Co.) and well 4/14-36Hl (Palos Verdes Water Co., well 1) were pumped. intermittently on an alternating schedule (fig. 8), and water-level measurements were made by the Geological Survey at about 10- minute intervals from 10: 00 a. m. to 9: 00 p. m. at wells 4/13-31E4, 4/13-31Pl, and 4/14-36Hl. The fluctuation of water level in these wells is shown on figure 8. During the periods of pump operation as. shown, the average joint discharge from the Union Oil Co. wells was. about 2,150 gpm, and the discharge from well 4/14-36Hl was estimated by the operator as 1,230 gpm.

Between 12:10 and 4:10 p. m., the water level in well 31E4 recovered along a uniform curve as a result of the shutdown of the pumps in the Union Oil Co. wells from noon to 4:00 p. m. From 4:10 to 7:10 p. m.,. the water rnvel in well 31E4 declined concurrently with pumping of the Union **Oil** Co. wells. There is no hydraulic barrier between the· Union Oil Co. wells and well 31E4 at the Lomita plant of the city of Los Angeles. On the other hand, the recovering water levels in wells, 31E4 and 31Pl did not show any response to the shutdown of the pump in well 4/14-36Hl (Palos Verdes Water Co., well 1) at 2:00p. m., nor to the starting of the pump again at 8:00 p. m. Also, the recover­ ing level in well 36Hl was not affected by the starting of the pumps­ in wells 4/13-31Pl and 5/13-6D2 of the Union Oil Co. at 4:00 p. m. Thus, there appears to be a substantial hydraulic barrier somewhere· between well 36Hl on the west and wells 4/13-31E4, 31Pl, and 5/13- 6D2 on the east. The location and direction of this barrier are not known but it is inferred to be a cemented fault zone, because the Silverado water-bearing zone is known to be continuous, highly permeable, and about 700 feet thick between wells 4/13-31E4 and 4/14-36Hl. If this barrier should extend northward from the Palos Verdes Hills into the west basin, it would have some effect on local circulation of ground water; but so far as known, it does not separate any of these wells from the main body of ground water in the west basin.

**REPLENISHMENT TO THE WEST BASIN**

**SOURCES AND GENERAL FE.A.TURES**

**EARLY CONDITIONS**

Under the early conditions of ground-water development, replenish­ ment to the water-bearing deposits of the west basin tapped by wells occurred in four ways. In probable relative order of importance they were as follows:

1. By underflow across the Newport-Inglewood uplift (the inland boundary **of**

the west basin) through the deposits of Recent and of Pleistocene age.

1. By direct infiltration from the land surface of (a) water from rainfall, and

(b) return water from irrigation, from cesspools, and by leakage from distribution systems.

1. By infiltration of local runoff water from the hills bordering the west basin, including the Santa Monica Mountains and the Santa Monica plain to the north, the hills of the Newport-Inglewood uplift (especially the Baldwin Hills) to the northeast, and the Palos Verdes Hills to the south.
2. By seepage within the west basin from the channels of the Los Angeles River to the south, and from Ballona Creek and its tributaries to the north.

**CONDITIONS DEVELOPED BY WATER-LEVEL DECLINE**

**OCEAN-WATER REPLENISHMENT**

During the period of ground-water use, the draft has become large and levels have been drawn down to sea level and below. As a result, in the twenties ocean water began to invade the water-bearing zones along the coast and became a source of recharge. Because of the accelerated decline of water levels in recent years this condition has become critical.

**WATER RELEASED BY COMPACTION**

Because of the drawdown of water level, water has been withdrawn from storage in the water-table reach, and some water has been derived by compaction of the aquifers and of the surrounding and enclosing fine-grained, relatively impervious sediments. The latter has been called "water of compaction" by Tolman (1937, p. 142-143, 470-472). The quantity so yielded doubtless has been largest in recent years and in areas of greatest drawdown of the pressure head, such as Dominguez Gap.

In certain other areas in California, large quantities of water have been derived by compaction of sediments resulting from regional drawdown of the pressure level. For example, in the Livermore Valley, Alameda County, Calif., Smith (1934; Tolman, 1937, p. 495- 498) has estimated from a careful ground-water inventory that some 15,860 acre-feet of water was supplied by compaction of the alluvial materials during a low-water-level period from 1925 to 1930-an

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average rate of about 3,200 acre-feet per year, as compared to an average yearly pumping draft of about 12,500 acre-feet. However, the amount of land-surface subsidence was not known, and the volume of compaction could not be determined.

In the Santa Clara Valley of Santa Clara County, Calif., Tolman and Poland (1940, p. 23-35) found that water of compaction, as measured by subsidence of the land surface and inferred equivalent reduction of pore space, was about 230,000 acre-feet from 1919 into 1937. Subsidence developed over an area of about 200 square miles as a result of an average water-level lowering of 100 feet in the 20 years from 1915 to 1935. The maximum subsidence, about *5.5* feet, was at San Jose. Insofar as water was derived from compaction of silt and clay bodies (aquicludes) within or enclosing the aquifers, it represented a nonreplaceable contribution to the usable ground-water supply.

In the west basin no such substantial subsidence of land surface has occurred as a result of ground-water withdrawal. In the vicinity of Terminal Island, near the crest of the Wilmington oil field, the land surface subsided as much as 7 feet between 1928 and 1947.9 This subsidence was attributed by Gilluly, Johnson, and Grant (1945, also see Gilluly and Grant, 1949) as due almost wholly to the pressure decline and resulting compaction of the oil-bearing sands of Miocene and lower Pliocene age in the Wilmington oil field (which was caused by the removal of oil and gas beginning about 1937). In a recent report, Harris and Harlow (1947, p. 1197-1218) have concluded that the subsidence resulting from the pressure decline has occurred chiefly in the shale and siltstone associated with the oil sands. The publi­ cation of these two conflicting concepts on the mechanics of land subsidence emphasizes the need for careful research to resolve the relatively unexplored question of whether subsidence of the land surface associated with the withdrawal of large quantities of fluid is caused primarily by compaction of the permeable reservoir beds or of the relatively impermeable but porous silt, clay, and shale members which are interbedded with or confine the permeable beds, and which, in e:ff ect, are a part of the reservoir system.

*A* large range in the proportion of compaction of coarse-grained permeable deposits to that of fine-grained, relatively impermeable deposits probably will be found, as more examples of land subsidence associated with withdrawal of fluids or gases are studied in detail. The compressibility of each deposit must be in part a function of the physical character; for the fine-grained deposits the rate of com-

**b** Since the present report was released to the open file (1948), the maximum subsidence in the Wilmington area bas increased to 22 feet (1955).

paction will also be a function of permeability which determines the rate at which pressure differentials can be equalized-that is, the rate at which fluid can escape from the fine-grained deposits to the more permeable reservoir rocks and permit compaction of the former.

Also in the vicinity of Terminal Island, a land subsidence of as much as half a foot occurred in 1941, concurrently with the dewatering for construction of the large graving dock at the Naval Operating Base on Terminal Island. A brief description of this dewatering operation, its effect on water levels in nearby wells, and the local subsidence of land surface has been given by Grant (1944, p. 149-154).

As summarized elsewhere (Poland, 1959), this dewatering at Ter­ minal Island was carried out by turbine pumps in 36 gravel-envelope wells which tapped the Gaspur water-bearing zone. The dewatering was started on June 27, 1941, and reached a maximum during August, when the average rate of withdrawal was about 35,000 gpm. Pump­ ing operations ceased on April 4, 1942, after the removal of about 26,000 acre-feet of water from the Gaspur zone in 9 months, or slightly more water than was pumped concurrently from this same zone by all water wells from Terminal Island to Whittier Narrows. The lowering of the piezometric level for the Gaspur water-bearing zone was as great as 35 feet in well 5/13-3Ll (Southern California Edison Co., well 4), and 15 feet in well 4/13-35Ml, respectively 0.5 mile and 1.7 miles north of the center of pumping at the graving dock. The maxi­ mum recorded subsidence was at bench mark 43, at the southwest corner of the Southern California Edison Co. property and 1,650 feet from the center of the graving dock. Records taken by this company indicate that subsidence of bench mark 43 was 0.495 foot relative to bench mark 18, which is about 3,500 feet from the center of the­ graving dock. As described by Gilluly and Grant (1949, p. 497), substantial recovery of bench-mark altitudes coincided with recovery of water level in observation wells, during the reduced pumping rates of the latter part of the dewatering operation and immediately after cessation of pumping. The recovery of bench-mark altitudes ranged from 14 to 78 percent, with an average recovery of about 42 percent. From these facts, it was concluded by Gilluly and Grant that one-half or more of this subsidence due to the drawdown of the piezometric level of the Gaspur zone was attributable to mineral-grain rearrange­ ment, and the remainder was due to elastic compression. It is of interest to note that the bench marks that underwent the largest subsidence had the smallest percentage of recovery of altitude.

At the center of the greatest drawdown of the pressure level of the Silverado zone within the ,,-est basin-at Carson and Alame:.la Streets in Dominguez Gap-the subsidence of land surface from about the

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end of 1933 to 1944-46 was 0.354 foot, according to first-order leveling by the U. S. Coast and Geodetic Survey.10

Three miles to the south, on the right-of-way of the Southern Pacific Railroad, about 0.6 mile northeast of the Anaheim Street crossing, bench mark G 33-67 subsided 1.316 feet between 1914 and 1944-46. Of this subsidence, 0.942 foot has occurred since December 1931, and

0.528 foot since July 1941. This bench mark is within the productive limits of the Wilmington oil field and the greater part of the sub­

•sidence is believed to have been caused by the compaction which

:accompani d the withdrawal of oil and gas from that field.

Although the land surface has subsided several tenths of a foot

·throughout much of the southern part of the west basin, it is not known how much of this subsidence is due to compaction of sediments

:accompanying the decline of pressure head in the Silverado water­

.bearing zone. It may have been partly because of tectonic adjust­ ments and partly because of pressure decline in the saline water sands

:at much greater depth which are hydraulically connected with the producing oil sands of the Wilmington and other oil fields. Accord­ iingly, a direct estimate of subsidence due to compaction of sediments

:accompanying the decline **of** pressure head in the Silverado zone has not been attempted in this investigation. However, the quantity of water made available by such compaction of sediments has been estimated on page 151, by use of the empirical storage coefficient determined from the lowering of pressure head in well 4/14-13Fl due to the pumping of the wells at the Lomita plant of the city of Los Angeles (p. 133).

With fully effective confinement, water is yielded from storage only in proportion to the compaction of the water-bearing system (and expansion of the fluid) in response to pressure drop; therefore, it follows that in such cases the storage coefficient must be a measure of the compressibility of the system, and of the land-surface subsidence that will occur with each foot of sustained drawdown of the regional f)ressure level. However, in the ground-water basins of southwestern United States the water-bearing deposits consist almost entirely of valley fill (Meinzer, 1923, p. 291-303), and confining beds, although

:abundant, commonly are not extensive. Thus, with prolonged and sub­

:Stantial withdrawal of water, conditions of fully effective confinement are rarely found, and most of the water commonly is withdrawn from

-storage in the unconfined reaches of the basins by draining of the pore

,spaces. Only near the coast, where relatively impermeable beds

.associated with marine deposition are extensive, and in valleys such

10 Bench mark D-167-At Dolores, at the southeast corner of the intersection of Alameda and Carson Streets, on the DomJngu.,ez Water Corp. property, at the pumping-plant building, in the face of the west

,wall.

as the San Joaquin, where the deeper water wells partly tap aquifers interbedded with fine-grained lacustrine deposits, would reasonably effective confining systems be found. When considered in•relation to time intervals of as much as a few years, and possibly even several tens of years, conditions of fully effective confinement presumably are encountered only in the great artesian basins in which the aquifers have been deposited in interior seas. Probably the Dakota sandstone and the overlying plastic shales form the outstanding example of such a basin (Meinzer and Hard, 1925, p. 73-96; Darton, 1896).

Within the west basin, the area of greatest overdraft and of most serious saline contamination is the Torrance-Inglewood subarea. For these reasons, this subarea now (1948) is involved in a. pending ad­ judication of water rights. Thus, the following appraisals of re­ plenishment concern first the magnitude of replenishment to the Torrance-Inglewood subarea and second the replenishment to the smaller subbasins in the Culver City subarea.

**REPLENISHMENT TO THE TORRANCE-INGLEWOOD SUB.AREA**

**MAGNITUDE OF REPLENISHMENT** IN **1903-4**

The average rate of replenishment to the west basin in 1903-4 is believed to have been nearly equivalent to the natural and artificial discharge of that time. Such discharge occurred almost wholly by underflow to the ocean through the undersea extensions of the aquifers of Pleistocene and Recent age and by withdrawal through wells. The water levels were too far below the land surface to afford appreci­ able opportunity for evapotranspiration losses.

For the Torrance-Inglewood subarea an estimate of the natural discharge to the ocean in 1903-4 can be made by summing up (1) the discharge from the San Pedro formation (Silverado water-bearing zone and correlative aquifers) along the west coast from Playa del Rey to the Palos Verdes Hills, and along the south coast from the Palos Verdes Hills to the Los Angeles River, and (2) the discharge from the Gaspur water-bearing zone to San Pedro Bay. For the Silverado zone, the cross section along the coast is known with reason­ able accuracy (pl. 30), but the hydraulic gradient during 1903-4 at the coast cannot be accurately determined. Although water­ level contours for the Silverado zone in 1903-4 have been recon­ structed from data of Mendenhall (pl. 9 and p. 90), few of the wells in which water-level measurements were made near San Pedro Bay and from Manhattan Beach northward to Playa del Rey tapped the

Silverado zone. The permeability . o\_f the Silverado zone was de­

termined from pumping tests near Torrance and near Bixby Slough, but it was not determined along the coast. Yield factors for wells near the west coast compared to yield factors for wells between Long

Beach and Torrance (table 5)-where the permeability has been de­ termined as about 2,000 ,gpm per square foot (p. 54)-suggest a proportion of about 2 to 3, or a permeability of about 1,300 gpm per square foot for the coastal reach from Palos Verdes Hills to Playa del Rey. The following paragraphs sum up the several increments of natural discharge:

1. For the reach from the Palos Verdes Hills to Hermosa Beach, the discharge to the ocean as *of* 1903-4 has been estimated as about 11 cfs, or about 8,000 acre­ feet a year (p. **92).**
2. In the same way and only as an approximation, the discharge to the ocean between Hermosa Beach and Playa del Rey can be estimated. The length of this reach is about 7 miles, the average thickness of the aquifer is about 125 feet (pl. 3C), the permeability is estimated as about 1,300 gpd per square foot, and the average hydraulic gradient at the coast in 1903-4 was at least 2 feet per mile. Thus, the discharge *of* that time (north of Hermosa Beach) is estimated to have been at least 2.3 mgd-about 3.5 cfs or about 2,500 acre-feet per year.
3. In regard to discharge from the Silverado water-bearing zone to San Pedro Bay, electric-log data for oil wells on Terminal Island indicate that the aquifers *of* the Silverado zone along that reach have an average thickness *of* about 250 feet. From the Los Angeles River west to the non-water-bearing rocks of the Palos Verdes Hills the width *of* the escape area is about 4 miles. Thus, the effec­ tive cross section is about 1,000 foot-miles. The coefficient *of* permeability for the Silverado zone in this area is not known, but it is probably somewhat lower than that in the Torrance area, where it was determined to be about 2,000 gpd per square foot (p. 54), and near Bixby Slough where it is about 1,400 'gpd per square foot. If the permeability beneath Terminal Island is assumed to be about 1,000 gpd per square foot and if the hydraulic gradient of 1903-4 is taken as 4 feet per mile (p. 91), then the oceanward discharge through the Silverado zone beneath Terminal Island can be calculated at about 4 mgd-about 6.2 cfs or approximately 4,500 acre-feet per year.
4. Underflow to San Pedro Bay from the Gaspur water-bearing zone of Recent age is estimated to have been about 2.8 cfs, or about 2,000 acre-feet per year. These figures are based on the assumption that conditions at the coast were as follows: width of water-bearing zone, 2 miles (pl. 8); thickness, 60 feet-or an area of 120 foot-miles; hydraulic gradient, about 5 feet per mile (Mendenhall, 1905a, pl. 4); and an estimated permeability of 3,000 gpd per square foot (see p. 31).

In summation, the estimated yearly discharge to the ocean in 1903-4 from the aquifers beneath the Torrance-Inglewood subarea was about 21 cfs or 15,000 acre-feet from the Silverado water-bearing zone and was about 2.8 cfs or 2,000 acre-feet from the Gaspur water­ bearing zone. Thus, the estimated total subsea escape was about 24 cfs or about 17,000 acre-feet per year. When this figure is added to the artificial discharge by pumping-which has been estimated at about 10,000 acre-feet per year during 1903-4 (p. 99)-the suggested over-all discharge was about 27,000 acre-feet per year, and the replen­ ishment was comparable to that figure.

The rainfall record for Los Angeles (table 2) indicates that the 11 years ending with 1903-4 included only 4 years of normal or slightly

.above normal rainfall. With respect to the 68-year average rainfall

,of 15.53 inches, at the end of the year 1892-93 there was a cumulated

-surplus of 43.34 inches of rainfall. By the end of 1903-4 there was

·a cumulated deficiency of 3.79 inch.es, indicating an 11-year deficiency

-0f 47.13 inches. The 3 years beginning with 1897-98 were the driest

-0n record. Thus, runoff to the 8treams and recharge to the main

-coastal basin must have been continuously deficient during the 11-year period. Largely because of this deficiency, ground-water levels in the intake area near Whittier declined about 14 feet in this

-period and those near Anaheim declined about 40 feet (Poland, 1958). Also, the pressure level a1, the Bouton wells 2.5 miles north

-0f Signal Hill and only 2 miles from the west basin boundary, declined

:about 80 feet in the same period. The decline of pressure head in

-the Bouton wells was far more than the average for the main coastal basin in Los Angeles County, however. The decline of artesian pressure along the northeast flank of the Newport-Inglewood uplift

:between Compton and Manchester Boulevard is known to have

:averaged about 30 feet from the initial historic level to 1904 (Menden­ hall, 1905b, pl. 5).

The recharge to the west basin must have been affected in two ways by this deficiency of rainfall. First, there must have been little if

:any direct penetration of rainwater from the land surface in this period; certainly there was essentially none except in the 4 wettest

,Years. Second, the replenishment by underflow across the Newport­ Inglewood uplift must have diminished substantially in the 11-year

·period, because the pressure levels on the inland side of the barrier

.faults fell about 30 feet. Draft from the Torrance-Inglewood sub­

:area was not large at that time and it appears doubtful that pressure levels in that subarea of the west basin could have declined in any

:Such amount. Accordingly, the pressure differential across the barrier faults is inferred to have been greatly reduced by the decline in pressure level in the main basin; thus recharge to the Torrance­ Inglewood subarea probably was considerably less in 1903-4 than in the eighties. It is believed that under native conditions of average rainfall the recharge to the Torrance-Inglewood subarea was 30,000 to 40,000 acre-feet per year.

**MAGNITUDE OF REPLENISHMENT** IN **1933-41**

The replenishment to an underground basin may be estimated by measurement or calculation of the rate of inflow (intake methods) or the rate of discharge (discharge methods), or by determining changes in ground-water storage. Methods that have been applied to deter-

mine intake and discharge from ground-water reservoirs have been summarized by Meinzer (1932, p. 99-144).

For the west basin, the direct appraisal of the several elements of replenishment would be very tedious, and estimates of rain-water penetration, irrigation return water, and underflow (subsurface recharge) are subject to substantial error unless the basic data are sufficient to furnish reasonable control over the variable factors in the respective equations. Such is not the ·case at the present time. However, it is understood by the writer that the California Division of Water Resources, as referee in the pending adjudication of water rights, is planning to make a careful estimate of the several elements responsible for replenishment -to the basin (California Division of Water Resources 1952).11

ESTIMATE BY RELATING PUMPAGE AND CHANGE IN STORAGE

For the purposes of this investigation, the ·elements of greatest interest are the over-all replenishment, the sea-water contribution, and the underflow across the Newport-Inglewood uplift. It can be assumed that, for years of average rainfall, the contribution by infil­ tration of water from rainfall and runoff from the land surface will be nearly constant from year to year. The residential and industrial areas are expanding rapidly and the agricultural area is decreasing, but the joint contribution by. return water from irrigation of crops and lawns probably will not change appreciably as agricultural lands become residential districts.

The average gross replenishment can be determined most simply by selecting a period of years in which the cumulated rainfall did not markedly digress from the cumulated average, and in which the position of the water level was about equal at the beginning and the end of the period-that is, a period of little or no storage change. If the pumpage is known (or closely estimated) and if the storage change is estimated by the use of the specific yield and storage coefficients, the replenishment can be calculated. If there is no seaward discharge and no change in storage within the period, the gross replenishment is equal to the pumpage.

For the Torrance-Inglewood subarea of the west basin-the area µicluded in the plaintiff's complaint for adjudication of water rights 12- a relatively small amount of storage change occurred from the spring high-water level of 1933 to the spring high-water level of 1941 (pls. 9 and 11). Accordingly, this period of 8 years has been

u Since this report was released to the.open file (1948), the CaJifornia Division of Water Resources **has**

completed its investigation as referee. .

12 California Water Service Co. and others **r,,** City of Compton and others, Action No. 506,806 in **th&**

Superior Court for Los Angeles County, Ca1if., Oct. 1945.

**460508-59-11**

**150 GEOLOGY, HYDROLOGY, TORRANCE-SAN'l'A MONICA AREA**

selected for appraisal of the average replenishment to this area before the accelerated draft and decline of water levels in the war years 1942-45.

The average yearly rainfall at Los Angeles in the years from 1933 into 1941 was greater than normal. However, 1940-4i was the only year of greatly excessive rainfall (table 2). With respect to the aver­ age rainfa11 for the 68 years from 1877-78 through 1944-45, as shown in table 2, the average rainfall in the years 1932-33 through 1939-40 was 1.76 inches above normal, and the cumulated surplus for the 8 years was 14.04 inches. For the 9 years from 1932-33 through 1940- 41 the yearly average increased to 3.47 inches above normal, and the cumulated surplus was 31.27 inches. Thus, it might be expected that inclusion of the year 1940-41 would yield a nonrepresentative figure for storage change and replenishment. However, most of the water withdrawn from the Torrance-Inglewood subarea is taken from the Silverado water-bearing zone, which is confined by relatively imper­ meable beds through most of the area. Therefore, it is doubtful that the rainwater penetration of the winter 1940-41 could have had an appreciable effect on the water levels of the Silverado zone or even on the water levels in the shallower "200-foot sand" by April 1941. Examination of the hydrographs introduced on figures 4 and 5 and plates 13 and 14 substantiates this general conclusion. Therefore, it is considered that the period selected is reasonably representative but that rainwater penetration in the 8 years was slightly above average.

The rise or fall of water level in the Silverado water-bearing zone from March 1933 (pl. 9) to April 1941 (pl. 11) is shown by lines of equal change (long dashes) on plate 10; the rise or fall for the "200-foot sand" in this 8-year period also is shown (short dashes). As discussed on pages 87-88, a water table occurs in the Silverado water-bearing zone only in the Redondo Beach area (pl. 10); another water table occurs in the correlative main water-bearing zone of the Sa,n Pedro formation in the vicinity of Playa del Rey. It will be noted from the lines of equal change on plate 10 that: (1) the storage change in the water-table reach of the Silverado zone near Redondo Beach did not exceed 5 feet; and (2) the storage change in the water-table reach of the main water-bearing zone near Playa del Rey did not exceed 6 feet. The maximum change (except for the local fall of 20 feet east of Inglewood between the Potrero and Inglewood faults) in the Tor­ rance-Inglewood subarea, east of Hawthorne in the pressure area, was about 16 feet. Inland beyond the west basin boundary, the maximum fall was in excess of 30 feet.

TA13LE *13.-Estimaled storage change in the Torrance-Inglewood subarea, fro\_m March 1933 to April 1941, for the Silverado water-bearing zone and correlative aquifers in the San Pedro formation*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Township (S.) and  range **(W.)** | Area (square miles) | Rise(+) or fall(-) (feet) | Change | in | volume | Storage change (acre-feet of water) |
| Square miles X feet | I | Acre-feet |
| **Silverado water-bearing zone, water-table area near Redondo Beach** | | | | | | |
| ------  ------  ------  ------  ------  ------ | 2.91  11.94  .72  1.38  1.05  .17  ---  18.17 | -1  -3  -5  +1  +3  +5 | -2.91  -35.82  -3.60  +1.38  +3.15  +.85 | -1, 862  -22, 925  -2, 304  +883  +2, 016  +544 | | --------  --------  --------  --------  --------  -------- |
| -------- | -36.95 | -23, 648 | | 1 -4, 730 |
| **Main aquifer, San Pedro formation, water-table area near Playa del Rey** | | | | | | |
| ------  ------  ------  ------ | 1.42  1.11  .39  2.00  ---  4.92 | -1  -3  -5  +1 | -1.42  -3.33  -1.95  +2.00 |  | -909  -2, 131  -1, 248  +1, 280 | --------  --------  --------  -------- |
| -------- | -4.70 | -3, 008 | 1 -600 |
| **Silverado water-bearing zone, confined area** | | | | | | |
| 2/14  2/15  3/13  3/14  3/15  4/13  4/14 | 7  1  8  33.5  5  32  7.5  ---  94 | -11.6  -5  -4.4  +8.5  -2.2  +.s 0 | -81  -5  -35  -285  -11  +25  0 |  | --------  --------  --------  --------  --------  --------  -------- | --------  -\_..-,..------  --------  --------  --------  -------- |
| -------- | -392 | -250, 880 | 2 -300 |

1 Total change in v-0l11me (acre-feet) multiplied by 0.20 (specific yield).

*i* Storage coefficient assumed to be 0.0012 throughout the pressure area.

The storage change in the Silverado water-bearing zone was deter­ mined in the following manner:

1. The working copy of plate **10,** at a scale of 1:48,000 was superimposed over **a** map sectionized in the manner of plate **2,** each main grid unit representing **1** square mile. For the two water-table areas, a grid subdivided in hundredths of a square mile was utilized to determine the part of each section falling between two• lines of equal change. For the larger pressure area, the average change of water level in feet was estimated for each square mile. For each territory the area **in** square miles lying between lines of equal water-level change (0-2, 2-4, and 4-6) was summed up separately. Cumulative areas so obtained were multiplied by the odd-foot value between the two boundary lines (the average change for the area between the 2- and 4-foot lines was assumed to be 3 feet), giving a volume­ for storage change in square miies X feet. By summing up all such volumetric­ elements for each area, the total volume change was obtained for that area.
2. The specific yield for the two water-table areas was assumed to be 20 percent (in accordance with estimates made by Eckis from samples collected in the field

.and tested in the laboratory) (1934, pl. *E).* The storage coefficient of 0.0012- obtained from the drawdown of water level in well 4/14-13Fl due to pumping of the Lomita plant wells (p. 133)-was applied to the main pressure area. Table **13** presents a summary of water-level changes, volumes dewatered or saturated (or of pressure-level change), and water released from storage.

The storage change has been computed for the "200..:.foot sand" in the same manner. Contours of the water level in this aquifer were not constructed for the beginning and end of the period of appraisal. Instead, the changes in position of the water level in the period for individual wells were plotted on the working copy of plate 10 and the lines of equal change were drawn from these data. Table 14 sum­ marizes the results of the computation. About one-fourth of the pertinent well logs show water-table conditions at current water levels in the upper Pleistocene deposits ("200-foot sand" and other deposits); therefore, the over-all specific yield was assumed to be about 5 percent.

TABLE *14.-Estimated storage change in the Torrance-Inglewood subarea, from March 1933 to April 1941, for the "200-foot sand" and correlative deposits of upper Pleistocene age*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Area (sqmi) | Rise(+) orfall (-) (feet) | Change in volume | | Storage change (acre-feet of water) |
| Square miles X feet | Acre-feet |
| 16.93  19.70  10.90  **8.24** | -3  -5  -7  -9 | -50.79  -98.50  -76.30  -74.16 | -32, 505  -63, 040  -48, 830  -47, 460 | ----------  ----------  --------------------- |
| 55.77 | ---------- | -299. 75 | -191, 835 | 1 -9, 600 |

**1** Total change in volume (acre-feet) multiplied by 0.05 (specific yield).

The estimated storage change within the Silverado zone in the 8-year period (table 13) is 5,600 acre-feet of which 5,300 acre-feet occurred in the water-table areas. The estimated storage change in the un­ named upper Pleistocene deposits (table 14) is 9,600 acre-feet. Thus, the over-all withdrawal from storage in the 8 years is estimated to have been 15,200 acre-feet, or an average rate of about 2,000 acre­ feet per year. Changes in storage in the shallow unconfined body

·and in the 400-foot gravel probably were inconsequential during this period.

The total withdrawal from the Torrance-Inglewood subarea in the 8 years from 1933 through 1940 (table 8) was 383,100 acre-feet; the average rate of withdrawal was about 47,900 acre-feet per year. There was essentially no natural discharge during this period, therefore, the gross replenishment is equal to the withdrawal less the ch nge in

storage-that is, 383,100 less 15,200 or 367,900 acre-feet. Thus, the average yearly gross replenishment is estimated to have been about 46,000 acre-feet.

**CONTRIBUTION FROM THE OCEAN**

With the extensive drawdown of water levels to and below sea level, saline waters have invaded the Torrance-Inglewood subarea along the full reach from Playa del Rey to the Palos Verdes Hills. .Also, along the south shore from the Palos Verdes Hills to the Los Angeles River channel, saline waters probably have moved northward beyond Terminal Island toward centers of pumping. The water in the Silverado zone beneath Terminal Island is inferred to have been of inferior quality undel' native conditions (Piper, Garrett, and others, 1953, p. 197). To date, these inferior waters have not advanced sufficiently far northward to reach any actively pumped well fields. As shown by the distribution of withdrawals on plate 12, the first major well fields to receive such inferior waters presumably would be that of the Union Oil Co. in Wilmington (pl. 12, no. 23) and that of the Texas Co. (pl. 12, no. 24) at the west edge of Dominguez Gap. Regardless of the quality of the ground water in the Silverado zone beneath Terminal Island, there must have been a substantial con­ tribution of water to the west basin from the subsea reach south **of** Terminal Island in response to the landward gradients that have existed since the early thirties. This contribution is not being replaced by water of good quality, and probably it is being followed landward by saline waters, either ocean water entering the outcrop **of the** Silverado zone beneath San Pedro Bay, or connate saline waters contributed from within the subsea ground-water system, or both.

Ocean water advanced inland in the Gaspur water-bearing zone in the thirties (seep. 259, also pl. 16); the extent of that inland advance has been shown in an earlier report (Piper, Garrett, and others, 1953, pl. 17).

The over-all contribution from the ocean or from the seaward extensions of the water-bearing zones of the Torrance-Inglewood subarea from 1933 to 1941 is estimated in following paragraphs.

The extent of encroachment of saline waters for the reach along the west coast from Playa del Rey to the Palos Verdes Hills is shown on plate 16. The contribution from the ocean can be computed if the assumption is made that the rate of advance of the saline front is a direct measure of the rate of landward inflow of salt water to the water-bearing deposits.

From the appraisal of the rates of saline encroachment as suggested by the advance of the saline front from 1931 to 1946 (pl. 16), and with, consideration to the effective hydraulic gradients, it is concluded

(p. 251 to 253) that the average yearly rate of advance of the saline front from Playa del Rey to El Segundo from 1931 to 1941 did not exceed 40 feet, from El Segundo to Hermosa Beach it was about 115 feet, and from Hermosa Beach to the Palos Verdes Hills it was about 90 feet. The effective porosity of the Silverado water-bearing zone and correlative water-bearing deposits along this full reach is estimated to be about 20 percent. The product of the cross-sectional area of water-bearing materials, the average yearly advance, and the effective porosity may be considered to be a measure of the contribu­ tion seaward from the front.

The cross-sectional area (pl. 30) for the reach from Hermosa Beach to the Palos Verdes Hills is about 3.5 miles long by 400 feet thick. If the average advance of the front (pl. 16) was 90 feet per year through material with an effective porosity of 20 percent, the quantity of water required to fill the block 3.5 miles long by 400 feet thick by 90 feet wide would be about 3,100 acre-feet. In the same way, the yearly displacement for the reach from Hermosa Beach to Playa del Rey is estimated at about 2,500 ·acre-feet.

By this method, the average annual contribution to tbe ground water in the area coastward from the saline front in the reach from Playa del Rey to the Palos Verdes Hills for the years from 1931 to 1941 is estimated to be about *5,600* acre-feet.

-By another method, the contribution along this reach can be com­ puted as the product of: (1) the cross-sectional area of permeable material; (2) an estimated permeability of 1,300 gpd per square foot (p. 147); and (3) the average hydraulic gradient. For the reach from Hermosa Beach to the Palos Verdes Hills, where the average landward gradient of the thirties was about 3.5 feet per mile, the contribution so computed is 7,100 acre-feet per year. If the contribution in the reach from Hermosa Beach to El Segundo is computed assuming a perme­ ability of 1,300, a cross-sectional area 4.5 miles long and 150 feet thick, and an equivalent hydraulic gradient of 3.5 feet per mile; and if the small co\_ntribution from El Segundo to Playa del Rey is estimated from the rate of saline encroachment, as above, the over-all contribu­ tion along the west coast is about 10,800 acre-feet per year.

· If the quantities derived by these two independent methods are assumed to indicate the general limits of such a contribution along the west coast in the thirties, the suggested mean is about 8,000 acre­ feet per year. Most of this contribution must have been ocean water, but it also included water that descended from the land surface to the water table, in the areas coastward from the saline front, south of Hermosa Beach and north of El Segundo. In the thirties, these two areas included about 3,000 acres, and the average annual contribution of water from the land surface in this dune-sand area may have been

as much as 1,000 acre-feet. If these figures are correct, the ocean­ water contribution is estimated to be about 7,000 acie-feet per year.

For the south coast facing San Pedro Bay, the landward movement of water in the Silverado water-bearing zone in the thirties can **be** estimated in the same manner as the coastward discharge of 1903-4 (p. 147). It is inferred that the Silverado zone or correlative deposits crop out on the ocean floor from 8 to 9 miles southwest of Terminal Island.13 The average depth of the piezometric level at Terminal Island from 1933 to 1941 was about 30 feet below sea level. Thus, the average inland gradient of those years is inferred to have been about 4 feet to the mile-about equal to the coastward gradient **of** 1903-4. Therefore, the annual contribution of water moving north­ ward in the Silve.rado zone from beneath San Pedro Bay in the thirties is estimated to have been about 4,500 acre-feet per year.

The landward movement of salt water in the Gaspur water-bearing zone is known to have underrun about 300 acres from 1931 into 1943 (Piper, Garrett, and others, 1953, pl. 17 and p. 178). The thickness of the· Gaspur water-bearing zone is about 60 feet and the effective porosity is about 25 percent. The landward encroachment of the thirties thus was approximately 400 acre-feet per year.

In summation, the average yearly contribution of water to the Torrance-Inglewood subarea from 1933 to 1941 from the ocean or from the subsea extensions of the aquifers is estimated to have been about 12,000 acre-feet per year. Thus, within the limitations of the assumptions made here the average net replenishment of fresh water to the Torrance-Inglewood subarea in these years is 46,000 acre-feet less 12,000 acre-feet, or about 34,000 acre-feet per year.

**UNDERFLOW ACROSS THE NEWPORT-INGLEWOOD UPLIFT**

Under native conditions of high-water level, the quantity of under­ flow passing across the Newport-Inglewood uplift from the main coastal basin to the Torrance-Inglewood subarea along the crestal reach from Long Beach to the Baldwin Hills varied in accordance with the differential in the water levels across the fault barriers of the uplift as the one variable (the product of permeability and cross section was a constant). At the crest of the uplift the Silverado water-bearing zone and related deposits in the San Pedro formation then were fully saturated. and the upper Pleistocene water-bearing zones were fully saturated, except at the crests of Dominguez Hill and the Rosecrans Hills, and high on the flank of the Baldwin Hills.

In accordance with the drawdown of water level due to increased withdrawal from the main coastal basin, water levels along the crest

of the uplift have declined from 100 to 150 feet below the initial levels

13 U.S. Coast and Geod. Survey hyd.rologic chart 5143, Los Angeles harbor and vicinity, 1936.

and substantial dewatering of certain aquifers has occUITed. For aquifers almost entirely dewatered along the crest of the uplift, the transmissibility of the saturated cross section has become the primary control on the quantity of water passing into the west basin, and the differentials at the barrier features have become secondary. For aquifers wholly dewatered along the crest, no water passes coastward beyond the crest, and the differentials along the barrier features have no meaning.

**DEWATERING ALONG THE UPLIFT CREST**

Plate 15 has been prepared for the purpose of appraising the magni­ tude of dewatering of the water-bearing beds along the crest of the Newport-Inglewood uplift from the Baldwin Hills to Long Beach. The ·position of the water-bearing beds .(pl. 15) has been generalized from plate *3A,* with slight modification between Manchester Avenue and Imperial Highway, in order to follow the land-surface and infe1Ted subsurface crests. Plate 15B shows on an expanded scale, the pres­ sure level and the local water table of the Silverado water-bearing zone and correlative aquifers along the alinement of the section for selected times from 1903-4 to 1945. A partial plot of the water levels of the eighties, inferred from data by Mendenhall, also is shown. The water-level profiles for 1904, 1933, 1941, and 1945 are taken from plates 9-12; the profile for 1930 is from a work map not included in the report. Although the water-level profiles are constructed from

data for wells tapping the Silverado zone and correlative 'deposits, these profiles also can be used to appraise the general order·-of de­ watering of the upper Pleistocene deposits. Part of the generalized

position of the top of the Silverado zone has been plotted at the expanded scale of plate 15B in order to emphasize the extent of dewatering in this principal aquifer.

As shown by the profiles of plate 15, the upper Pleistocene water­ bearing deposits (the "200-foot sand" and correlative deposits) have been extensively dewatered along the crest. On the other hand, the Silverado water-bearing zone and lower Pleistocene correlative de­ posits have been partly dewatered in the 6-mile reach between the Baldwin Hills and El Segundo Boulevard, but no dewatering has occUITed in the 8-mile reach from El Segundo Boulevard to Los Cerritos (Long Beach). The extent of dewatering is summarized as follows:

1. The upper Pleistocene water-bearing deposits initially were fully saturated except at the crests of the Dominguez Hill and Rosecrans Hills and high on the south flank of the Baldwin Hills. By 1945 these deposits had been entirely dewatered along all the crestal reach northwest of El Segundo Boulevard, and had been dewatered nearly to sea level along the crestal reach of Dominguez Hill. Thus, in the early forties, the only segments of these deposits still saturated were: the 3-mile reach between El Segundo Boulevard and Artesia Street, along most

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**of** the Avalon-Compton fault; and the 3-mile synclinal reach beneath and adjacent to Dominguez Gap. The water-bearing beds in the reach along the Avalon­ Compton fault are only about 60 feet thick but they are highly permeable and are tapped by many wells;'thus, these deposits are believed to transmit substantial underflow through the fault barrier. On the other hand, the water-bearing beds beneath Dominguez Gap, which are composed almost entirely of fine sand (pl. 3A), as niuch as 120 feet thick (well 4/13-2Jl), are not tapped by many wells because they are not highly permeable, and their transmissibility is less than that of the thinner aquifers northwest of Dominguez Hill.

In terms of cross-sectional area, about 50 percent of the upper l>leistocene water-bearing deposits throughout the area shown on plate 15A have been de­ watered by the drawdown of water level from native conditions to the levels **of** 1945. However, the reduction in transmissibility has been much more than 50 percent, because the permeable deposits which occur northwest of well 3/13-17El and including those at the Centinela Park well field of the city of Inglewood, have been wholly dewatered. Utilizing the generalized data of plate 15A, the calculated cross-sectional area of the initially saturated upper Pleistocene aquifers is *4A* million square feet and by 1945 the dewatered area totaled 2.1 million square feet.

1. The Silverado water-bearing zone and correlative aquifers in the San Pedro formation of early Pleistocene age initially were fully saturated along all of the crestal reach from Los Cerritos (Long Beach) to the Baldwin Hills. In nearly all of the 8-mile reach southeast of El Segundo Boulevard, the top of the Silverado zone is more than 100 feet below sea level, and beneath Dominguez Gap is as much as 400 feet below sea level. However, between El Segundo Boulevard and the Baldwin Hills, the top of the Silverado zone and correlative deposits is several tens of feet above sea level on a large area. Thus, because of the decline of water level to near sea level, by 1945, extensive dewatering has occurred in the deposits in the 6-mile reach northwest of El Segundo Boulevard.

In terms of cross-sectional area, abmit 35 percent of the water-bearing beds of the San Pedro formation northwest of El Segundo Boulevard had been dewatered by 1945. Throughout the entire reach, only about 10 percent had been de.. watered. However, in the 2-mile reach from near well 2/14-27Jl (city of Ingle­ wood, well 16) southeast to the intersection of Century Boulevard and Western Avenue, the decline of water level by 1945 had dewatered about two-thirds of the thickness and only 30-50 feet of the Silverado zone remained saturated. **No** well data are available to- determine whether the reduction in saturated cross section may have been partly compensated by a steepening of the hydraulio gradient. In any case, a drawdown of water levels to as much as 30 feet below sea level would essentially dewater the Silverado water-bearing zone in this reach and would prevent underflow to the west basin.

From the generalized data of plate 15, the calculated cross-sectional area **of** the Silverado water-bearing zone and correlative aquifers is 18 million square feet, of which about 12.8 million is south of El Segundo Boulevard and about 5.2 million is north; of the latter, about 2 million square feet had been dewatered by 1945. Thus, the saturated cross-sectional area of the lower Pleistocene aquifers, as compared with that of the upper Pleistocene aquifers, was about four times **as** great· under initial conditions and about seven times as great in 1945.

**CHANGE IN DIFFERENTIAL HEAD ACROSS THE BARRIER FEATURES**

The average· differentials in water level across the barrier features of the uplift between the Baldwin Hills and the southeast edge of

Dominguez Gap can be calculated appr ximately from water-level contour maps of the Silverado water-bearing zone by estimating average differential heads across measured segments of the barrier features and totaling these differentials, which are weighted in accord with the lengths of the respective segments. In this manner, average differentials in water level have been estimated for 1904, 1933, 1941, and 1945, from the data of plates 9 to 12. Results are summarized in table 15.

**TABLE** *15.-Average water-level differentials, in feet, across the barrier features of the Newport-Inglewood uplift between the Baldwin Hills and Long Beach, 1904-45*

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Baldwin Hills to El Segundo Boulevard  (6 miles) | El Segundo Boulevard to Long Beach (8 miles) | Totaled average frolll BaldwtiJ. Hills to Long,  Beach  (14 miles) |
| 1904  1933 (March)  1941 (April)  1945 (November) | 49  29  22  32 | 33  37  33  40 | 40  34  28  36 |

The water-level differentials have been summed up separately for the 6-mile reach northwest of El Segundo Boulevard and the 8-mile reach to the southeast. The former parallels the area of partial dewatering along the crest, and also is the one with the poorer control on water-level differentials, especially across the Potrero fault north of Century Boulevard; here, the amount of drawdown of water level in the several fault blocks between the Potrero and Inglewood faults is irregular and largely unknown.

Although the average differentials presented in table 15 are only approximate and their derivation has required a considerable amount of extrapolation, they suggest with respect to the Silverado water­ bearing zone and correlative deposits that:

* 1. In 1904 the differential in water levels was about 50 percent greater north­ west of El Segundo Boulevard than to the southeast.
  2. By 1933 the differential northwest of El Segundo Boulevard had decreased about 40 percent and was less than the differential to the southeast, which had increased slightly.
  3. The average differential was least in 1941 only 28 feet for the over-all 14- mile reach.
  4. If the average head differential between 1933 and 1941 is assumed to be the average of those **2** years, then the head differential northwest of El Segundo Boulevard in that 8-year period (26 feet) was just about half of that in 1904, whereas southeast of El Segundo Boulevard it was slightly higher than in 1904 (35 feet). If the water transmitted across the barrier features is proportional to the differential in head, as seems reasonable, if the permeability of the water­ bearing beds is considered uniform along the full reach, and if the effect of de-

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watering north of El Segundo Boulevard is ignored, the underflow into the Tor­ rance-Inglewood subarea in the period 1933-41 can be estimated to be about 86 percent as great as in 1904 (product of differential head times cross-sectional area, for each segment).

* 1. In the same way, the underflow into the Torrance-Inglewood subarea as of 1945 can be estimated to be about the same as in 1904. If the dewatering along the crest north of El Segundo Boulevard is considered wholly effective in propor­ tionately reducing the underflow to the west basin, then, the underflow as of 1945 would have been about 90 percent as great as in 1904, with respect to the Silverado zone and correlative deposits.

Of all water-bearing deposits of Pleistocene age along the reach from the Baldwin Hills to Los Cerritos-that is, the extensively de­ watered upper Pleistocene deposits as well as the Silverado zone and correlative deposits of early Pleistocene age-it is estimated that the underflow as of 1945 was about 85 percent as great as in 1904.

**METHODS OF ESTIMATING UNDERFLOW**

The underflow to the Torrance-Inglewood subarea from the main coastal basin comprises two elements, (1) the underflow in the Gaspur water-bearing zone of Recent age, which passes into the west basin through the throat of Dominguez Gap, and (2) the underflow through all the aquifers of Pleistocene age, of which the Silverado water­ bearing zone and correlative aquifiers constitute the principal conduit.

The Gaspur water-bearing zone is not cut by the barrier features of the uplift-specifically, the Cherry-Hill fault (pl. 12)-and thus no differential in water level has been developed. Accordingly, the un­ derflow to the west basin through this aquifer can be estimated as the product of the permeability, the cross-sectional area, and the hydraulic gradient. The permeability has been estimated to be about 3,000 gpd per square foot (p. 31), the cross-sectional area at the throat between Dominguez Hill and Los Cerritos is about 72 foot-miles (width 1:2 miles parallel to the ground-water contours, and thickness about 60 feet), and the hydraulic gradient through the throat has been about 12 feet to the mile in recent years (pl. 11). Thus, the current underflow to the west basin through. the Gaspur water-bearing zone is estimated at about 4 cfs, or about 2,900 acre-feet per year.

The quantity of underflow to the Torrance-Inglewood subarea through the deposits of Pleistocene age also could be estimated directly if: (1) the permeability of the water-bearing deposits from place to place along the crest of the uplift had been determined by means of a sufficient number of pumping tests to afford reliable control; (2) the average hydraulic gradient across the crest were known for the particu­ lar instants or periods of appraisal; and (3) the amount of withdrawal between the crest of the uplift and the inland boundary of the west basin were known, so it could be subtracted from the underflow passing

the crest. Neither the permeability nor the crestal hydraulic gradient can be evaluated with reasonable accuracy at this time. In the 3-mile reach from the top of Dominguez Hill to the Los .Angeles River not a single water well taps the Silverado water-bearing zone immediately inland from the baITier faults. It is here that the greatest differential in pressure level now exists across the bamer features of the uplift. During this investigation an attempt was made, with the cooperation of the Los .Angeles County Flood Control District, to utilize certain oil-test holes for obtaining data on the permeability and piezometric level of the Silverado zone within this critical reach; however, the negotiations were unsuccessful.

The importance of obtaining accurate data on the hydraulic gradient can be illustrated by the following example. If the average perme­ ability along the crestal reach is assumed for the moment to be 1,000 gpd per square foot, the quantity of water transmitted across the saturated crestal section of the Silverado zone and coITelative deposits in 1945 would have been about 3,400 acre-feet per year for each foot per mile of hydraulic gradient.

The quantity of underflow passing into the ToITance-Inglewood subarea through the Silverado water-bearing zone and coITelative deposits· could be estimated by another method. The axis of the pres­ sure trough, as shown on plates 9 to 12, marks the boundary between water moving inland and water moving coastward. That axis has migrated inland in recent years because the draft from the ToITance­ Inglewood subarea has increased about 50 percent while the underflow has remained roughly constant. The quantity of water withdrawn betwMn the baITier and the axis of the pressure trough-that is, within the area underlain by a coastward gradient-is a measure of the replenishment by underflow. It is impossible to estimate this draft accurately at present. For example, the axis of the pressure trough as of 1945 passed through the main well field of the Dominguez Water Corp. (pl. 12, plant 14b). The proportion of water contributed to this well field from the inland side (coastward hydraulic gradient) and from the coastward side (landward hydraulic gradient) canno\_t be determined without constructing additional observation wells to indicate the steepness of the coastward gradient as compared to the landward gradient.

However, as plates 9 and 11 suggest, the coastward hydraulic gradient on the inland side of the trough of pressure relief is somewhat steeper than the landward gradient on the oceanward side of the·cone. If, for purposes of rough calculation, it is assumed that the coastward hydraulic gradient to such pumping plants along the axis of the pres-

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sure trough was twice as great as the inland gradient in 1945, and presuming that the transmissibility of the deposits on the two sides is the same, then the contribution from the inland side would be two­ thirds of the total to such well fields. On the basis of this assumption, the underflow from the main coastal basin to the Torrance-Inglewood subarea through the Silverado water-bearing zone as of 1945 is esti­ mated roughly to have been about 12,000 to 16,000 acre-feet per year. If the estimated underflow through the upper Pleistocene deposits and through the Gaspur water-bearing zone is added to this, the total contribution to the Torrance-Inglewood subarea by underflow from the main coastal basin in 1945 is estimated to have been within the range of 15,000 to 20,000 acre-feet.

**FACTORS AFFECTING CURRENT AND FUTURE REPLENISHMENT**

The net replenishment to the Torrance-Inglewood subarea from 1933 to 1941 has been estimated at about 34,000 acre-feet per year (p. 148-155). Although the withdrawal as of 1945 had increased to some 78,000 acre-feet (table 8), or to about 160 percent of the average yearly draft of the thirties, the net replenishment in 1945 is believed not to have differed greatly from that of the thirties. Be­ cause the average differential in the water level across the barrier features is believed to have increased by a few feet from the thirties into 1945 (p. 158), the underflow to the Torrance-Inglewood subarea probably was slightly greater in 1945 than in the thirties. Therefore, because the sum of the other elements of net replenishment is con-­ sidered to have been about equal in years of average rainfall, the net replenishment of the middle forties presumably has been at least equal to and probably slightly in excess of that of the thirt,ies.

The increase in draft during the war years drew down the water levels substantially in the Torrance-Inglewood subarea and steepened the landward hydraulic gradient along the coastal reaches of the basin. The ocean-water or subsea contribution, which is estimated to have b\_een about 12,000 acre-feet per year in the thirties, is believed to have more than doubled by the end of 1945. Additional drawdown of the water levels in the Torrance-Inglewood subarea would increase the rate of ocean-water contribution in direct proportion to the increase in landward hydraulic gradient along the coastal reach.

If a decrease in draft should occur and water levels in the Torrance­ Inglewood subarea should remain about constant for the next few years, and if water levels in the main coastal basin should be drawn down appreciably below the levels of 1945, contributions by underflow from the main coastal basin, which are believed to constitute about

half the current net replenishment to the subarea, would be reduced roughly in proportion to the decrease in average differentials across the barrier. The reduction in underflow probably would be slightly greater than the decrease in differential head because of the effect of additional dewatering along the crest of the uplift. Thus, it is to the interest **of** water users in the west basin that water levels inland from the barrier be maintained as high as is feasible-in other words, replenishment to the Torrance-Inglewood subarea is affected beneficially by conser­ vation of the water supply and increased replenishment to the ground­ water reservoir throughout the coastal plain in Los Ang les County.

**REPLENISHMENT TO THE CULVER CITY SUB.ARE.A.**

Under initial conditions and to date, replenishment to the Culver City subarea has been supplied very largely by infiltration of runoff from the south flank of the Santa Monica Mountains west of the Inglewood fault and from rainwater penetration beneath the Santa Monica plain and within Ballona Gap. Initially, some replenishment doubtless passed coastward across the Inglewood fault from the main coastal basin. Since the middle twenties, however, little if any water has entered the Culver City subarea from the Pleistocene deposits to the east, because water levels in those deposits consistently have stood lower on the inland side of the Inglewood fault than on the coastal side. In the "50-foot gravel," however, a coastward gradient still prevails across the Ingelwood fault and some water presumably passes into the Culver City subarea through this conduit.

In the crestal subbasin (between the Inglewood and Overland Avenue faults) withdrawal now is wholly from. the San Pedro forma­ tion. The draft did not exceed a few hundred acre-feet per year until the middle thirties, when it increased to about 1,100 acre-feet per year (p. 108). Replenishment to the San Pedro formation is believed to be almost entirely from the north. As shown by the hydro­ graphs for wells 2/14-7Ml and 18Fl (pl. 14), the water level declined at a gentle rate of about 0.6 foot per year in the early thirties, but it had declined at more than double that rate since 1936. The water­ level trend in these observation wells must be interpreted with caution, because a general decline of water level in the subbasin would be expected to have occurred in response to drawdown of water levels to the south (escape area), east, and west, as well as to the increased withdrawal in the subbasin itself. Nevertheless, the evidence suggests that the replenishment under present conditions is somewhat less than the draft.

Replenishment to the Charnock subbasin as of 1904 was from: (1) the north by infiltration of rainfall and runoff on the Santa Monica

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plain; (2) the east by movement of water from the crestal subbasin, probably largely through the "50-foot gravel," which is not cut by the Overland Avenue fault; and (3) by direct penetration of water from the land surface in the part of the subbasin within Ballona Gap. The concentrated withdrawal from the Charnock and Sepulveda well fields (p. 97 and pl. 12) has developed and maintained a central ground-water depression in· which water levels have stood several tens of feet below sea level for the past two decades. Because of this great drawdown of water level, replenishment to the cen'tral part of the Charnock subbasin has been derived in part froru the south since the late twenties. On the other hand, the general drawdown of water level within the Culver City subarea has largely dewatered the "50-foot gravel," and replenishment from the crestal subbasin to the east probably has about ceased, except for possible contributions across the Overland Avenue fault.

The draft froru the Charnock subbasin is estimated to have ranged

froru 12,500 acre-feet in 1941 to 7,000 acre-feet in 1945. The hydro­ graphs for wells 2/15-11E3 and 2401 (pl. 14) suggest that in 1945 the replenishment was about equal to the estimated draft of 7,000 acre-feet. The water-level contours of plate 12 suggest that the hydraulic gradient froru the north was then about 2½ times as steep as that..froru the south, and thus-assuming uniform permeability of the water-bearing material-that more than two-thirds of the replen­ ishment was from the north. With respect to replenishment from the south, the water-level contours of plates 9-12 suggest that sorue of this replenishment moves northward from south of the Ballona escarpment, possibly in part from the crestal subbasin around the south end of the Overland Avenue fault.

The coastal area apparently receives almost all its replenishment from the Santa Monica upland to the north and by direct infiltration of rainwater in Ballona Gap. Through the thirties, when water levels stood below sea level, it also received substantial recharge from the ocean. For the past two decades no replenishment has moved west­ ward across the Charnock fault. In fact, with the great differential in water leve]s that has existed across the Charnock fault since the late twenties, some water probably has moved inland across the fault. ·

The draft in the coastal area in the forties is estimated to have been between 2,000 and 3,000 acre-feet per year. The hydrographs for wells 2/15-16Fl and 22B4 (pl. 14) suggest that the replenishment from all sources has been at least equal to this draft in recent years.

**CHEMICAL CHARACTER OF NATIVE AND CONTAMINATED**

**GROUND WATERS** 1

**GENERAL NATURE OF THE CHEMICAL PROBLEMS**

Locally, in the early twenties and more widely in the early thirties, certain wells near the coast from Ballona Gap to and beyond Redondo Beach began to yield saline water, leading ultimately to abandonment **of** some wells in which the salinity of the water became so great that it could no longer be used.

The districts in the Torrance-Santa Monica area in which the chlo­ ride content of some or all of the ground-water bodies exceeded 100 ppm in 1945-46 are shown on plate 16. These districts include several bodies containing water of native inferior quality-specifically, a part of the Wilmington district, a narrow zone extending along the north flank of the Palos Verdes Hills, the Gardena area, an area be­ tween Hawthorne and Inglewood, and a narrow strip along the west edge of the Baldwin Hills. They also include areas of inferior water in Dominguez Gap, along the coast from Redondo Beach to El Segundo, and in Ballona Gap, which have developed from progressive contamination during the past two decades; these are identified by, diagonal ruling on plate 16.

The approximate extent of saline contamination in 1931-32 is .also shown and represented by the boundaries of contaminated waters then containing more than about 100 ppm of chloride. Thus, the spread of contamination in the 14-year period is indicated by the relative position of the two boundaries.

In the Gardena area, the ;native waters of inferior quality occur within the shallow unconfined water body. In all the other districts underlain by water of more than 100 ppm of chloride, the inferior water is in the principal water body.

In Dominguez Gap, native waters of inferior quality ccurring in the shallow unconfined body have become contaminated extensively during the past two decades. However, contamination has developed more widely in certain underlying water-bearing deposits in the principal water body-specifically in the Ga.spur water-bearing zone and in the unnamed upper Pleistocene deposits to depths of .150 to 200 feet below land surface. In Dominguez Gap, the extent of con­ tamination as shown on plate 16 relates to conditions in the principal water body and not to those in the shallow unconfined body.

Within the west basin and outside of the districts underlain by inferior waters as indicated on plate 16, a few wells t pping: the principal water body yield water containing more than 100 ppm of chloride. Although these are not identified on plate 16, several of the wells are treated in the text beyond.

Because of the increased development of ground water in the west basin and the continuing decline in ground-water levels, local agencies that draw water from the basin or are concerned with the conservation of ground water have become increasingly alarmed by the spread of saline contamination.

Following sections of this report treat this problem of saline con­ tamination by: (1) describing the chemical character and extent of waters of good quality and of inferior quality existing under native conditions; (2) describing the sources of saline contamination insofar as they can be identified; (3) determining the present extent of salt­ water encroachment in the several water-bearing zones in the west basin; and (4) evaluating the possibilities for saline contamination to become more extensive in the future.

**SCOPE AND SOURCES OF ANALYTIOAL DATA**

In connection with the canvass of water wells within the coastal plain by Mendenhall (1905a, 1905b) in 1903-4, the approximate dis-· solved-solids content of the water from about 2,500 wells in the Tor-· ranee-Santa Monica area was computed from their electrical con­ ductances. Except for these determinations, only a few analyses are available for the period prior to 1929. The bulk *of* chemical analyses are for well waters sampled since that time--beginning chiefly in 1931-32, that is, sampling programs of the several active agencies began at about the time that local contamination problems became serious. At the present time, a large amount of analytical data has· accumulated; this information includes both comprehensive analyses and those in which only one or two constituents, usually chloride or bicarbonate, have been determined. The scope of these data and the term of record by each contributing agency have been given in an earlier report (Sinnott and Garrett, 1946). In all, about 1,500 com:. prehensive analyses and about 12,000 field (partial) analyses have been made available for study. The Geological Survey has drawn freely upon this information in compiling the part of this interpretive report that deals with the chemistry of native and contaminated waters in the Torrance-Santa Monica area. From these data, representative analyses have been selected (table 30) to show the character of native waters and the progressive development of contamination in critical areas.

In addition to the large number of analyses, several interpretive

reports relating to the problems of saline contamination have been made. Nearly all of these reports have been made by or for the Los Angeles County Flood Control District and c.hiefly discuss contamina- \_

**480IOB-G9--12**

tion in Ballona Gap. Most of these have been cited earlier in this report (p. 9).

Beginning late in 1943 as a part of the field canvass, the Geological Survey sampled 427 water wells in the Torrance-Santa Monica area, subsequently 73 of these were resampled. About 46 wells in critical areas were sampled periodically to determine if any change in salinity was occurring. In addition, a number of wells were sampled re­ peatedly while pumping. In all, the Geological Survey made 667 field analyses, comprising determinations of electrical conductivity, soap hardness, and chloride. These analyses are presented in table

29. Also, the Geological Survey has made 12 preliminary analyses in :which electrical conductivity, soap hardness, calcium, bicarbonate, sulfate, chloride, borate, and iodide were determined; and 21 com­ prehensive analyses were made. These 33 analyses are included in table 30.

Plate 17 shows the location of wells for which chemical analyses -are available from all sources, and indicates by symbol the type of analysis made. This plate also shows the water-quality data of Mendenhall by means of contours which indicate the approximate content of dissolved solids in parts per million. Necessarily, some generalization has been made; however, these contours suggest the approximate quality of the ground water under native conditions. During the survey by Mendenhall the approximate dissolved-solids content of the samples from about 7,500 wells-of which about 2,500 were within the Torrance-Santa Monica area-was computed from determinations of their electrical conductances, corrected to 60°F. The relationship between electrical conductivity and the approximate dissolved-solids content of natural waters within the coastal plain in Los Angeles and Orange Counties has been set forth in a recent report (Piper, Garrett, and others, 1953, p. 10, 11, and pl. 3). This relationship is a simple one and in many cases obviates the need for a gravimetric determina­ tion of dissolved solids.

**CHARACTER AND DISTRIBUTION OF NATIVE WATERS IN THE DEPOSITS COMMONLY PENETRATED BY WATER WELLS**

RANGE IN **CHEMICAL CHARACTER OF WATER FROM WELLS**

Native waters tapped by wells in the Torrance-Santa Monica area vary widely in quality from excellent to markedly inferior. For purposes of this report, water is considered inferior when its dissolved­ solids content is more than about 600 ppm (Piper, Garrett, and others,· 1953, p. 50). In general, all the confined waters in that part of the area inland from the Newport-Inglewood uplift are of good to excel­ Jent quality and are suitable for all domestic and irrigation purposes

-and for industrial use with only moderate treatment. These are chiefly calcium-bicarbonate waters; their chloride content ranges from 20 to 30 ppm and their hardness from 150 to 225 ppm. In this report, terms describing the general chemical character of a water are used in particular senses, as in the following examples: (1) Calcium bicarbonate designates a water in which calcium amounts to *50* percent or more of the bases and bicarbonate to *50* percent or more of the acids, in chemical equivalents; (2) sodium calcium bicarbonate designates a water in which sodium and calcium are first and second, respectively, in order of ·abundance among the bases but neither amounts to 50 percent of all the bases; and (3) sodium sulfate bicar­ bonate designates a water in which sulfate and bicarbonate are first and second in order of abundanc among the acids, as above.

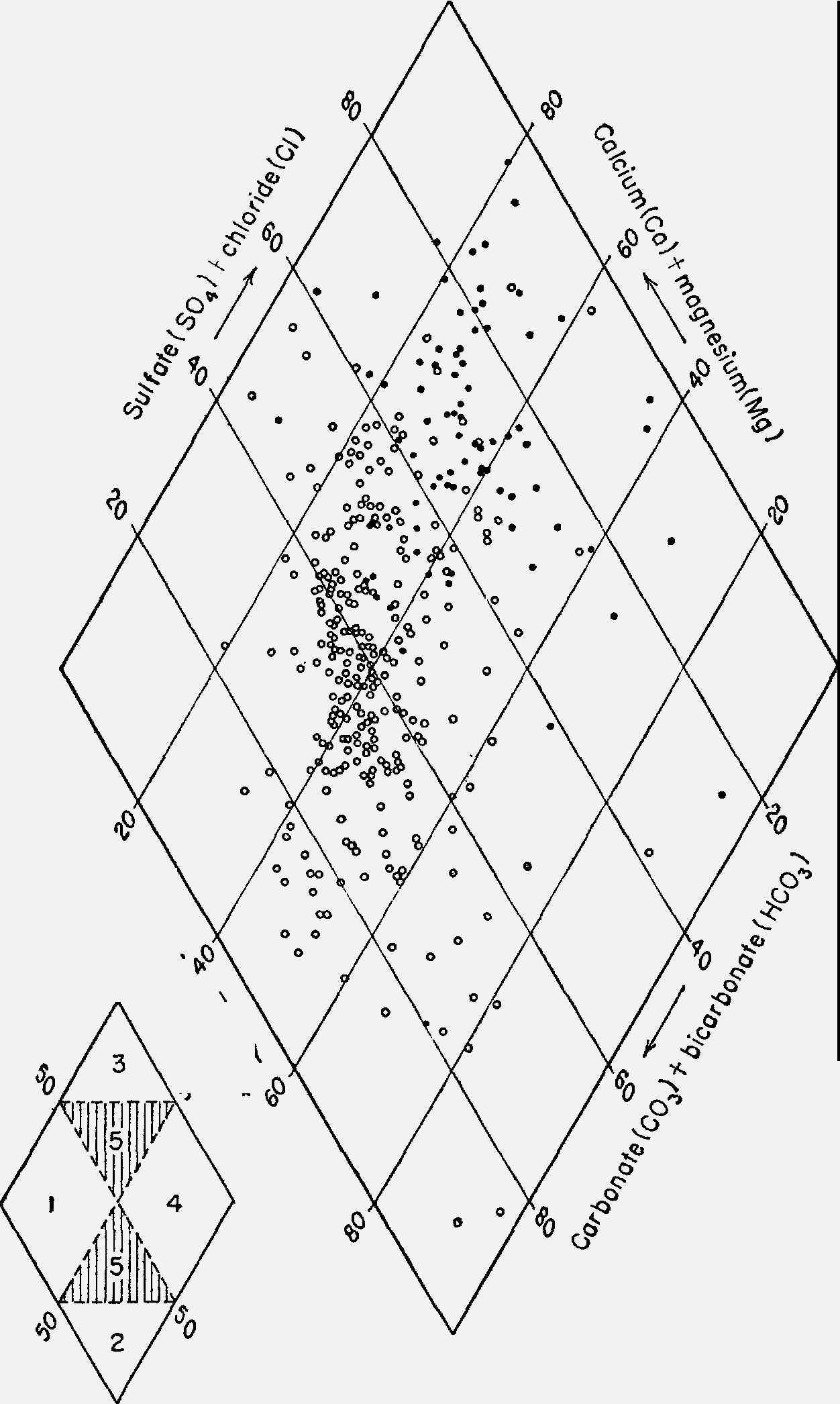
Coastward from the Ne'Yport-Inglewood uplift within the west basin, native waters of good quality range in character from calcium to sodium bicarbonate. Except locally, the chloride in confined waters here ranges about from 30 to 200 ppm, but those containing more than about lOQ ppm are considered inferior because their dissolved-solids content is usually in excess of 600 ppm. Locally, the chloride content of certain presumed native confined waters is as high as 400 ppm, alt,hough it is possible that some of these have been con­ taminated in recent years.

Unconfined vrnters on both sides of the Newport-Inglewood uplift are generally inferior but are poorest in quality on the coastal side. The chloride in these waters is as great as 2,200 ppm and dissolved solids as much as 4,000 ppm.

To show the overall range in chemical character of waters in the Torrance-Santa Monica area, chemical analyses of 375 samples from 338 wells have been plotted on figure 9. This method of plotting well waters has been used earlier to show the chemical character of water from wells in the Long Beach-Santa Ana area. The plotted positions of the analyses on the graph are dependent upon the pre­ dominating chemical constituents in the water. Hence, water types can be recognized at once by inspection of the graph. Additional· explanation is given on figure 9. This plate presents almost all of the analytical data available to the Geologicai Survey in graphic form. Included on the graph are analyses of (1) native waters of good quality,

* 1. native waters of poor quality, (3) native blended waters, and (4) contaminated waters-those native waters that have been modified by the addition of inferior waters from sources exterior to the initial native water body.

The native waters of diverse character can be divided in a general way into several types; each type is more or less characteristic of a

t -

%

-*'e,*

'?/'.

**0**

Native or blended waters **of**

both good and inferior quality Contomfno fed waters

Scale indicates percentage equivalents

KEY DIAGRAM

**Area** I Carbonate hardness exceeds

50 percent

2· Carbonate alkali exceeds 50 percent

1. Non carbonate hardness exceeds 50 percent
2. Noncorbonote alkali exceeds 50 percent
3. None of the preceding characteristics exceeds 50 percent

FIGURE 9;-Cbemical character of 375 water samples from 338 .wells in the Torrance-Santa Monica area,

**1929--46.**

'Stratigraphic range. The zones of water quality associated with

,certain stratigraphic ranges are discussed later in this section.

**ZONES OF WATER QUALITY**

In the Long Beach-Santa Ana area, eight distinct vertical ranges of water quality have been discriminated within the deposits tapped by water wells (Piper, Garrett, and others, 1953, p. 17-18). Each **of** these except the uppermost-that occupied by the body of unconfined water--coincides roughly with a particular stratigraphic zone. In

-general, the waters of the several ranges as delineated differ from each

,other in chemical character. The difference in character is striking between certain ranges and between others it is minor. Similarly, in the Torrance-Santa Monica area each zone of water quality coincides in a general way with a particular stratigraphic range. As in the Long Beach-Santa Ana area, differences in character between adjacent Tanges may be small, and water of uniform charact\_er does not neces­

:sarily exist throughout the lateral extent of any one range. However, although the full stratigraphic sequence of the Long Beach-Santa Ana

:area prevails in the Torrance-Santa Monica area, only six ranges **of**

water quality have been discriminated. Certain of these ranges span

:Stratigraphic intervals identical with those of their counterparts in the Long Beach-Santa Ana area to the east; others span a more inclusive stratigraphic interval.

In both the Long Beach-Santa Ana and the Torrance-Santa Monica

.areas the uppermost range is that occupied by the semiperched and essentially unconfined water body in the upper part of' the filluvial deposits of Recent age in Dominguez and Ballona Gaps and in the topmost part of the upper Pleistocene deposits beneath the Torrance plain. Commonly, the semiperched water body in both the Recent

.and Pleistocene deposits is separated from the underlying principal water body by a few- tens of feet of relatively impermeable layers of silt and clay.

The five ranges in the principal confined ground-water body in the Torrance-Santa Monica area have been assigned numbers identical to those used for comparable ranges in the Long Beach-Santa Ana area In downward succession, these five ranges are as follows:

*Range* 1.-The lower division of the Recent deposits, which in­ cludes the Ga.spur water-bearing zone of Dominguez Gap and the "50-foot gravel" of Ballona Gap. In Dominguez Gap the Gaspur water-bearing zone is 40 to 60 feet thick and its base is about 120 feet below land surface. In Ballona Gap, the base of the "50-foot gravel" is about 50 feet below land surface, and its thickness ranges from 10 to 40 feet. Locally the "50-foot gravel" is in hydraulic continuity with underlying permeable Pleistocene deposits. The extent of the

Gaspur water-bearing zone and the "50-foot gravel" is shown on plate 18.

*Range* 2.-The Long Beach-Santa Ana area, the uppermost Pleisto­ cene deposits beneath the Downey plain, is not differentiated from range 3 in the Torrance-Santa Monica area.

*Range* 3.-The unnamed upper Pleistocene deposits, including the "200-foot sand" and strata correlative with or in hydraulic continuity with those deposits, ranges in thickness from a feather edge at the Baldwin and Palos Verdes Hills to as much as 300 feet along the syn­ clinal trough within the west basin. The base of this range commonly is from 200 to 300 feet below land surf ace in the west basin.

*Range* 4.-In theLong Beach-Santa Ana area-the uppermost part. of the San Pedro formation beneath the Downey plain-is not dif­ ferentiated in the Torrance-Santa Monica area.

*Range* 5.-The upper part of the San Pedro formation, including the­ "400-foot gravel" of the area between Gardena and Inglewood, but excluding the Silverado water-bearing zone. In general, this is the stratigraphic equivalent of range 5 of the Long Beach-Santa Ana. area. In the west basin, this range is thickest in the synclinal trough (as much as 200 feet); along the crest of the Newport-Inglewood uplift,. although this range is present, it is substantially thinner. Along much of the coast from Redondo Beach to Santa Monica the range decreases in thickness to a feather edge or is entirely absent. Along the synclinal trough the base of this range is about 300 feet below land surface in Inglewood, about 400 feet below at Gardena, and as much as 700 feet below in Dominguez Gap, near the intersection of Alameda Boulevard and Carson Street. In Ballona Gap, just inland from the Newport­ Inglewood uplift-specifically, in 1/14-32M and 2/14-5D-the San Pedro formation has been divided tentatively into an upper, a middle1 and a lower part (fig. 14). However, the separation is intended pri­ marily for local subdivision of the formation on the basis of water­ bearing zones and is derived chiefly from examination of logs of wells at the Sentney plant of the Southern California Water Co. Although the upper part of the San Pedro formation here may not be correlative with any part of range *5,* as here defined, it has been found most feasible to include the waters yielded from this upper part of the San Pedro formation in that range.

*Range* 6.-The middle and lower parts of the San Pedro formation1 including the Silverado water-bearing zone of the Torrance-Inglewood subarea and the main water-bearing zone in Ballona Gap coastward from the Newport-Inglewood uplift-the essential correlative of the

Silverado zone. Within the west basin the thickness of this range is as much as 600 feet between Wilmington and Redondo Beach, but northward from Gardena the thickness commonly does not exceed 200 feet and in Inglewood it is as little as 50 feet. The depth of its base is shown by the contours of plate 2. In Ballona Gap, just inland from the Newport-Inglewood uplift, the aggregate thickness of the middle and lower parts is probably about 230 feet, and the top of the middle part is about 290 feet below land surface. In the Long Beach-Santa Ana area, range 6 included the lower part of the Silverado water­ bearing zone; there the upper part was included in range 5. However, range 6 includes the full vertical extent of the Silverado zone. In other respects, range 6 of the two areas is essentially common.

*Range* 7.-The upper division of the Pico formation underlies nearly all the west basin. This range contains the deepest fresh waters known to occur in the area, although its waters are brackish locally north of Ballona Gap. Its vertical range has been described on pages 57-59. The depth of its base, where known, is shown on plate 8.

On following pages the waters contained in the six ranges of the Torrance-Santa Monica area are described in detail; on plates 18 and 19 are plotted the wells from which native waters have been selected that are considered representative of the respective ranges tapped. For each of the waters so selected, the dissolved solids content and a "binomial symbol" are shown on the plates 18 and 19. The binomial symbol is written in the form of a decimal fraction. The first term denotes the percentage of hardness-causing constituents among the bases-that is, of calcium and magnesium; the second term denotes the percentage of bicarbonate-and carbonate calculated to bicar­ bonate-among the acids. For example, the symbol 60.75 would in­ dicate a water in which the calcium and magnesium amount to 60 percent of all the bases, in terms of chemical equivalents, and in which bicarbonate (including carbonate, if present) amounts to 75 percent of all the acids.

The complement of this binomial symbol indicates the percentage amounts of non-hardness-causing constituents or "alkalis" among the bases, and of noncarbonate acids. In the example here given, the complement is 40.25, which indicates 40 percent sodium and potassium [the "percent sodium" of Scofield (1933, p. 22-23)] and 25 percent. sulfate and chloride, in chemical equivalents.

The analyses selected as representative for native waters are listed on table 16 and are grouped according to their respective ranges.

TABLE *16.-Analyses of representative native ground waters*

[See table 30 for description of sources and for analytical data in parts per million]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Well | Dissolved solids (parts  per million) | Constituents (percentage equivalents) | | | | | |
| Calcium (Ca) | Magna- slum (Mg) | Sodium and po- tassium (Na+K) | Blear- bonate (HCO3)l | Sulfate (SO,) | Chloride (Cl) **2** |

**Waters Crom the unconfined shallow body**

[Location of sources shown on plate 18]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 3/13-27BL  30PL  31H4  34//1143--286L0L2 --\_ -- \_ | s 954  31,125  3 924  a 3,907  33,609 | 34.0  39.4  48. 4 37.2  25.0 | 24.4  26.2  20. 8 21.0  28.0 | 41.6  34.4  30.8  41.8  47.0 | 46.4  31.8  27.0  5.4  7.2 | 22.8  !6.6  22.6  **6.4**  46.2 | 30.8  51.6  **50.4**  88.2  46.6 |
|  |
| Minimum  Maximum\_. |  |  |  |  |  |  |
| 924  3,907 | 25.0  48.4 | 20.8  28.0 | 30.8  47.0 | 5.4  46.4 | 6.4  46.2 | **30.8**  88.2 |

**Waters from the Gaspur water-bearing zone or "50-foot gravel" in alluvial deposits of Recent age**

[Location of sources shown on plate 18]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2/14-5D9  3/13-36DL  4/13-2P4  15A3  35M3  Minimum Maximum | 5 747  404  3338  a 449  a 318 | 43.6  52.6  52.4  50. 2 23.2 | 29.2  13.6  11.4  17.0  15. 6 | 3 27.2  3 33.8  36.2  32. 8  3 61. 2 | 48.0  68.6  62.0  52.8  66.2 | 28.4  19.6  25.6  28.6  14. 4 | **23.G**  11.8  12. 4  18. 6  **19.4** |
| 318  747 | 23. 2  52. 6 | 11.4  29.2 | 27. 2  61. 2 | 48. 0 68.6 | 14.4  28.6 | **11.8**  23.6 |

**Waters Crom unnamed upper Pleistocene deposits including the "200-Coot sand"**

[Location of sources shown on plate 18]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2/14-29KL  32EL  3/13-20HL  3/14-26Jl i/13-6.JL  4/13- mL- | 442  3 496  362  3 377  a 308  3 518  787 | 46.0  37.6  51.4  44. 2 51.4 46.0 34.2 | 20.8  24.0  19.0  20.4  14.8  17.0  19.2 | 3 33.2  3 38. 4  29.6  35.4  33.8  37.0  46.6 | 57.0  59.8  60.0  54.2  63.4  39.2  **30.4** | 11.6  13.8  28.0  8.6  **24.8**  **14.8**  **5.4** | **31.4**  26.4  **12.0**  **37.2**  **11.8**  46.0  **64.2** |
| Minimum Maximum |
| 308  787 | 34.2  51.4 | 14. 8 24.0 | 29.6  46.6 | 30.4  63.4 | 5.4  28.0 | **11.8**  **64.2** |

**Waters Crom the "400-Coot gravel'' in upper part of San Pedro formation**

[Location of sources shown on plate 19)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 3/14-rnm------  23LL | 3 347  3 359  3 323 | 34. 2  42. 0 46.2 | 17.8  21.2  21.0 | 3 48.0  3 36.8  332.8 | 69.8  65.0  62.0 | 13.6  19.6  24.6 | **16.6**  **15.4**  **13.4** |
| Minimum Maximum |
| 323  359 | 34.2  46.2 | 17.8  21.2 | 32.8  48. 0 | 62.0  69.8 | 13.6  24.6 | **13.4**  16. 6 |

1 Includes carbonate (COs) and borate (BOa), if determined.

2 Includes fluoride (F) and nitrate (NOs), if determined.

**a** Calculated.

TABLE *16.-Analyses of representative native ground* waters-Continued

[See table 30 for description of sources and for analytical data in parts per million}

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Di lved | Constituents (percentage equivalents) | | | | | |
|  |  |  |  |  |  |
| **Well** | \_SOlids  (parts  per | Calcium | Magne- sium | Sodium  and po- | Blear-  bonate | Sulfate | Chloride |
|  | million) | (Ca) | (Mg) | tassium (Na+K) | (HCOs)I | (SO,) | (Cl) 2 |

**Waters from the Silverado water-bearing zone, or. beyond that zone, from the middle and lower pans ofthe San Pedro formation**

[Location of sources shown on plate 19}

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 21141m-\_::::::::::::::::::::::  15D4062 ----·-------------  1901 ------------- \_  2/14-22PL  23H2 •  2115- ail:----------------------  11D\_2  2115-Uf/-----------------------  14AL  15A4 •  15F2..  2/15-15Hl.  24CL  26BL  34AL  34Hl\_  3/13-6G**1..** ··  3/14-IGL ----------------------  3K2•• --·  4Nl\_ ----------------------  9N3\_ - ---------------------  3/14-lOG L- --------------------  1231JB3~~2~~ -- \_. -- --\_-- ----\_ --·  30A2 • •  35Rl- -------------  3/151-l2HB\_LL ---------------------  13Rl --------------------  25AD4 l -----------•-----•---- | 3350  3 313  473  1 360  3 535  8 355  8 371  **s** 563  3 483  3 557  3546  3 476  3 558  3 631  3 620  3 567  3 567  3 492  3 474  3 445  3 363  3349  3 335  3305  3 327  3425  a 319  3 319  8 343  3 251  s 583  3484  3367  3433  3 365  3 236  *a* 208  1 218  221  3239  3 377  3388  3 252  3 303  3 320  3 344  3 327  8 267  8 291  3325  3427  3332  3 547  8834 | 47.2  34.8  36.6  49.4  40.8  53.8  49.4  47.0  44.8  49.2  45.8  35.0  44.0  44.0  57.8  42.8  42.8  26.4  37.8  33.6  46.6  51.0  39.4  35.6  33.0  25.6  49.2  32.0  33.8  35.0  29. 2 33.6 36.4  42. 2 39.6  27.2  23.8  16.0  26.4  17.8  13.0  11.2  43.4  35.6  35.2  33.0  31.6  27.8  18.8  27.2  28. 2  15. 2 29.6 22.0 | 20.8  33.6  19. 2 20.6 15.0  17.8  25.6  26.8  31.8  35.2  29.6  19.0  30.6  21.6  18.4  30.4  32. 2  28. 2 15.8 21.8  3. 2  15.6  20.8  22. 2 19.4  15.0  18.4  14.6  17.2  19.8  23. 4 18.6 19.6 20.6 19.0  11.4  13.8  5.0  11.2  19.4  11.0  8.0  14. 2 24.6 17.6  18.8  22.0  20.4  7.4  16. 8  20.0  8.0  6.6  19.2 | 32.0  a 31.6  3 44. 2  30.0  3 44. 2  3 28.4  3 25. 0  **s** 26. 2  23.4  3 15.6  3 24.6  3 46.0  25.4  3 34.4  a 23. 8  26.8  25.0  45.4  3 46.4  3 44.6  3 50.2  3 33.4  3 39.8  3 42.2  3 47.6  a 59.4  3 32.4  s 53.4  3 49.0  45.2  47.4  3 47.8  I 44.0  8 37. 2  **41.4**  61.4  62. 4 79.0 62.4 62.8  76.0  3 80. 8  3 42. 4  39.8  3 47.2  148.2  46.4  8 51.8  **s** 73.8  56.0  3 51. 8  3 76.8  8 63.8  3 58.8 | 61. 6 59.4 63.6 61.0 65.2  61.6  59.4  52.0  51.0  50.6  48.0  60.0  52.0  44.6  43.6  48.0  51. 2 65.0 61.0 59.4  64.0  63.4  72.8  80.4  83.0  86.8  62.4  84.2  83.0  82.8  71. 2 75.0 77.4 67.0 57.2  66. 2 76.6 82.0  81. 2 85.8  72. 4 61.0 68.6 67.6 67.6  62.6  65.8  87.6  87.4  76.4  68.4  78.8  63.0  72.0 | 27.4  17.6  **20.8**  26.8  12.0  26.6  27.2  30.8  31.7  37.8  37.0  19.8  26.8  37.2  39.4  32.4  38. 2 8. 6 7.8 11.4  24.6  24.0  11.2  3.4  .2  .8  23.6  1. 2  ..,  1. 2  5. 6  ..2o  2.6  7.0  18. 2 5. 2  ----------  1.6  .4  .o  10.8  11.0  4. 2  1.0  .8  **1**.**.**o**2**  .o  1.8  .4  1.0  .o | 11.0  23.0  15.6  12.2  **22.S**  **11.S**  13.4  17.2  17.3  11.6  15. 0 **20.2** 21.2  18. 2 17.0  **19.6**  10.6  26.4  31. 2 29.2  11.4  12.6  16.0  16.2  16.8  12.4  14.0  14. 6 17.0 16.0  23.2'  24.8  22.6  30.4  35.8  15.6  18.  18.0  17.2  13.8  27.6  28.  **20.4**  28.  31.4  **36.6**  33.0  12. 4  12.&  23.-6  **29.8**  20.S  36.0  28. 0 |
| 4/lt¼-l4Q4 • •  15A2 ---------------------  : t:::::::::::::::::::::  30Kl•• --------------------  4/13-31E3  31E4  4/14-lH\_. \_. • •• \_.  5N\_2. ---------------------  7J3\_ •• ---------------------  4/14-80l\_ --------------  8EL  161L032.------------- --------  170 l. ---------------------  4/14-17Nl. \_.  3253EN22\_.--------------------  36Hl••• |
| Minimum Maximum |
| 208  631 | 11. 2 57.8 | 3.2  35.2 | 15.6  80.8 | 43.6  87.6· | .o  39 4 | 10.6  36 6 |

1 Includes carbonate (COa) and borate (BOs), if determined t Includes flttoride (F) and nitrate **(NOs),** if determined. · a Calculated.

TABLE *16.-Analyses of representative native ground* waters-Continued

[See table 30 for description of sources and for analytical data in parts per million]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Well | Dissolved solids (parts per million) | Constituents (percentage equivalents) | | | | | |
| Calcium (Ca) | Magne- sium (Mg) | Sodium and po- tassium (Na+K) | Bicar- bonate (HCOa) I | Sulfate  (804) | Chloride  (Cl) 2 |

**Waters Crom undifferentiated Pleistocene deposits north or Ballona Gap**

[Location of source'! shown on plate 19]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **1/14-19RL**  20ML l/15-28B2 32Al  Minimum Maximum | 3 719  3 683  3 569  --- 3 577  569  719 | 49.8  20.0  49. 2  --- 42.0  20.0  49.8 | 34.6  19.0  31.6  36.6 | 3 15. 6  3 61. 0  19. 2  21.4 | 156 0  67.0  53.2  42. 2 | 21. 2 4. 2 26.4  44.0 | 22.8  28.8  20.4  13.8 |
| 19.0  36.6 | 15. 6 61.0 | 42. 2 67.0 | 4. 2  44.0 | 13.8  28.8 |

**Waters Crom upper division or Pico formation**

[Location of sources shown on plate 19)

|  |  |  |
| --- | --- | --- |
| l/15-25CL\_ 32,670 40. 2 30. 2 29.6 13.4  2/14-27JL 31,225 4. 2 3. 0 92.8 90. 2  32//145-1C7J5~~L~~ --- ---- \_ -- --- --- 31,698 4.0 6. 2 3 89.8 38.2  3 481 19.4 14.6 3 66.0 77.6  4/13-12A2 3 452 5. 2 2.0 3 92.8 79. 2  5/13-3H 3 750 7. 6 3.4 3 89.0 6S.0  Minimum --- 452 --- 4.0 2.0 29. 6 13.4  Maximum 2,670 40. 2 30.2 92.8 90. 2 | 7.4  I. 6  6. 2  1. 6  .8  .o  7.4 | 79.2  8.2  61. 8 16.2 19.2  31. 2 |
| 8. 2  79. 2 |

1 Includes carbonate (COa) and borate (BOa), if determined.

2 Includes fluoride (F) and nitrate (NOa), if determined. a Calculated.

**CHEMICAL CHARACTER OF THE WATERS UNCONFINED WATERS**

**ln** general, the native unconfined waters in the Torrance-Santa

Monica area are of poor quality. Only locally are they used for do­ mestic or irrigation purposes. Comtnonly, the high salinity of the water and the low permeability of the shallow deposits discourage extensive development.

The unconfined waters in Dominguez Gap generally range from 17*5* to 2,200 ppm in chloride content and from 1,000 to 12,900 ppm in dissolved solids; they are chiefly sodium sulfate to sodium sulfate, chloride waters. Typically, the bicarbonate content is high, rang­ ing from 250 to 1,100 pptn. It is likely that these unconfined waters have been concentrated by evaporation and, locally, by addition of saline waters at land surface, and thus they do not represent native waters. Therefore, no conclusion can be set forth here in regard to the chemical character of these waters under purely native condi­ tions. Probably, however, their chloride content was usually more than 100 ppm.

Near Gardena, about in secs. 24 to 27, T. 3 S., R. 14 W., and in

·.secs. 29 and 30, T. 3 S., R. 13 W. (pl. 16), many domestic wells tapped the unconfined water body in 1903, as shown by the well canvass of that time. As of 1946, the body is tapped by about 100

·active wells. The salinity of these unconfined waters is low enough "at least locally, to he used for domestic purposes and for irrigation. Their chloride content ranges from 50 to 2,200 ppm but commonly

-it is from 300 to 500 ppm. An analysis of water from well 3/14-2602

(table 30) indicates a sodium, calcium chloride water. No other com-

-plete analyses of the unconfined water in this area have been made,

·so far as known, hut it is inferred that the proportion of sulfate and bicarbonate in these waters is somewhat lower than in Ballona Gap. On the basis of determinations of electrical conductivity, the dissolved

·solids are estimated to range from 1,000 to 4,000 ppm.

In Ballona Gap, as of 1903, many domestic and stock wells 10 to 30 feet deep tapped the shallow water body. At that time the dis­

:Solved solids in these unconfined waters ranged from 750 to more than 2,000 ppm, but chiefly were about 1,000 ppm; all estimates were based on determinations of electrical conductivity. Locally, how­ ever, the dissolved solids of these waters ranged froru 1,500 to 2,300 ppm. Presumably, the water quality as determined in 1903 was {IB­ sentiilly native. Because of the gradual drawdown of the water levels in Ballona Gap during the twenties and early thirties, many of these shallow wells went dry. Others were abandoned as a result of deterioration in the quality of the water. By the middle thirties none of these early shallow wells were in use. About all that is known concerning the quality of the unconfined water body in re­ cent years has been obtained from 19 shallow wells bored by the Los Angeles County Flood Control District since 1936; almost all these wells were located in the reach between Lincoln and Centinela Boule­ vards. That agency has made complete analyses of water from two of these wells and partial analyses from five others. The two com­ plete analyses (2/15-23Ql and 23Q2, table 30) indicate that locally in sec. 23 the shallow unconfined waters are sodium sulfate to sodium, calcium sulfate waters. The partial analyses, which span a more ex­ tensive reach, show a chloride content ranging from 170 to 300 ppm. On the other hand, samples tak n in 1943-45 from well 2/15-23M2, adjacent to the Ballona Creek channel and 13 feet deep, ranged in chloride content from 2,600 to 11,580 ppm. The channel here is within the reach of tidal water; doubtlessly, this accounts for the very high salinity of water from that well.

The chemical data for the unconfined water in Ballona Gap are so incomplete that its regional chemical character is not known, either under native conditions or in recent years. The complete analyses

from wells 2/15-23Ql and Q2 (table 30) are probably not of native waters but instead, they concern waters concentrated by evaporationr by the possible addition of saline waters at land surface, or by infil­ tration of ocean water. However, from knowledge of the native quality of the unconfined body in other areas, it is reasonable to ex­ pect that even under native conditions the sulfate content was. somewhat high.

Inland from the Newport-Inglewood zone, but proximate to it, little is known in regard to the character of the shallow waters be­ cause of the dearth of chemical analyses. One well, 3/13-27Bl, in· 1932 yielded a sodium, calcium bicarbonate, chloride water. The chloride and dissolved-solids contents of this water were 181 and 954: ppm, respectively. The well is 8 feet deep and taps Recent deposits.. The chemical character of the unconfined waters beneath the Downey plain has been discussed in an earlier report (Piper, Garrett, and others, 1953, p. 21, 26, 51).

**CONFINED WATERS**

**WATERS IN RANGE** I **(GASPUR WATER-BEARING ZONE AND "50-FOOT** GRAVEL")

The Gaspur water-bearing zone extends from the coast through Dominguez Gap and inland to Whittier Narrows. Only the coastal 8-mile segment is within the Torrance-Santa Monica area, however (pl. 18). Inland from the Newport-Inglewood uplift the native waters of the Gaspur zone contain about 250 to 350 ppm of dissolved solids and about 175 to 225 ppm of hardness. All are calcium bicar­ bonate waters. Across the Newport-Inglewood belt and within the west basin, the native waters gain in dissolved solids about 25 to 40 percent, so that concentrations are as much as 450 ppm, largely ow­ ing to an increase in sulfate, chloride, sodium, and calcium. This increase may be due to contributions of water from the westerly "arm" of the Gaspur zone. However, at the present time much of the Gaspur zone throughout its extent in the west basin is either incipiently or definitely contaminated either from local sources or from the ocean to the extent that the native character of the water is completely obscured (pl. 16).

The "50-foot gravel" in Ballona Gap contained water ranging from 650 to 7*50* ppm of dissolved solids in 1903-4; this estimate is based upon determinations of electrical conductance. Locally, however, the dissolved-solids content was at least 850 ppm. Fragmentary data available suggest that ocean-water intrusion had not then occurred. In general, the water in the "50-foot gravel" initially was of substan­ tially better quality than the unconfined water in the overlying shallow deposits.

Comprehensive analyses are not available to show the chemical character of native waters in the Gap--contamination of the "50-foot gravel" had started before extensive sampling of well waters was begun. The available analyses indicate that the dissolved solids have increased to about 1,000 to 1,500 ppm in recent years.

Inland from the Inglewood fault, well 2/14-5D9 (Southern California. Water Co., Sentney plant, well 9) taps the full thickness of the "50-foot gravel." That well in -1940 yielded calcium, sodium bicar­ bonate water containing 747 ppm of dissolved solids. In '1945 it yielded a calcium sulfate, bicarbonate water whose dissolved solids had increased to 958 ppm.

Inland from Ballona Gap, well 2/14-lMl, 80 feet deep,yielded water in 1935 containing 27 ppm of chloride, showing that at least locally the water from the "50-foot gravel" was then as low in chloride as that from deeper aquifers.

**WATERS IN RANGE 3 (UNNAMED UPPER PLEISTOCENE DEPOSITS)**

Within the west basin the chemical character of waters in the unnamed upper Pleistocene deposits is known almost wholly from analyses of waters from wells tapping the "200-foot sand" or correlative extensions in the Torrance-Inglewood subarea (pl. 18). Beneath the central part of the Torrance plain south of Rosecrans Avenue, under native conditions the "200-foot sand" yielded water in which the dis­ solved solids ranged about from 300 to 500 ppm and which was of the calcium, sodium bicarbonate type. Analyses made since 1929 (particularly chloride determinations by the Geological Survey for 1944-45) show that the chloride content of these native waters ranges about from 50 to 90 ppm. The upper limit here placed on their chloride content may be too low; water from two wells (3/14-22R2 and 26Q3) in 1943 contained 155 and 121 ppm of chloride, respectively (table 29), and dissolved solids were less than 600 ppm, according to determinations of electrical conductivity. However, data showing these to be native waters are lacking, and the chloride content may have be.en increased by local contamination. On the other hand, in sec. 26, T. 3 S., R. 14 W., the chloride content of waters taken in 1944-45 from wells tapping the unnamed upper Pleistocene deposits is as low as 22 ppm (table 29, wells 3/14-25N3, 26Pl, and 26Q5).

North of Rosecrans Avenue, and especially in the area between Hawthorne and Inglewood, the unnamed upper Pleistocene deposits contain water in which the dissolved solids range about from 500 to 700 ppm and the chloride from 125 to at least 250 ppm. Analyses are not ·available to define the character of these waters closely, chiefly because wells tapping the unnamed deposits for which an-

alyses are available also tap the underlying San Pedro formation.. However, these waters are of native inferior character.

Southeast of Gardena, in sec. 31, T. 3 S., R. 13 W., the unnamed upper Pleistocene deposits now (1948) contain water which probably is contaminated locally. Under native conditions these deposits yielded water ranging in dissolved solids from 400 to 500 ppm (pl. 17). Analyses of water samples collected periodically by the Geological Survey in 1941-42 from wells i.n sec. 31 suggest that confined water in these unnamed upper Pleistocene deposits may contain somewhat more than 500 ppm of dissolved solids locally; also, they suggest an increase in salinity during that period in certain wells tappi.ng these deposits (Piper, Garrett, and others, 1953, p. 264).

To the south, about in sec. 19, T. 4 S., R. 13 W., the unnamed upper Pleistocene deposits yield water in which the chloride content (based on water samples from 2 wells, each 180 feet deep) is about 25 ppm and the dissolved solids content is about 300 ppm. Here the water from that depth is of excellent quality and is considered free of contamina­ tion. However, water from wells not more than 100 feet deep­ inferred to tap the upper part of the unnamed deposits-is of poorer quality. In 1941-42 that water ranged from 62 to 409 ppm in chloride content and from 350 to 1,050 ppm in dissolverl soli.ds. Waters of both poor and good quality in sec. 19 are believed to be native, however.

**WATERS IN RANGE 5 (UPPER PART** OF **THE SAN PEDRO FORMATION)**

In the west basin, the character of waters from range 5 (the upper part of the San Pedro formation) is known only from data of wells tapping the "400-foot gravel" in the synclinal trough beneath the Torrance plain. Analyses are available for four wells in T. 3 S.,

R. 14 W., and for one well in T. 2 S., R. 14 W., all of which tap only the "400-foot gravel." Of these five analyses, three are for waters considered representative for the "400-foot gravel." These are 3/14- 1001, analysis of August 21, 1945; 3/14-15Gl, analysis of 1940; and 3/14-23Ll, analysis of December 5, 1940 (table 30 and pl. 19). In these analyses the dissolved solids range from 323 to 359 ppm; from north to south, the ratio of calcium to other bases increases somewhat, with a corresponding decrease in the ratio of bicarbonate to other acid radicals. Also from north to south, chloride decreases from 38 to 28 ppm, and sulfate increases from 42 to 69 ppm. The content of

69 ppm of sulfate at well 23Ll-the southernmost of the three­ marks that water as being different from the water in the underlying Silverado water-bearing zone, which here contains less than 34 ppm of sulfate. The other two analyses do not conform to the regional character as described. For example, well 3/1415D1 yields a water

definitely poorer in quality than the type water. In 1930 this well yielded a calcium, sodium chloride water in which the dissolved solids and chloride content were 576 and 198 ppm, respectively. This water has about the same amount of dissolved solids as that known to occur in the overlying unnamed upper Pleistocene deposits west of Hawthorne. Thus, analysis 3/14-15Dl probably represents a blend of waters from the "400-foot gravel" and from the unnamed deposits above.

In Ballona Gap, east of the Inglewood fault, the upper part of the San Pedro formation is tapped by several wells at the Sentney plant of the Southern California Water Co.. (wells 2/14-5D5, 5D7, and 5D10); also by several public-supply wells *of* the city of Beverly Hills (wells 32M3 and 32Kl). Chemical analyses are available for these wells. As shown on figure 14 and as discussed on pages 210-212, the character of these waters has varied between wide limits; however, as there explained, this fluctuation presumably does not represent a trend toward contamination but probably results from the blending with inferior native waters that existed in sec. 32. The waters were initially sodium bicarbonate waters; later analyses show a slight trend toward sodium, calcium bicarbonate waters. Chloride ranges generally from 62 to 173 ppm.

**WATERS IN RANGE 6 (MIDDLE AND LOWER PARTS OF THE SAN PEDRO FORMATIOK)**

Throughout its known extent in the west basin, except near the coast and locally elsewhere, the Silverado water-bearing zone or the middle and lower parts of the San Pedro formation yields native waters of excellent quality (pl. 19). These range from sodium, calcium bicarbonate to sodium bicarbonate waters.

In the southeastern part of the west basin, in and near Dominguez Gap, wells tapping the Si.lverado water-bearing zone yield sodium bi.carbonate water, i.n which the dissolved solids range from 210 to 250 ppm, the hardness generally ranges from 70 to 85 ppm, and the chloride content is about 25 ppm. From east to west across Dominguez Gap, the sulfate seems to diminish; at well 4/13-14Q4 the sulfate con­ tent is about 35 ppm, and at well 21Ql it is negligible. In Dominguez Gap most of the waters selected as representative of the, Silverado water-bearing zone, as shown on plate 19, are from the upper or central parts of the zone. These waters are similar \_in hardness content to waters froin wells tapping the upper part of the Silverado zone north­ east of the Signal Hill uplift, where they range in hardness about from 66 to 91 ppm; those froni the lower part of the Silverado zone range in hardness about from 15 to 28 ppm.

Along the northeast flank of Palos Verdes Hills in T. 4 S.,

R. 14 W., and in the southwest corner. of T. 4 S., R. 13 W., the

Silverado water-bearing zone contains waters markedly different from those in the same zone beneath Dominguez Gap.

These markedly different waters are essentially sodium bicarbonate waters in which the bicarbonate is as high as 389 ppm; they differ from typical Silverado waters to the north and to the northeast in that (1) their sodium content is somewhat in excess of 100 ppm and

* + 1. their chloride content commonly ranges from 50 to 75 ppm higher than that of the typical Silverado waters. The chloride is as high as 129 ppm (4/14-35E2) and sulfate commonly is less than 3 ppm. The high chloride content of these waters doubtless is -due to blending with connate sodium chloride water occurring locally in the Silverado water-bearing zone beneath the flank of the Palos Verdes Hills (Piper, Garrett, and others, 1953, p. 57-58, and p. 230 analyses for well 5/13-6Dl). This connate water is considered native, but .since its inclusion with marine sediments it has been modified by the usual processes of base exchange and sulfate reduction, and, in addition, it has been diluted by land-derived waters. Analyses of water from well 5/13-6Dl are typical of this diluted connate water; the chloride and dissolved solids content are about 450 and 1,200 ppm, respectively. To the north, the effect of blending with this connate water does not extend more than about half a mile; wells 4/13-30Kl and 4/14-16L3, each about three-quarters of a mile northeast of the Palos Verdes Hills, yield water containing only 24 ppm of chloride. To the east, water from wells 4/13-31E3 and E4 shows the effect of blending with the connate water, although such blending has not been particularly deleterious; the chloride content of water from both wells in 1932 was less than 70 ppm. To the southeast, the extent of the connate water is not known, but evidence from electric logs of oil wells suggests that it may underlie the eastern part of Terminal Island.

In the west basin northwest of Dominguez Gap and extending about to Inglewood-that is, through the known extent of the Silverado water-bearing zone-the waters are consistently harder and higher in proportion of calcium and magnesium among the bases than those from this zone in Dominguez Gap. For example, the hardness ranges about from 100 to 275 ppm; north of Rosecrans Avenue, it is commonly more than 200 ppm. In these sodium, calcium bicarbonate waters the dissolved solids range about from 250 to 500 ppm but commonly are about 300 to 350 ppm. Across this central part of the west basin, from northeast to southwest;-:..that is, from the crest of the Newport-Inglewood uplift to the coast-certain trends in chemical character are suggested by available data. These trends are as follows:

* + - 1. Near, but c·oastward, from the crest of the Newport-Inglewood uplift, the sulfate in the -Silverado waters is at least 30 ppm. Westward, the sulfate di-

minishes rapidly and becomes low or negligible at the axis of the syncline; in general, it remains small or negligible to the coast.

* + - 1. Near, but coastward from the crest of the Newport-Inglewood uplift, the chloride content of the Silverado waters is probably not more than 36 ppm. This chloride content is reasonably constant to within about 2 miles of the coast; under native conditions it increased to about 90 ppm at the coast.

Adjacent to the coast, from the Ballona escarpment to and beyond Redondo Beach, native water no longer occurs in the Silverado water­ bearing zone; as of 1946 this coastal strip was moderately to intensely contaminated. The chemical features of this contamination, and minor lateral differences in native waters found here initially will be discussed later.

Inland for 2 miles or more from the crest of the Newport-Inglewood uplift, from Dominguez Hill on the south to near Inglewood on the north, wells tapping the Silverado water-bearing zone yield water characteristically different from that in the central part of the west basin. As shown by analyses of water from wells 3/13-6Gl, 3/13-8L2, and 3/14-lGl (table 30), these are predominantly calcium bicarbonate waters; they differ chiefly in chloride and sulfate content from those waters coastward from the Newport-Inglewood uplift. In these waters, chloride is about 26 ppm and sulfate about 75 ppm.

Beyond the known extent of the Silverado zone (pl. 19), waters of excellent quality occur in the middle and lower parts of the San Pedro formation correlative with it. Analyses of water from well 2/14-22Pl at Inglewood, from wells 2/14-4Nl and 5D6, north of the Baldwin Hills, and from well 2/14-1402, east of the Baldwin Hills, are repre­ sentative. These wells contain calcium bicarbonate to sodium bicarbonate waters; their range in constituents and character may be determined from table 30, plate 19, and from table 16.

In sec. 5, T. 2 S., R. 14 W., available analyses indicate that water in the lower and middle parts of the San Pedro formation is sodium bicarbonate water and possibly is of somewhat better quality than that from the upper part of the formation (fig. 14).

In the Ballona Gap, about from the Inglewood fault to the coast, native waters in the San Pedro formation range from calcium, sodium bicarbonate to calcium bicarbonate waters. They contain about 40 to 70 ppm of chloride (usually about 60 ppm), nearly 100 ppm, and locally more than 200 ppm of sulfate, and about 480 to 650 ppm of dissolved solids. Thus, compared to waters inland from the Inglewood fault, their content of dissolved solids is higher than in the waters in the middle and lower parts of the San Pedro formation to the east. Also, tkey differ in character from the waters in the San Pedro formation yielded to wells just south of the Ballona escarpment (pl. 19, also p. 215). Native waters from wells 2/15-llJl and 23Pl

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in Ballona Gap were anomalous in character (as compared to the type waters in the gap) but were roughly similar to the waters south of the escarpment; this fact suggests some blending of the two types of water.

As of 1946, in the coastal part of the gap the waters in both the San Pedro formation and the overlying "50-foot gravel" of Recent age were contaminated; the extent and degree of contamination be discussed later.

will

In the area just south of the Ballona escarpment, about in secs. 26

and 34, T. 2 S., R. 15 W., analytical data suggest that the waters under native conditions generally ranged from 80 to 100 ppm of chloride, from 30 to 50 ppm of sulfate (but usually less than 40 ppm) and from 500 to 600 ppm of dissolved solids. They were sodium bicarbonate to sodium, calcium bicarbonate waters and are repre­ sented by analyses of water from wells 2/15-26Bl, 34Al, 34Hl, and 34Kl (table 30: well 26Bl, Mar. 29, 1932; well 34Al, Nov. 18, 1929; well 34Hl, Jan. 8, 1930). Their chemical character is shown by figure 11, which compares them to representative waters of the San Pedro formation in Ballona Ga.p. (See also discussion of contamina­ tion at Playa del Rey.)

WATERS OF THE UNDIFFERENTIATED PLEISTOCENE DEPOSITS

To the north of Ballona Gap, and particularly beyond the north limit of T. 2 S., water-bearing zones are so discontinuous that a regional stratigraphic correlation has not been made (p. 45). Here, as may be expected, the waters from these several zones range con­ siderably in quality and show striking local differences in character. Nevertheless, the over-all range in character is not markedly greater than that of the waters in the San Pedro formation immediately to the south in Ballona Gap. This also is to be expected because of the presumed hydraulic continuity with those deposits. Analyses of waters from wells 1/14-19Rl, 1/14-20Ml, 1/15-28B2, and 32Al are believed to illustrate the range in chemical character of these waters (table 30 and pl. 19).

Typical of water from wells tapping the undifferentiated Pleistocene deposits is a nonsystematic fluctuation of dissolved solids, particularly chloride, in recu1Tent analyses for any given well over a period of several years. The chloride content in these waters ranges from 40 to 268 ppm and the sulfate content ranges about from 5 to 212 ppm. They range from calcium bicarbonate to sodium bicarbonate waters. Definite evidence of local contamination in these deposits cannot be proved because of the great range in proportion of individual con­ stituents and because of the great range of dissolved ,solids as a whole. However, definitely inferior waters in • these Pleistocene

deposits may be derived through upward movement from the under­ lying Pliocene rocks.

**WATERS IN RANGE 7 (UPPER DIVISION OF PICO FORMATION)**

For the Torrance-Santa Monica area, information on the chemical quality of water from the upper division of the Pico formation is­ obtained from analyses of water from six widely separated wells- 1/15-25O1, 2/14-27Jl, 2/15-105, 3/14-17Jl, 4/13-12A2, and 5/13-3H:

(See table 30 and pl. 19.) Three of the analyses (3/14-17Jl, 4/13- 12A2, and 5/13-3H) are from wells in or near the Torrance-Inglewoo subarea. In these the dissolved solids range from 452 to 750 ppm, the chloride from 52 to 130 ppm, and the bicarbonate from 413 to 487 ppm. All are sodium bicarbonate waters. For the three the average percent sodium is 83. Thus, these are potable waters, although they are not desirable for irrigation because of their high percent sodium. In well 4/13-12A2 (city of Long Beach, North Long Beach well 6) the water was dark brown and the temperature was about 104°F. Although color and temperature could have been reduced by treat­ ment, the yield of the well was considered too low to make treatment economical and the well was abandoned.

Of the other three analyses, one is from a well in the eastern part of\_ Inglewood (2/14 27Jl) and the others are from wells north of Ballona. Gap, which are inferred to tap the upper division of the Pico formation or correlative deposits. In these the total solids range from 1,225 to 2,663 ppm, the chloride from 66 to 1,363 ppm, and the bicarbonate from 396 to 1,266 ppm. All these waters are unfit for ordinary uses. Thus, available analytical data suggest that the waters in the upper division of the Pico formation north of Inglewood are saline and un­ usable; however, south of Inglewood, locally at least, they are of a quality suitable for some uses, although they may require treatment. In the descriptions of native waters in the water-bearing zones of the Torrance-Santa Monica area of Recent and Pleistocene age, the silica content of the waters was not discussed because it does not appear to be a distinctive characteristic of any of the several ranges. The silica content of these waters was from 10 to 30 ppm, commonly less than 20 ppm. However, of the analyses of waters from the upper division of the Pico formation, four analyses indicate a considerably higher silica content, ranging from 35 to 59 ppm. Because of this greater concentration in the waters of the upper Pico, silica might be used as a diagnostic constituent in a critical study dealing with blended native waters yielded from wells tapping both the upper divi­

sion of the Pico formation and the overlying water-bearing zones.

**WATERS AT THE CENTINELA PARK WELL FIELD OF THE CITY 011' INGLEWOOD**

At the Centinela Park well field of the city of Inglewood, wells on opposite sides of the Potrero fault yield water with marked differences in chemical character. Elsewhere along the faults of the uplift, at least south to Dominguez Gap, differences are minor. Hydrologic information shows conclusively that the fault here is a substantial hydraulic barrier. Chemical evidence confirtns the existence of that barrier. At this well field, seven wells were sampled in 1944-45 by the Geological Survey. Of the wells so sampled, five were east **of** (inland from) the Potrero fault and two were west of it. Inland from. the fault, the chloride content of the water ranged from 25 to 56 ppm; coastward from the fault but adjacent to it, the chloride content ranged from 121 to 156 ppm. (For type analyses, see wells 2/14-22N3 and 2/14-27D3, table 30.) Inland from the fault, the waters are calcium bicarbonate in character and the dissolved-solids content is about 375 ppm. To the west, across the fault, well 2/14-27D3 also yields calcium bicarbonate water but the dissolved solids content is about 450 ppm. Although not cited here, chemical data from wells about a mile to the southwest, in sec. 28, T. 2 S., R. 14 W., suggest that the increase occurs chiefly in chloride and sulfate, with a proportionate increase in calcium. and sodium. Only at well 28El (city of Ingle­ wood well 23) is the increase in cations wholly in sodium. However, the character of water from this well probably is anomalous; transverse faulting south of the well may separate it from the others in sec. 28. for which chemical data are available.

At the Centinela field, both the "200-foot sand" and the water­ bearing zones in the San Pedro formation are tapped by many of, Inglewood's public-supply wells. However, water levels here are now (1948) at or below sea level and the "200-foot sand" is almost wholly dewatered; thus, in recent years the water has been withdrawn almost entirely from the San Pedro formation.

**POTENTIAL CONTAMINANTS OF FRESH-WATER BODIES IN THE TORRANCE-SANTA MONICA AREA**

Fresh waters in the Torrance-Santa Monica area, which have be­ come contaminated, or which have received an increase in salinity, are a result of a mixture with certain waters, either moderately or ex­ cessively high in total solids. These latter waters have their source either outside the fresh-water zones, with migration into those zones after discharge at or near the land surface, or by establishment of favorable gradients through permeable deposits, or both, or inside the fresh-water zones, occupying either a part of a permeable zone strati­ graphically equivalent to that containing the fresh water, or a con-

tiguous zone or zones that may be either younger or older than that containing fresh water, but requiring a suitable gradient and hydraulic continuity to advance into the fresh-water zone.

**EXTERIOR CONTAMINANTS**

Contaminants that initially are outside zones containing fresh water under native conditions and that require hydraulic continuity and a favorable gradient toward those zones in order to mingle with the fresh waters are: (1) ocean water, (2) industrial wastes, and (3) oil­ field brines.

**OCEAN WATER**

As in the Long Beach-Santa Ana area, ocean water is an obvious potential contaminant in the Torrance-Santa Monica area because water-bearing zones, at places along the coast from Santa Monica to the Palos Verdes Hills and beneath San Pedro Bay, crop out on the ocean floor and are inferred to be in hydraulic continuity with the ocean; because certain areas, specifically the coastal parts of Domin­ guez and Ballona Gaps, have been or are now being overrun by ocean water within the tidal range; and because the water levels near the coast widely have been drawn down below sea level.

In the coastal part of Dominguez Gap, the original tidal flats have been filled in and dikes have been constructed along both the Los Angeles River and Dominguez Channel with the result that inland movement of tidal water is restricted to those water courses; in the Los Angeles River, the extreme inland reach of oceanic water during the highest tides is 0.95 mile 01· to a point about a quarter of a mile south. of Anaheim Street. To the northwest in Ballona Gap, tidal tnarshes extend inland nearly to Lincoln Boulevard. In the old channel of Ballona Creek, the tidal range was about the same as in the adjacent tnarsh; in the new channel, completed early in 1938, the inland reach of tidal water is about to Inglewood Boulevard, 1 tnile farther inland and about 3 miles frotn the coast.

To show the chemical character of ocean water, two analyses are given in table 31-a "standard" analysis and an analysis of water from San Pedro Bay. For these representative analyses, ocean water generally ranges from 34,100 to 34,500 ppm in solids, and from 18,400 to 19,000 ppm in chloride. Magnesium is about three titnes as abundant as calcium; however, in native ground waters, calcium is the more abundant. In ocean water, the bicarbonate content is about 140 *ppm;* in native ground waters, bicarbonate may be as great as 400 to 500 ppm, but normally it is about 250 to 300 ppm.

**INDUSTRIAL WASTES**

Wastes discharged as a result of industrial activity become potential contaminants of fresh-water zones in the Torrance-Santa Monica area when (1) they are discharged into natural or artificial water courses that traverse that area, or (2) they are discharged at land surface in sumps and pits and are allowed to evaporate and seep away.

Four water courses traverse the Torrance-Santa Monica area. These are the Los Angeles River, Dominguez Channel, and Compton Creek, which are all in and near the Dominguez Gap, and Ballona Creek, in the Ballona Gap. The conditions of industrial-waste disposal in Dominguez Gap have been discussed at length in an earlier report (Piper, Garrett, and others, 1953, p. 80-83). Wastes discharged to the Los Angeles River inland from Dominguez Gap commonly are sodium chlo:tide or sodium sulfate waters and in most cases are considerably less concentrated than oil-field brines. However, the analyses here cited suggest that in recent years, disposal of wastes into the Los Angeles River inland from Dominguez Gap has been carried on to a lesser degree than formerly.

Within the west basin, the chief point of disposal of waste to the Los Angeles River (in 1946) is just upstream from Wardlow Road. Here are the skimming sumps of the Oil Operators, Inc. From these sumps, oil-field brines have been discharged to the Los Angeles River at a rate that averaged 4.4 cfs from 1928 through 1943. These brines have ranged in chloride content from 9,000 to 16,000 ppm since 1932 and at times of low natural runoff the brines have made up the total fl.ow of the river.

The Dominguez Channel is used for disposal of oil-field brines from the Dominguez and Rosecrans fields and of saline wastes from the several oil refineries in the industrial area west of Long Beach. As shown by analyses of water taken from Dominguez Channel by the Geological Survey in 1942-43, the water of the channel has ranged at least from 145 to 10,000 ppm of chloride throughout its reach southeast of Main Street to Wilmington Avenue. For at least a part of the time, the volume of wastes carried by the Dominguez Channel has been as much or more than that carried by the Los Angeles River. Inland from the west basin, Compton Creek discharges to the Los Angeles River about 5.5 miles from the coast and 0.3:mile inland from the Cherry-Rill fault. In 1942-43 from analyses by the Geological Survey, the chloride content in the lower reac of Compton Creek ranged from 62 to 132 ppm. Although the indicated concentration is low, the creek carries organic material which makes the water very turbid and foul-smelling. For approximately the same period through which the water samples were taken, the mean fl.ow in the creek was

about 10 cfs; the minimum flow was 3 cfs.

Available chemical analyses for Ballona Creek suggest that, at least at times, the creek has received contributions of water of marked salinity. For instance, the highest chloride sample reported (4,354 ppm) was obtained in 1932 from a spring discharging from the north­ west bank of Ballona Creek, 700 feet upstream from Higuera Street (in 2/14-5M). A comprehensive analysis was not made, hence the chemical nature of the saline water is not known. Most of the samples collected from the creek have contained only a few hundred parts of chloride. The lowest concentration known was for a sample taken from the creek February 11, 1936 by Dr. Carl Wilson; this sam­ ple had a chloride content of 15 ppm. A series of five analyses, two by Dr. Wilson in 1936 and three by the California Division of Water Resources in 1937-38, indicate that the streamflow then ranged in character from a sodium chloride water to a sodium, calcium bi­ carbonate water. None of the comprehensive analyses suggest ad­ ditions of oil-field brines during that period; fluctuations in chloride content are accompanied by a corresponding change in sulfate content. If such chloride fluctuation had resulted from addition of oil-field brine, little or no change in sulfate would have occurred. Koch (1940, p. 18) reports that a sample taken in December 1939 from a small creek flow­ ing into Ballona Creek from the Baldwin Hills (sampling point in 2/14-5N, about 100 feet north of Jefferson Boulevard) contained 2,630 ppm of chloride. This creek, according to the report, carries much of the surface runoff of the Inglewood oil field. However, the extent to which the Ballona Creek has been used as a means of disposal for oil-field brines is purely conjectural in the absence of analyses of creek flow showing such discharge.

From the early thirties to 1938, extensive sections of Ballona Creek were paved with concrete. As of 1938, the channel was paved with an impervious lining from Crenshaw Boulevard for about 4 miles down­ stream to LaSalle Avenue, which is about 0.75 mile upstream from the Overland Avenue fault (pl. 2). From LaSalle Avenue to the coast, about 5 miles, only the sides of the channel are paved (1946). The tidal reach now extends inland about 3.1 miles, or to Inglewood Boule­ vard. Thus, since 1938, it has been only in the 2-mile reach from LaSalle Avenue to Inglewood Boulevard that the channel bottom has been open to receive influent seepage from the creek discharge. This 2-mile reach spans the Charnock subbasin and the coastward 0.75- mile segment of the crestal subbasin. It is not known whether sub­ stantial seepage losses from the creek occur in this reach, but certainly a potential threat of contamination exists at such times as the creek carries water unfit for use. Coastward from Inglewood Boulevard, seepage contributions, if any, are from the saline tidal waters.

**OIL-FIELD BRINES**

There are eight major oil fields in the Torrance-Santa Monica area­ theInglewood, Potrero, Rosecrans, and Dominguez fields along the Newport-Inglewood uplift nd the Playa del Ray, El Segundo, Tor­ rance, and Wilmington fields along the coast (pl. 18).14 In addition, there are two minor fields-Lawndale and Beverly Hills-from which production is small. In all these fields most of the connate waters raised to the land surface are separated from the oil by settling or by mechanical or chemical dehydration. Analyses of the connate waters for four of these fields are given in table 31.15 For the several oil fields, methods of brine disposal are described as completely as possible insofar as such information was made available to the Geological Survey.

*Yield of oil-field brines.-The* total amounts of brines pumped from the several oil fields in the Torrance-Santa Monica area are substantial. Table 17 shows the quantities of these brines discharged by each oil field for the year 1940, from records published by the California Division of Oil and Gas {1940-41, p. 28, 30).

TABLE *17.-Quantities of water produced from oil fields in the Torrance-Santa Monica area in 1940*

[Data from publications of *the* California Division of Oil and Gas]

|  |  |  |
| --- | --- | --- |
| Oilfield | Fluid yield (barrels) | |
| Annual | Daily average |
| Beverly Hills \_ Inglewood \_ Potrero \_  Rosecrans \_ Dominguez \_  Playa del Rey ----  El Segundo \_  Lawndale \_  Torrance \_  Wilmington \_ | 90,141  3,705,140  337,368  1, 556, 879  3,291,324  3,833,257  1, 179, 636  79,730  1, 695, 170  759,856 | 247  10,150  924  4,265  9,017  10,500  3,232  218  4,644  2,082 |

The total withdrawal of brines from these 10 fields in the Torrance.. Santa Monica area as of 1940 was about 45,000 barrels a day or about 2,200 acre-feet a year, which is about 3 percent as great as the quantity of ground water pumped from the west basin alone in that same year. *Inglewood .field.-The* Inglewood oil field covers much of the Bald­ win Hills north of Inglewood. The discovery well was completed late in 1924, and 150 productive wells had been drilled by September

14 Two of *the* fields, Dominguez and Wilmington, are discussed at length by Piper, Garrett and others (1953, p. 70, 78) but those discussions will be briefed here.

u For analyses of connate waters from *the* Dominguez and Wilmington fields, see Piper and others (1953, table 29).

1925. The field has been developed almost entirely by the Kettleman and Inglewood Corp., Standard Oil Co. of California, Tidewater

.Associated Oil Co., Shell Oil Co., and the Texas Co. As of 1946, at least two companies, the Tidewater Associated Oil Co. and the Stand­ ard Oil Co. of C lifornia, ran the brines from their producing wells into settling ponds from which the overflow was piped chiefly to the city of Los Angeles Hyperion outfall sewer, which follows the north flank of Baldwin Hills and the south edge of Ballona Gap to the ocean. A part of the Standard Oil Co. waste water reportedly is discharged (1946) to Ballona Creek about half a mile upstream from Lincoln Boulevard, or well within the tidal reach. As of 1946, the Tidewater Associated Oil Co. discharged about 2,650,000 gallons of waste fluid each month. Although none of the brines from the Inglewood field are known to have been discharged to Ballona Creek above tidewater as of 1946, the analysis of the flow of a small stream from the north slope *of* Baldwin Hills (sampled in 1939 with a chloride content of 2,630 ppm) suggests that at least a diluted connate water was then discharged at land surface

*Potrero field.-The* Potrero field, east of Inglewood, was discovered in 1927, and by mid-1941 about 26 wells were in production. It is reported that, in the early thirties, the brines either were diverted into unlined ditches and sumps where they drained to the southwest, or they were hauled to a dump in Centinela Creek within the city of Inglewood until a city ordinance was passed to prohibit such practice. As of 1946 most of the production has been from wells of the Basin Oil Co., and waste brines are discharged to the Los Angeles County Sanitation District sewer system.

*Rosecrans field.-This* field occupies the west-central part of T. 3 S., R. 13 W., about 2 miles west of Compton. The chief operators

in the field are the Union Oil Co. and the Barnsdall Oil Co. The Union Oil Co. carries (1946) the oil with its admixed brine from each well to a central dehydrating system. From there, the brine is pumped to a skimming pond near the intersection of Rosecrans Avenue and Main Street. This pond is used by the several companies operating in the field. The effluent from this pond reportedly is piped to a Los Angeles County sewer line. Of the total quantity so disposed, the Union Oil Co. in 1946 reportedly contributed about 57,000 barrels a month.

*Dominguez field.-The* Dominguez oil field was discovered in 1923 and has been developed largely by the Shell Oil Co. and the Union Oil Co. Since about 1930, at least a part of the waste fluids from the oil wells in this field have been piped to the plant of the Deepwater Chemical Co. for extraction of iodine. This plant is about 0.1 mile north and 1 mile west of the intersection of Wilmington Avenue and

Victoria Street, on the northwest flank of Dominguez Hill. The efHuent from the plant is piped (1946) to an outfall on the Dominguez Channel about 0.4 mile northwest of *A.*valon Boulevard. When the plant is idle, the brines are piped to the Dominguez Channel through the same line.

Other means of disposal of brines formerly were· employed by at least one of the operating companies (Piper, Garrett, and others, 1953, p. 70). In 1932, the Shell Oil Co. reportedly released brines into a ravine high on the southwest flank of Dominguez Hill and into the crater of a blown-out oil well near the crest of Dominguez Hill, just west of Wilmington A.venue and about 0.3 mile south of Victoria Street. It is understood that this practice was discontinued late in 1932. The quantity of brine so discharged at the land surface is not known, but if such disposal had been practiced since 1923, several hundred acre-feet of waste brine could have percolated to perme­ able deposits formerly saturated with fresh water.

*Playa del Rey field.-This* field is divided into two areas: (1) The ocean front or Venice area, along the coastal front of Ballona Gap, which was discovered in 1929; and (2) the Del Rey Hills area, almost wholly in sec. 27, T. 2 S., R. 15 W., which was discovered in 1931. In the Venice area, the brines from wells operated by the Union, Ohio, and Barnsdall Oil companies are piped to a plant operated by the Dow Chemical Co. for extraction of iodine. A.s of 1946, about 460,000 gpd was treated. The effluent from the plant is piped to a canal which is open to tidewater a short distance north of the plant. The brine treated by the plant constitutes almost the total water production of the field, although locally small amounts of brine may be discharged at land surface and allowed to drain away. The area occupied by this field is or has been overrun by tidal water of salinity equal to or greater than that of the connate brines.

In the Del Rey Hills part of the field, the brines are collected from the individual wells and then are piped into the city of Los Angeles

Hyperion outfall sewer.

*El Segundo field.-The* EI Segundo field, which is just east of the city of El Segundo, was discovered in August 1935 and was completely developed by late 1938. Waste fluids from wells east and southeast of El Segundo are piped (1946) to a main disposal line that crosses Sepulveda Boulevard at El Segundo Boulevard. Waste fluids from active wells in a minor producing area within the city of El Segundo, south of the city's water-treatment plant at Holly A.venue and Mary­ land Street, are conveyed to this line through a pipe running south on Center Street. The main disposal line runs west along El Segundo Boulevard, thence to the Standard Oil Co. refinery where, presumably, the brine is discharged to the ocean.

*Torrance.field.-The* Torrance field is about 7.5 miles long; it reaches, nearly to the Wilmington field on the east and to within about a mile of the coast on the west. The first productive well was completed in 1922, and peak production was reached in 1924. As of mid-1941, most of the production was from the southeastern part of the field.

From investigation of means of brine disposal in this field, it appears that (1946) many of the smaller companies discharge the brines from their wells to small sumps-usually one for each well-from which the brines evaporate or seep away. For the southeastern part of the field, brines from about 300 acres each of the Superior Oil Co. and of the Standard Oil Co. are piped to a skimming pond, about 1,500 feet east of Normandie Avenue and 0.9 mile south of Sepulveda Boulevard. From the pond, the brines are piped to the Los Angeles County sewer farm, which is between Vermont Avenue and Figueroa Street and about 0.8 mile south of Sepulveda Boulevard. In 1946, about 20,000 gpd of waste fluids were discharged to the sewer farm. Previous to about 1940, the fluids were conveyed from the skimming sump to the sewer farm by an open ditch. A large sump, just southwest of the intersection of Hawthorne Avenue and Torrance Boulevard, is reported to be used for disposal of waste fluids from wells of the Del Amo Estate Co.; from this sump, the fluids reportedly are allowed to evaporate or seep away. Disposal methods of waste fluids from the western part of the field are not known.

Thus, in the Torrance field it is possible that at least several hundred acre-feet of saline brines have passed from the land surface into the ground-water bodies, although only in sec. 9, T. 4 S., R. 14 W., are they inferred to have reached deposits tapped by an active water well. *Wilmington .field.-The* Wilmington oil field is west of the Los Angeles River and extends inland for a distance of about a mile to 3

miles from the Cerritos Channel and the innermost basins of the Los Angeles harbor. The first well of commercial importance was drilled here late in 1936. By the early forties, more than 900 wells were in production. At least three of the principal operators pipe their brines directly to tidewater (1946). However, many operators reportedly discharge brine into sumps or at land surface. Such disposal is of no serious consequence in the eastern two-thirds of the field, because that area now is underlain at shallow depth by con­ taminated waters which are no longer used. In the western third **of** the field, however, water wells not more than 75 feet deep yielded water of fair quality in the early forties; hence, in this western area, these brines are a potential contaminant, not only of the shallow water-bearing zones but also of the underlying Silverado water­ bearing zone, by passage from the shallow zones through defective

* well casings, or by slow downward movement through intervening deposits that are not wholly impermeable.

**INTERIOR CONTAMINANTS**

The native interior contaminants in the Torrance-Santa Monica area are chiefly those inferior waters that have been described earlier. These include:

* + - * 1. Unconfined and semiperched waters in the Dominguez and Ballona Gaps and beneath the Torrance plain. Locally in the gaps these contain as much as several thousand ppm of dissolved solids; their concentration probably has been increased both by contamination and by evaporation. Beneath the Torrance plain the dissolved-solids content of the unconfined waters ranges from 11000 to 4,000 ppm.
        2. Waters in the southernmost reach of the Gaspur water-bearing zone in Dominguez Gap. Here, this water-bearing zone has been extensively invaded by exterior contaminants; it, in turn, can contaminate deeper water-bearing zones now containing water of good quality.
        3. Native connate or diluted connate water confined in the San Pedro formation adjacent to or underlying the northeast and east flanks of the Palos Verdes Hills. This is sodium chloride water and locally, at least, contains 1,200 ppm of dissolved solids.

**Of** the three sources, the first and second are the most critical. Wells tapping underlying aquifers must pass through these two, and where the inferior shallow water has a higher head than the deeper water of good quality, downward circulation will occur if well casings are defective. Both in Dominguez Gap and beneath the Torrance plain, water levels in underlying zones are several tens of feet be­ low levels in the inferior water bodies above.

**CONTAMINATION OF THE NATIVE FRESH WATERS**

**GENERAL EXTENT OF WATER-QUALITY DEPRECIATION**

As stated earlier, a few wells near the coast began to yield salty water in the late twenties. Subsequently, many of these wells were abandoned because contamination became so intense that the water could no longer be used. On plate 16 are shown the districts in the Torrance-Santa Monica area in which one or more of the ground­ water bodies contained more than about 100 ppm of chloride in 1945-46. In certain of the districts, inferior waters existed under native conditions. In the Ballona and Dominguez Gaps, and along the coast from Playa del Rey to the Palos Verdes Hills, however, the extent of waters containing more than 100 ppm of chloride has re­ sulted largely from saline contamination in the last 20 years, pri­ marily from exterior sources. The inland advance of contamination along the coast since 1931-32 is indicated on plate 16 by the change in the position of the line showing 100 ppm of chloride. · ·

CHEMICAL CHARACTER , OF WATERS **193**

**MODIFICATIONS** IN **CHEMICAL CHARACTER OF CONTAMINATED WATERS**

For both the Torrance-Santa Monica area and the Long Beach­ Santa Ana area, contaminated waters are, almost without exception, not a simple blend of a native and a saline water. Instead, chemical reactions have occurred either concurrently with, or subsequent to,,. blending with the contaminant to the extent that the nature of the contaminant is completely or substantially disguised. Most com­ monly these reactions involve (1) base exchange and (2) sulfate reduction.

1. For many of the contaminated waters·in the Torrance-Santa Monica area, successive analyses of water from a given well during its period of active contam­ ination show a definite increase in calcium along with the customary increase in chloride. Hence, these analyses might erroneously be taken as evidence to show blending with a calcium-chloride contaminant. However, no contaminant has been known to exist in the Torrance-Santa Monica area in which calcium pre­ dominates as an alkali radical. Therefore, this calcium enrichment, resulting from blending with a contaminant in most cases known to predominate in sodium among the bases, must be due to a modification in the ratios of calcium, mag­ nesium, and sodium to each other. This modification is known as base exchange.

The fact that the base exchange process goes on extensively has become well­ established. It can occur because the zeolite and glauconite minerals and certain clay-forming minerals have the property of holding the bases (calcium, mag­ nesium, sodium, and potassium) loosely and in variable proportions. In the presence of a natural water, with whose chemical composition it is not in equi­ librium1 any of these particular minerals (and possibly some types of organic matter associated with sedimentary deposits) has the property of releasing to the water 3: part of the base or bases most loosely held and of absorbing from the water an equivalent amount of the base or bases for which it has a stronger bond. This process of exchanging bases goes on until an equilibrium is reached between the proportions of the several bases in the mineral and in the water, or until the exchangeable bases are exhausted in one or the other. With respect to the chemical character of the water, the effect is an increase in one or more bases and an ion-for­ ion decrease in one or more of the remaining bases. Thus, if a sediment in equi-\_ librium with a calcium bicarbonate water be subjected to contact with a water in which sodium predominates among the bases, a part of that sodium **will** be removed and will be replaced by calcium and to a smaller extent by magnesium in an ion­ for-ion proportion. Hence, from this base-exchan e phenomenon may arise the: illusion that a calcium-rich contaminant has invaded the aquifer.

1. In botn the Long Beach-Santa Ana area and the Torrance-Santa Monica

area, many of the waters known to be contaminated by ocean water contain less sulfate than would result from a simple mixture of native water and the ·ocean' water in the· proportions indicated by the total amount of chloride present. This sulfate removal probably is due to the reduction of sulfate to sulfide, either by th - ctio\_n of anaerobic bacteria or by the action of organic material, with the. concu rent production of CO 2 in either case, which-would incrl:lase the bicarbonate content of tp.e water. In brines associated with petroleum, chemical analyses show the· folfate content to be low or *zei6,* doubtless because the hydrocarbons have reacted· with the sulfate and have resulted in the formation of hydrogen sulfide; the hydrocarbons in turn are oxidized to form carbon dioxide and water.

For a more complete discussion of these phenomena and for a bibliography relating thereto, reference should be made to the report on chemical character of waters in the Long Beach-Santa Ana area (Piper, Garrett, and others, 1953, p. 85-91).

**CONTAMINATION** IN **BALLONA GAP**

**SUMMARY OF NATIVE WATER QUALITY**

The geologic conditions in Ballona Gap and the hydraulic relations between the "50-foot gravel" and the underlying San Pedro formation have been summarized on pages 94 to 98. It is inferred that the difference in chemical character between waters yielded from the "50- foot gravel" and from the San Pedro formation was not great under native conditions. Water from wells tapping the "50-foot gravel" ranged about from 650 to 750 ppm of dissolved solids, although local wells presumably tapping the "50-foot gravel" yielded water contain­ ing at least 850 ppm of dissolved solids. Data concerning the chemi­ cal quality of water from wells tapping the San Pedro formation are fragmentary; the dissolved solids content probably ranged about from 480 to 650 ppm, although locally it was probably nearly as great as in the "50-foot gravel." These data represent the conditions as ***of***

1903-4 and are based on determinations of electrical conductance 0£:

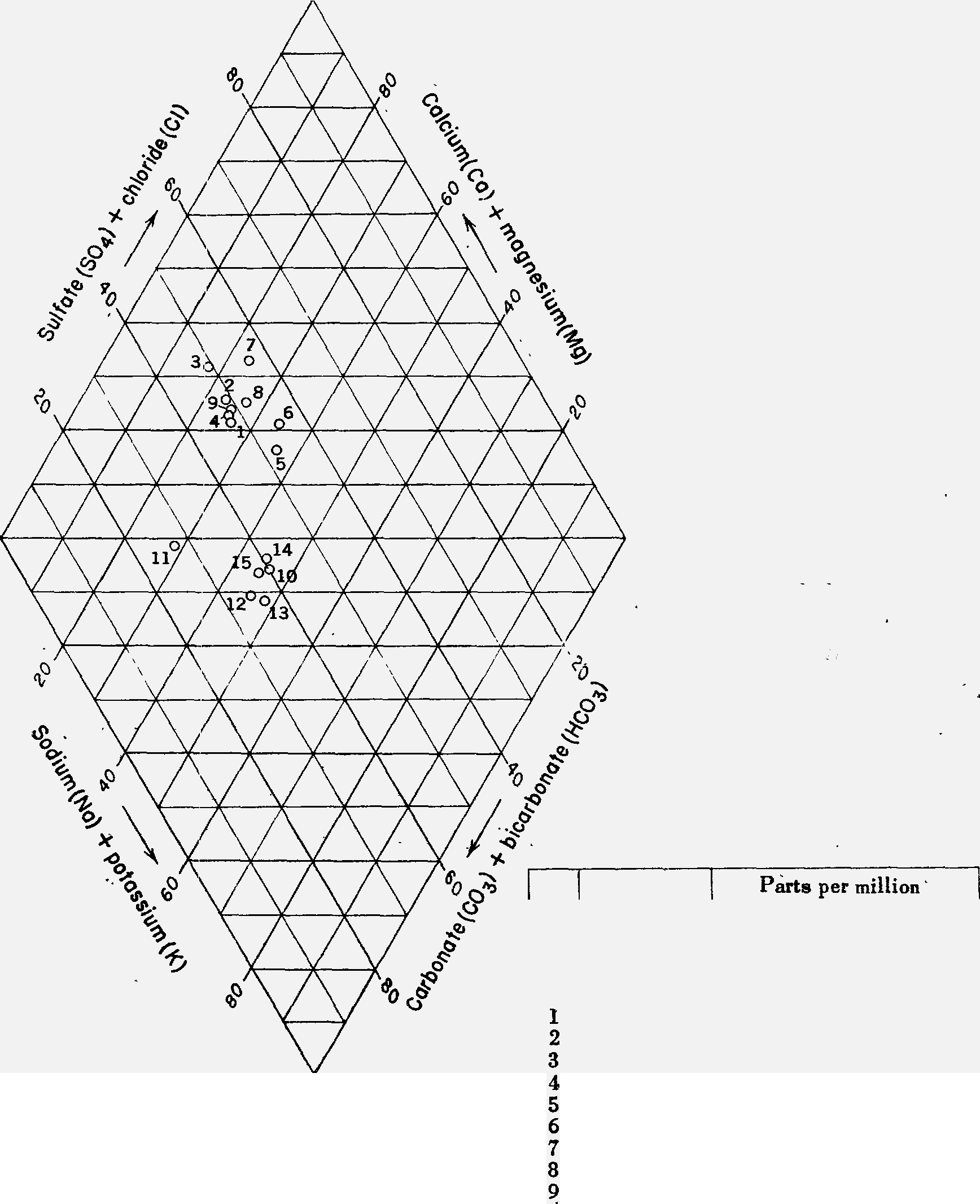
water from the wells sampled.

Chemical analyses of samples taken since about 1929 suggest tha **at** least for the period preceding that of extensive contamination­ wells within Ballona Gap, tapping the "50-foot gravel" or underlying z mes, yielded water markedly different from that yielded by wells tapping the San Pedro formation just south of the Ballona escarp­ ment. In Ballona Gap, the waters contained from 40 to 70 ppm of chloride (the higher part of the range is confined to the shallower de­ posits), and nearly 100 to more than 200 ppm of sulfate. South of the

Ballona escarpment, particularly in secs. 26 and '34, T. 2 S., R. 14 W-,

native water contained 80 to about 100 ppm of chloride and usually less than 40 ppm of sulfate. Figure 10 compares the chemical -charac­ ter of native or only incipiently contaminated waters in Ballona Gap to those immediately south of the Ballona escarpment. The prin­ ciples of the procedure in plotting chemical character of waters on a so-called trilinear diagram have been described by Piper (1945). Also, figure 9 explains the chemical character of waters in the Tor­ rance-Santa Monica area relative to their plotted positions on the diagram. On figure 10 the waters from Ballona Gap and from the area south of the gap plot in two separate fields, chiefly because of the difference in ratio of calcium and magnesium to sodium, and of bicarbonate to sulfate.

No.



Well

Dissolved

solids Cl

Waters in Ballona Gap 2/15- 1C2 563

11C6 483

UD2 557

**14AI** 558

15A2 645

15A4 631

l5F2 620

15Hl 567

24Cl 567

62

52

41

77

-75

71

65

59

38

150,

134

182

131

185

197

204

151

184

**Waters** south of Ballona Gap

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10 | 2/15-11 JI | 476 | 62 | 82 |
| 1l | 23Pl | 631 | 96 | 28 |
| 12 | 26B1 | 492 | 87 | 39 |
| l3 | 34Al | 478 | 94 | 29 |
| 14 | 34Hl | 445 | 86 | 46 |
| 15 | 34K1 | 483 | 100 | 30; |

FIGURE 10.-Chemical character of selected native waters in Ballona Gap compared to waters just south of the Ballona escarpment.

However, this distinction in water character is not universal. For example, two wells in the gap, 2/15-llJl and 23Pl, in 1930-31 yielded water somewhat similar to that from wells tapping the San Pedro for­ mation immediate]y south of the Ballona escarpment. The water in well 2/15-23Pl may represent a blend with a northward-extending lobe of the waters occurring south of the escarpment; it is difficult, however, to see how such a blend could have reached well 1lJl with­ out appearing first in wells 2/15-2401 and 14Al (pl. 19). Thus, the chemical evidence here presented suggests that under native condi­ tions, little, if any, water moved from the gap to the deposits south of the escarpment, or vice versa. Although the type native waters selected from secs. 26 and 34, T. 2 S., R. 15 W., are sodium, calcium bicarbonate waters, the analyses of water from wells 2/15-34Al and 34Kl (table 30) suggest that, at least part of the time, sodium bi­ carbonate waters were present locally.

On the west flank of Baldwin Hills, well 2/14-18Fl in 1925 yielded water containing 182 ppm of chloride, 143 ppm of sulfate, and 823 ppm of dissolved solids. This water is probably a native blend in which waters from pre-Pleistocene deposits have moved into the San Pedro formation and are tapped by- that well. The analysis repre­ sents a water similar to, but less concentrated than that from well 5/14-1201 (table 30), on the east flank of the Palos Verdes Hills; this well is believed to tap pre-Pleistocene deposits in an area presumed to be free of contamination from surface-disposed brines. Analyses of water from well 2/14-18Fl in 1932 and 1945 show definite contami­ nation, in which oil-field brine doubtless has contributed most, al­ though not all, of the observed salinity.

For the shallow unconfined waters in Ballona Gap, too few analyses have been made to gain definite knowledge of their chemical character, either under native conditions or during the development of contami­ nation. However, under native conditions dissolved solids commonly ranged from 800 to 1,000 ppm, but locally they are inferred to have been as high as 5,000 ppm. For water from several wells tapping the unconfined body in secs. 22, 23, and 24, T. 2 S., R. 15 W., the chloride concentration in 1930-32 was about 200 to 400 ppm-not inordinately high for shallow unconfined waters near the coast. However, be­ cause the unconfined waters can be expected to differ markedly with local conditions, these analyses are of little value for determining the quality of the unconfined waters elsewhere within the gap. It is con­ cluded that th\_e native unconfined waters at shallow depth in Ballona Gap generally were somewhat inferior and locally w re greatly inferior to the waters in the underlying aquifers of the principal water body.

**GENERAL FEATURES A.ND EXTENT OF CONTAMINATION**

The study of the history and progress of contamination in Ballona Gap is complex and is rendered difficult for three reasons:

\_ 1. Before 1930 only a few comprehensive analyses of Ballona Gap waters were made. Because of this dearth of analyses, some locally native water types in the gap may have been considered in this report as definitely or incipiently contami­ nated.

1. Only locally in the areas of contamination has the salinity increase been sufficiently great to afford definitive knowledge of the chemical character or the source of the contaminant.
2. The directions in which contaminated waters and contaminants move within the gap are influenced locally by hydrologic barriers which transect the San Pedro formation but do not transect the "50-foot gravel" (p. 94). Therefore, the paths taken by the contaminated waters during the period of development .to date (1946) have depended not only upon the hydraulic gradient and the amount of hydraulic connection between the "50-foot gravel" and the underlying water­ bearing beds of the San Pedro formation, but they also depend upon the barrier partitions,.within tbat f9rmation.

Since 1930 many active wells have been sampled periodically. Consequently, a lwge number of analyses are available for study for the period 1930-46, and much can be learned regarding the chemical character and contamination of the waters during this period.

Information is not available to indicate the time contamination began in Ballona Gap. As of 1930-32, however, waters containing more than 100 ppm of chloride occurred within the "50-foot gravel" or the underlying .wa. r-hel!ring deposits of the San Pedro formation beneath about 5,100 acres, or about 8 square miles, along the coast and extending inland to the vicinity of Sepulveda Boulevard (pl. 16). In this area, the chloride concentration then ranged from 100 to about 400 ppm, and the dissolved solids commonly ranged from 800 to 2,000 ppm. The extent of contamination between the Charnock and Over­ land Avenue faults as of 1930-32 is not known because analyses are not avaitable. However, in the middle and late thirties, wells south of Ballona Creek in this block yielded water containing as much as 500 ppm of chloride (wells 2/15-13K2 and K4), and it is inferred that this area was contaminated as early as 1930-32.

At the north edge of the Baldwin Hills, and some 6 miles inland from the coast, chiefly in sec. 5, T. 2 S., R. 14-W., an area of about 250 acres was underlain by contaminated waters in 1930-32. **Of** six wells for which analytical data are available, the chloride content of five wells was in excess of 500 ppm and was 254 ppm in the sixth. The contamination extended northward beyond well 2/14-5F2 and south­ ward beyond well 2/14-8Dl. The greatest concentration was .in· well 5Nl (5,414 ppm of chloride). Fragmentary analytical data suggest that the waters were not contaminated betwMn the, coaet l

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and inland areas as of 1930-32, although native water containing more than 100 ppm of chloride existed along the west flank of the Baldwin Hills; this is shown by a chloride concentration of 182 ppm in well 2/14-18F2 in 1925.

As of 1946, nearly all of Ballona Gap coastward from the Overland Avenue fault was underlain by contaminated waters; this coastal area of contamination had extended to some 7,300 acres, or about 11.4 square miles, an increase of about 2,200 acres in 15 years (pl. 16). The movement of the saline front had been generally northward across the gap; coastward from the Charnock fault, it had advanced from 0.4 to 0.9 mile; inland between that fault and the Overland Avenue fault, it probably had advanced about 1 mile in the 15 years. As of 1946, essentially all the area coastward from Lincoln Boulevard was underlain by water with a chloride content greater than 500 ppm. At the north edge of the Baldwin Hills, in sec. 5, T. 2 S., R. 14 W., the area of contamination probably remained about constant from 1930 into 1946, although its front may have moved northward be­ cause of the large withdrawals from tlie wells of the Southern Cali­ fornia Water Co. and the city of Beverly Hills in 2/14-50 and 2/14-5D. Between the coastal area of contamination and the area north of the Baldwin Hills, a third area of contamination developed on the west flank of the Hills in the thirties and early forties. By 1946, about 200 acres east of the 'intersection of Overland Avenu and Jeffer­ son Boulevard was underlain by water containing more than 500 ppm of chloride (pl. 16). The focus. of this contamination is presumed to be in the vicinity of well 2/14-7Kl, because water from this.well con­

tained 18,810 ppm of chloride in 1939.

In contrast to the general contamination in the gap, an area about

0.15 mile wide and 0.8 mile long, inland from the Charnock fault and south of Ballona Creek, was still uncontaminated as of 1940-accord­ ing to analyses of samples from wells 2/15-2401 and 24F3. so· far as known, the main water-bearing zone in this narrow strip then con­ tained less than 60 ppm of chloride; as of 1945, it probably was no more than incipiently contaminated. ··

**CONTAMINATION NEAR THE COAST**

In the coastal area of contamination, saline. encroachment pre­ sumably began in the twenties and abandonment of wells started about 1930. For example, two wells of the Venice Consumers Water Co. in sec. 16, T. 2 S., R. 15 W., about 1 mile from the ocean, were abandoned in 1930 because of salinity. Abandonment of wells at the Marine plant of the city of Santa Monica in 2/15-9N began about 1933, although at least one or two of the wells were used into 1941. In 1940, well 2/15-9N7 (well 5 of the city of Santa Monica) yielded

- CHEMICAL CHARACTER OF WATERS **199**

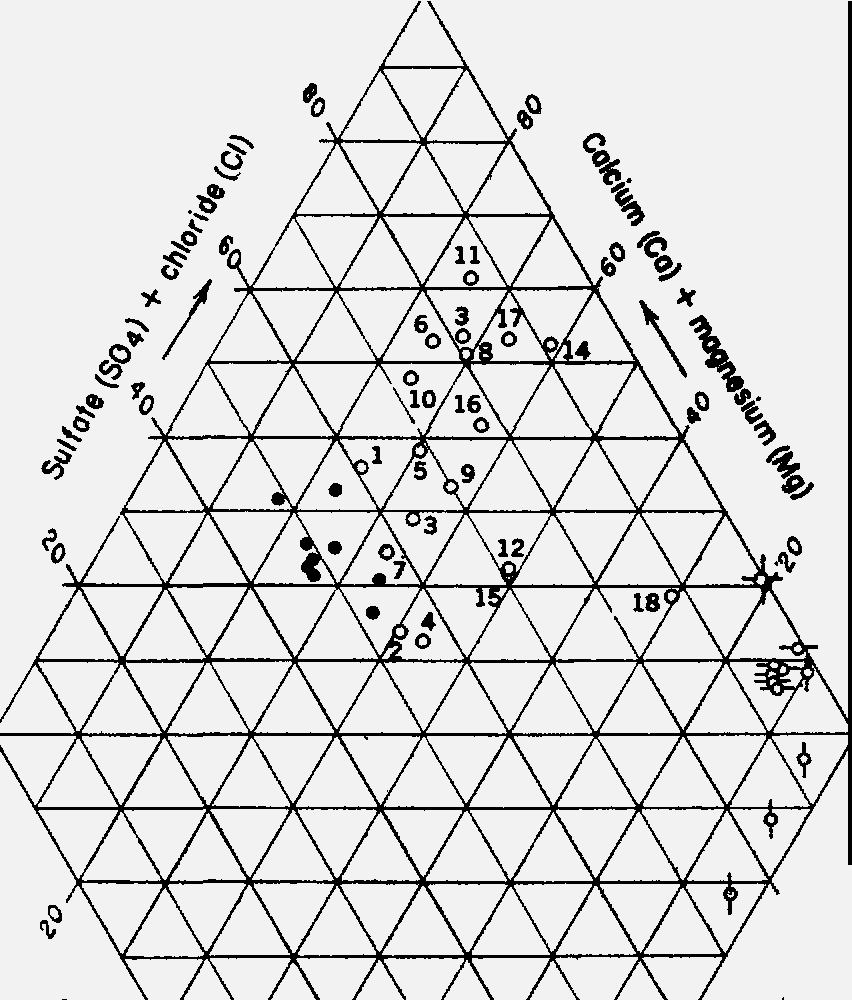
water containing over 1,100 ppm of chloride. For the interval from 1930 to 1945, sharp increases in salinity were restricted chiefly to wells within 1.5 to 2 miles of the coast. Records of chloride analyses

-for selected wells are plotted on plate 20 to show the rate of salinity increase in the coastal area of contamination in Ballona Gap. Anal­ yses were made chiefly by Los Angeles County Flood Control Dis­ trict, California Division of Water Resources, and Los Angeles De­ partment of 1vfater and Power. In general, the chloride increase has been greatest in wells less than about 1.5 miles from the coast. Except ior these badly contaminated wells, and some local wells not shown here, the graphs indicate that, for the area as a whole, salinity has not definitely increased since the middle thirties; in fact, many of the well waters have had a slight decrease in salinity in recent years. For this coastal area of contamination, chemical evidence does not sug­ gest any regional quality gradient between the "50-foot gravel" and the San Pedro formation.

, The information regarding the zones tapped is too meager to indi­ cate'whether any definite relation exists between depth of zone tapped a;nd water quality. Tentatively it may be concluded that, at least for ·.the coastal part of .the gap, no uniform vertical gradation i.J?.: quality exists. Therefore, the two water-bearing zones are not dis­ cussed separately ju dealing with contamination here, but instead, they are treated as\_ containing a single contaminated water body.

**CHEMICAL FEATURES OF CONTAMINATION**

, In the coastal area of contamination many of the well waters have beco e grossly contaminated; in 1945, at least one well (2/15-22Jl) yielded water in which the dissolved-solids content was more than 4,000 ppm. To show the manner in which chemical character of the contaminated waters h changed with increase in concentration, figure 11 is plotted to show a number-oUhe more highly. contaminated waters -in order of increasing concentration. Also plotted on the graph are the group of native waters from figure 10. Figure 11 shows that the points representing the contaminated waters scatter to the right and range upward. In terms of character change, departure to the right indicates an increase in the proportion of sulfate or chloride and a similar increase in the proportion of sodium. The shift up­ ward and increased concentration denotes an increase in calcium and magnesium and a proportionate loss of sodium. Inferentially, the in­ crease in alkaline earths at the expense of the sodium might be inter­ preted to indicate that a high-calcium or high-magnesium contami­ nant is present in Ballona Gap. However, neither here nor in the Long Beach-Santa Ana area has such a contaminant been found. Therefore, the increase in alkaline earths is presumed to be due to



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|  |  |  |  |
| --- | --- | --- | --- |
| No.  1  2  s  s**4**  6  7  8  9  10  11  12  lS  **14**  15  16  17  18 | Well  2/1S-9N6  26Cl  9Nl  26133  14J2 UiJ3  l3Ml l6Jl 2SF3  24L2  lSNl 2SN1  22C3  9N6  2282  22F2  22Jl  2SQ1 | Date  ·July.SO, 1931  Oct. l, 1931  Aj,r. ll, 1933  Dec. 12, 1989  Dec. 12, 1989  Oct. 9, 1931  De-c. 1s2,, 1930  1939  Oet. 9, 1931  Oct. 3, 1939  Mar. 28, 1932  Apr. 16, 1945  Oct. 9, 1931  Apr. 24, 19'0  Apr. 19, 1945  Apr. 16, 1945  Aj,r. 17, 1945  Dec. 14. 1939 | Diasolved solids, parts per **million**  653  1,254 l,SIJS 1,419  1,442  1,468  1,596  1,724  1,885  2,038  2,181  2,300  !?,409  2,415  2,470  2,510  4,007  **S,182** |

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**11Cali ve wat- in** Ballona Gap; %

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Ocean water

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**Brina**

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lar.f-ood

**Brine from**

oil fie

FIGURE 11.-Chemical character of native and contaminated waters in the coastal part of Ballona Gap.

base exchange, in which the sodium in the incoming contaminant is replaced nonuniformly by calcium or magnesium, or both. As will be noted on figure 11, the occurrence of base exchange disguises com­

pletely any possible gradation in quality· toward that of known con­ taminants. As shown on the illustr tion ft is obvious that, as salinity

of the water increases, the path of the plotted points d es not head toward the plots for either ocean water or a typical oil-field brine. If the degree to which base exchange has occurred could be deter­ mined and a correction made in the. position of the plotted points, then a trend toward one or the other of the possible contaminants might actually occur.

Although, as shown by figure 11, no consistent trend in chemical character occurs with increasing concentratio:q., it. will be noted from data presented below that from the coast to- about 1.5 miles inland,

-or about to Lincoln Boulevard, chloride increase is attended by an increase in sulfate in about the proportion to be expected if ocean water were the contaminant. The progress of contamination from Lincoln Boulevard inland to near Sepulveda Boulevard indicates that the sulfate content of the contaminated waters has increased above that which could possibly result from the addition of sulfate carried into the aquifers by ocean water alone. Hence, inferentially, the en­ croachment of ocean water into Ballona Gap extends about to Lin­

·coln Boulevard, or nearly as far as the 500 ppm chloride contour shown on plate 16.

To show the proportionate amount of sulfate increase in the coastal strip, analyses of contaminated water from three wells have been selected (2/H>-9N6, 16Jl, and 2601, all within 1.75 miles of the coast) and are compared to hypotheti al mixtures of native waters with ocean water. Table 18 shows these contaminated waters and the corresponding hypothetical mixtures, based on an equality **of**

,chloride concentration. As the table shows, only 9N6 contained an

-excess sulfate content (8 percent) but, because of possible analytical

-errors in the determination of that constituent, this small excess is not considered. to be sufficient to rule out ocean water as the contam­ inant. On the other hand, analysis 2601 showed a deficiency of 42 percent in su1iate content. In this case, however, a loss in sulfate is

TABLE *18.-Contaminated water from wells 2/15-9N6, 16J1, and 26C1, in com- parison with hypothetical mixtures of the presumed native water with ocean water*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Constituents | | | | | |
| Calcium (Ca) | Magne- sium (Mg) | Sodium (Na) | Bicarbon- ate (HCOa) | Sulfate (SO4) | Chloride (Cl) |
| Parts per million:  Presumed nativ13 water of well 2/15- 9N3, April 11, 1933  WAelpl r2./1254-,91N9460, contaminated water of  Native water mix:ed with ocean water\_ WAelpl r2./135,-11963.T0l, contaminated water of  Native water mix:ed with ocean water\_ WoefllO2c/t1.51-,2169031\_ contaminated water  Native water mix:ed with ocean water\_ Equivalents per million:  Well 2/15-9N6, .A.pr. 24, 1940  Native waters mixed with ocean water\_ Well 2/15-16.Tl, Apr. 3, 1930  Native water mixed with ocean water\_ Well 2/15-26Cl, Oct. 1, 193L  Native water mix:ed with ocean water\_ Excess (+) or d.eficiency (- ) of the  contaminated waters with respect to native and ocean water mix:tures, as follows:  Water of 2/Ut-9N6  Water of 2/llt-16.TL Water of 2/lft-26CL. | 76  380  95  270  87  131  81  18.97  4. 75  13.48  4.36  6.54  4.06  +14.22  +9.12  +2.48 | 26  60  100  105  70  90  47  4.93  8.20  8.64  5. 72  7.40  3.83  -3.27  +2.92  +3.67 | 78  465  711  210  451  225  255  20.21  30.92  9.11  19.59  9. 76  11.09  -10.71  -10.48  -1.33 | 274  250  266  373  269  662  272  4.10  4.36  6.11  4.41  10.85  4. 46  -.26  +1.70  +6.39 | 151  323  299  231  238  112  192  6. 72  6.22  4.81  4.95  2.33  4.00  +.50  -.14  -1.67 | 60  1,180  1,180  720  720  373  373  **33.29**  33.29  20.31  20.31  10.52  10.52  --------------------  ---------- |

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not diagnostic, because the process of sulfate reduction is common in both native and contaminated waters-it certainly could have oc­ curred here. Referring again to the table, all the contaminated waters are lower in sodium and higher in the sum of calcium and magnesium than the hypothetical mixtures. This discrepancy is due­ to base exchange in the direction of calcium enrichment and is to be expected. Hence, its occurrence will not, in itself, invalidate the postulation of ocean-water contamination of those well waters whose analyses are examined here.

In contrast, table 19 presents the sulfate content of water from a number of wells inland from the 500 ppm chloride contour, but coastward from Sepulveda Boulevard. The sulfate content of these waters is compared to that which would result from mixtures of native water with ocean water, based on an equality of chloride concentration. As may be seen from the table, all the analyses cited show more sulfate in the contaminated water than could possibly have resulted from an ocean water-native water blend. The excess of sulfate, expressed as the percent of excess over that contained in the hypothetical blend, ranges from 31 to 440 ppm for waters in the confined body. Well 2/15-23Ql, tapping the unconfined body, yielded water in which the percent excess of sulfate with respect to the native confined water is 1,240 ppm. Thus, considering the change in sulfate concentration that has occurred, the shallow water could be causing part of the contamination. Hence, for the coastal part of Ballona Gap, the concentration of sulfate suggests that ocean­ water contamination doubtless has occurred inland about to and possibly beyond Lincoln Boulevard. From Lincoln Boulevard to Sepulveda Boulevard, the shallow water in the unconfined body may be the principal contaminant. However, it is likely that the boundary between the ocean-water and high-sulfate-water contamination is very irregular and indefinite.

In an attempt to define the position of this boundary, and to identify

the contaminant inland from Lincoln Boulevard, three other chemical characteristics of potential contaminants were considered. These characteristics are (1) bicarbonate content, (2) calcium-magnesium ratio, and (3) borate content. The study **of** these characteristics failed to provide a better definition of the boundary.

1. The bicarbonate content in ocean water is about 140 ppm; in the shallow unconfined waters of Ballona Gap it commonly is about 500 to 700 ppm but in

-one locality it is as great as 1,670 ppm; in oil-field brines from the Inglewood

:field-according to six available analyses-it ranges from 297 to about 2,0001 ppm and averages 1,350 ppm. In native waters in Ballona Gap it probably ranged about from 275 to 300 ppm. Therefore, a Ballona Gap native water contaminated by ocean water alone would decrease in bicarbonate, but if the contaminant were either shallow unconfined water, or an oil-field brine, the

TABLE *19.-Sulfate content of water from selected wells in the coastal part of Ballona Gap -in comparison to that resulting from a hypothetical mixture of native water* 1 *and ocean water*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Well** | Parts per million | | | Excess  (percent) |
|  | | Sulfate (hypo- thetical) |
| Chloride | Sulfate (actual) |
| 2/15-13J3\_ ----------··-----------------\_-- \_-- \_-- ---------  14QMLL --·-- \_ --- ---.- -. -. -. \_-  1225BN2L\_. -------····---------------------------· ·-\_  2/15- gt\_-\_=-: ==== ::::::::=========::::::======= === :::::  23A2 .. --- - - -- - --- - - - - •- - - - - - - - -- - -- - - -  23A3•••• . .. ----------------**-**-- -----  23CL ••••• ----· . \_  2/15-23F3••••• ... \_  23GL.  2302 -- ------··-------------------- ---\_-- ---------  23HL ----··---------------------- \_  23J2\_ -------- --··- ------------------------ ----------  2/15-23M3 \_  23QL .. \_  24L2 ··---------------------- \_ | 456 | 492 | 208 137 | |
| 375 | 295 | 192 54 | |
| 259 | 231 | 177 31 | |
| 604 | 492 | 223 121 | |
| 222 | 931 | 173 438 | |
| 266 | 835 | 169 394 | |
| 337 | 674 | 188 259 | |
| 187 | 532 | 168 217 | |
| 214 | 449 | 172 161 | |
| 371 | 483 | 193 150 | |
| 206 | 593 | 170 249 | |
| 240 | 607 | 175 247 | |
| 231 | 633 | 174 264 | |
| 300 | 730 | 183 299 | |
| 174 | 476 | 166 187 | |
| 250 | 583 | 176 231 | |
| 941 | 2,234 | 167 1,240 | |
| 208 | 923 | 171 **440** | |

**1** Native water selE,cted is that from well 2/15-9N3, analysis of Apr. 11, 1933.

bicarbonate content of the contaminated water would increase slightly and I irregularly. A study of the analyses of contaminated waters throughout the coastal part of Ballona Gap indicates that in such waters a bicarbonate content of 400 to 500 ppm is common and that, with very few exceptions, notably at the Marine plant of the city of Santa Monica, the increase in chloride is attended by an increase in bicarbonate. Well 2/15-9N6, at the Marine plant, yielded water that decreased in bicarbonate from 308 ppm in 1931 to 226 ppm in 1940. Over the same period, the chloride content increased from 81 to 930 ppm. How­ ever, here the bicarbonate loss is considerably more than would result from ocean­ water contamination alone. In general, the conclusion was ·reached that, for this coastal area of Ballona Gap, bicarbonate is useless as a criterion for deter­ mination of the sources of contaminants.

1. The calcium-magnesium ratio for ocean water, computed from equivalents

per million, is 0.19; for oil-field brines from the Inglewood field, it ranges from

0.28 to 1.04 and averages 0.56, according to six available analyses; for shallow, unconfined waters, it appears to be less than 1 (well 2/15-23Ql, 0.57; well 23Q2,

**0. 73).** For presumed native waters in Ballona Gap, the ratio ranges from **1.2** to 2; hence, it would be expected that native waters rendered inferior by blending with any of the known contaminants, would show a decrease in calcium-magnesium ratio concurrent with salinity increase; of course, for only moderate contamination the decrease would be slight. According to computations (not presented here),. such a decrease in calcium-magnesium ratio does not occur. Actually, with increase in salinity of randomly selected native waters, a considerable scatter (from 0.9 to 2.,5) occurs in the value of the ratio; therefore, such a ratio could be of little value in discriminating the source of a contaminant.

In contrast, waters in Dominguez Gap that were contaminated by ocean water have a much lower calcium-magnesium ratio than waters contaminated by oil­ field brines (at least, for chloride concentrations less than 1,000 ppm). There, in water contaminated from the ocean, the ratio averages about 0.6, whereas in

waters primarily contaminated by oil-field brine, the ratio averages about **2.3** (Piper, Garrett, and others, 1953, p. 190). That is, a calcium-magnesium ratio much greater than 0.6 would seem to indicate a contaminant other than ocean water. In regard to those waters in Dominguez Gap, the base-exchange reac­ tions, which usually occur with blending **of** native waters and saline waters and which cause much irregularity in the proportion of bases, was operative to only a small extent. On the other hand, in Ballona Gap, the great irregularity in calcium-magnesium ratios in contaminated waters doubtless results from base­ exchange reactions which prevent the use of that ratio as a diagnostic charac­ teristic.

1. The borate content in ocean water is about 25 ppm. In presumed native waters of Ballona Gap, the borate content commonly ranges from 0.3 to 0.8 ppm, although some of these native waters-particularly those which may rep­ resent a blend with waters from the flank of the Santa Monica Mountains­ contain as much as 1.4 ppm. Therefore, if a contaminated water with 500 ppm of chloride contains more than about 1.5 to 2 ppm of borate, it is inferred that some saline water other than ocean water has been the cause of such contamina­ tion. Little is known concerning the borate content of potential contaminants in Ballona Gap; however, a sample of water from Ballona Creek, collected in 1931, contained 350 ppm of chloride and more than 5 ppm of borate. Although not in Ballona Gap, and cited for example only, a sample of water collected in 1932 from the Los Angeles River just downstream from the sumps of Oil Oper­ ators', Inc., contained 14,289 ppm of chloride and 169 ppm of borate. Frag­ mentary data not presented here suggest that oil-field brines in the Los Angeles basin contain several times as much borate as ocean water (Piper, Garrett, and others, 1953, p. 67 and table **8).**

Information on the borate content of contaminated waters in the coastal part of Ballona Gap shows that at least 13 wells have yielded water containing more than about 1.5 ppm of borate (for waters in which the chloride content is not appreciably more than 500 ppm). Of these 13 wells, 8 are in sec. 23, T. 2 S., R. 15 W.; all of the.wells are in that part of the coastal reach of Ballona Gap about from Lincoln Boulevard to Centinela Boulevard. For 12 of these wells, the borate content ranges from 1.6 to 3.4 ppm. The additional well, 2/15-23Nl, yielded water in 1931 containing 7.6 ppm. Nearly all of these wells are farther inland than the presumed inland extent of ocean-water contamination, as determined on the basis of sulfate content. However, throughout the area in which the 13 foregoing wells are located, other wells, equally saline, contain only slightly larger amounts of borate than is presumed to have occurred in the native waters; many of these wells yield high-sulfate waters. There­ fore, it is concluded that the borate content of contaminated waters inland from Lincoln Boulevard is of virtually no value in attempting to delimit the inland extent of ocean-water contamination, because no definite borate-chloride ratio seems to exist.

With respect to possible contamination from Ballona Creek, the available analyses of side inflows and creek water are listed in table 20.

The points where the samples were taken are shown by corresponding numbers on plate 17. The table shows that waters discharged into the creek are of sufficiently great sulfate and chloride content to cause contamination of ground waters within the coastal reach inland from tidewater; that is, providing that the materials beneath and adjacent to the creek are sufficiently permeable to permit appreciable seepage from the creek. Regarding such seepage, the California Division of Water Resources (1933, p. 26) notes that, "Discharge during summer usually penetrates into creek bottom before re,aching tidewater." At the time of this observation, August 1931, the flow in the creek was estimated at :3 cfs.

**TABLE** *20.-Chloride, bicarbonate, and sulfate content of water samples from Ballona Creek and its tributaries or points of inflow, 1931-40*

[Analyses principally by Los .Angeles County Flood Control District]

Num- beron plate **17**

Sampling point

Date sampled

Constituents, parts per million Chloride Bicar- Sulfate

(Cl) bonate (SO4)

(HCOa)

1 La Cienega. storm drain; west half, near West

Apr. 20, 1931

86 353 **45**

Adams Blvd., 200 feet north **of** Washington Blvd.

Mar. 1,1932

304

418 ----------

2 La Cienega storm drain, east half Apr. 20, 1931

160

353

**100**

1. Sacatela storm drain, 50 feet upstream from out- let of La Cienega storm drains.
2. Spring at west half of La Cienega storm drain----
3. Spring, 700 feet upstream from Higuera St., dis-

Mar. 1, 1932

Mar. 1,1932

Mar. 1, 1932

Mar. 1,1932

241

**227**

524

4,354

**500** ----------

369 ----------

622 ----------

806 ----------

charging to Ballona Creek from northwest bank.

Mar. 25, 1932

4,083

**778**

**1,880**

1. Storm drain, Moynier Lane, 900 feet south of
2. W.doest Adams Blvd.

8 Creek flowing from north flank of Baldwin Hills and entering Ballona Creek about at Jefferson Blvd.

1. Spring, issuing from cave at north flank of Bald- win Hills, 0.37 mile south of Jefferson Blvd., in Lenawee Ave., extended.

Mar. **1,** 1932

Mar. 1,1932

Dec. 21, 1939

Apr. 29, 1932

468

262

2,633

311

422 ----------

320 ----------

363 ----------

581 ----------

1. Ballona Creek, at Duquesne St. Analyses by California Division of Water Resources.

Ballona Cr!lek, at Sawtelle Blvd

Aug. 19, 1931

Aug. 11, 1937

Oct. 27, 1937

Feb. 21, 1938

350

240

532

265

360

361

394

508

..,

201

218

**231**

225

11 Dec. 27, 1939

1. Ballona Creek, at Inglewood Blvd Apr. 25, 1940

Dec. 17, 1935

Jan. 30, 1936

Apr. 15, 1936

May 11,1936

Oct. 14, 1936

Jan. 19, 1937

Mar. 8,1937

1. Ballona Cri ek, at Centinela Blvd Nov. 27, 1939

Aug. 24, 1936

Oct. 14, 1936

Jan. 19, 1937

May 10,1937

Nov. 27, 1939

Dec. 9, 1939

368 ----------

489 ---------- ----------

68 ---------- ----------

185 ---------- ----------

460 ---------- ----------

446 ------ ---- ----------

383 ---------- ----------

388 ------- --- ----------

450 ---------- ----------

**441** ---------- ----------

629 ---------- -----------

321 ---------- ----------

306 ---------- ----------

287 ---------- --------- -

356 ---------- ----------

306 ---------- ----------

1. Ballona Crnek, at Lincoln Blvd. Sampling point within tidal reach in creek.

Aug. 24, 1936

Jan. 19, 1937

Dec. 14, 1939

7,.560 ---------- ----------

12,600 ---------- ----------

17,600 ---------- ----------

Ballona Creek. Sampling point not known. Analysis by Dr. Carl Wilson.

.do .• - ------------ • \_

Jan. 30, 1936

Feb. 11,1936

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As discussed on page 187, the channel of Ballona Creek is paved with an impervious lining inland from La Salle Avenue; however, coastward from this avenue the bottom of the channel is unlined. The analyses (table 20) of creek water suggest that, if seepage has occurred here, the waters so introduced into the ground-water body may have caused a substantial part of the contamination. From La Salle Avenue inland, the ground-water bodies are protected from saline waters flowing within the creek channel. La Salle Avenue is

0.7 mile inland from the fault separating the Charnock and the crestal subbasins; hence, both basins are subject to possible con­ tamination from the creek channel at the present time.

In regard to the sources of contamination in the coastal part of Ballona Gap, it may be concluded that inland at least as far as Lincoln Boulevard and including the abandoned Marine plant of the city of Santa Monica, ocean water has caused most if not all of the contami­ nation. The presence of a landward hydraulic gradient from the early twenties to the late thirties coincides with this conclusion. The conclusion regarding an oceanic source of contamination is in

.general agreement with that of the Los Angeles County Flood Control District, which was the result of extensive work in Ballona Gap by that agency (Koch, 1940, p. 16).

The Los Angeles County Flood Control District also prepared the first detailed map showing contamination conditions in Ballona Gap. This map (Koch, 1940, pl. 2) shows lines of equal salinity and designates a suggested boundary between sea-water intrusion

.and oil-field brine pollution.

Inland about from Lincoln Boulevard to Sepulveda Boulevard, water from the shallow, unconfined body tentatively is presumed to be the chief cause of contamination, although near Lincoln Boulevard the contaminant may have been a blend of ocean water and unconfined water. Although confirmatory information is not available, it is likely that Ballona Creek has been an important factor in contami­ nating the shallow water body, at least as far inland as La Salle Avenue. Nowhere in this coastal part of Ballona Gap has it been

-possible to identify any contamination from oil-field brines. In part, this may stem from the difficulty of applying any of the criteria that ordinarily may be used in recognition of a blend of oil-field brine with native water.

**CONTAMINATION ON THE WEST FLANK OF BALDWIN HILLS**

An area of contamination developed on the west flank of the Baldwin Hills in the thirties; by 1946, about 200 acres east of the intersection of Overland Avenue and Jefferson Boulevard was under­ lain by water containing more than 500 ppm of chloride (pl. 16). Evidence suggesting that the contamination originates in the Baldwin

Hills is afforded by a sample of water (collected in 1939 from well 2/14-7Kl), which contained 18,810 ppm of chloride. Referring to table 31, the chloride content of brines from the Inglewood oil field, based on six analyses, ranges from 17,500 to 20,000 ppm. The depth of well 2/14-7Kl is not known, but it is high on the west flank of the Baldwin Hills and presumably taps the San Pedro forma­ tion.

The location of well 7Kl is such that contamination by ocean water is physically impossible, because the base of these water-bearing deposits is more than 100 feet above sea level (pl. 2). Hence the well doubtless is contaminated by oil-field brines. It is to be ex­ pected that such highly contaminated waters would percolate through the water-bearing deposits and ultimately would contaminate wells in Ballona Gap. Evidence of this fact is provided from two analyses of water from well 2/15-7P2 (table 30). *1n* June 1945 the well yielded water containing 600 ppm of chloride; in February 1946 it yielded water containing 1,100 ppm. During that period the sulfate content increased from 152 to 156 ppm; the comparatively small increase in sulfate is consistent with brine contamination considering the small J.tmount of sulfate present in the brines of the Inglewood field. These two analyses are plotted on figure 12. The analyses are so plotted

-0n this graph that the vertical height of a given constituent represents the amount of that constituent in equivalents per million. The oil­ field brine contamination has reached at least as far south as wells 2/14-18Fl and 18F2; to the west it presumably extends into sec. 12, but chemical evidence showing its exact extent is lacking. As shown by plate 2, the permeable sand and gravel of the San Pedro formation

,crop out extensively to the north, east, and south of well 2/14-7Kl,

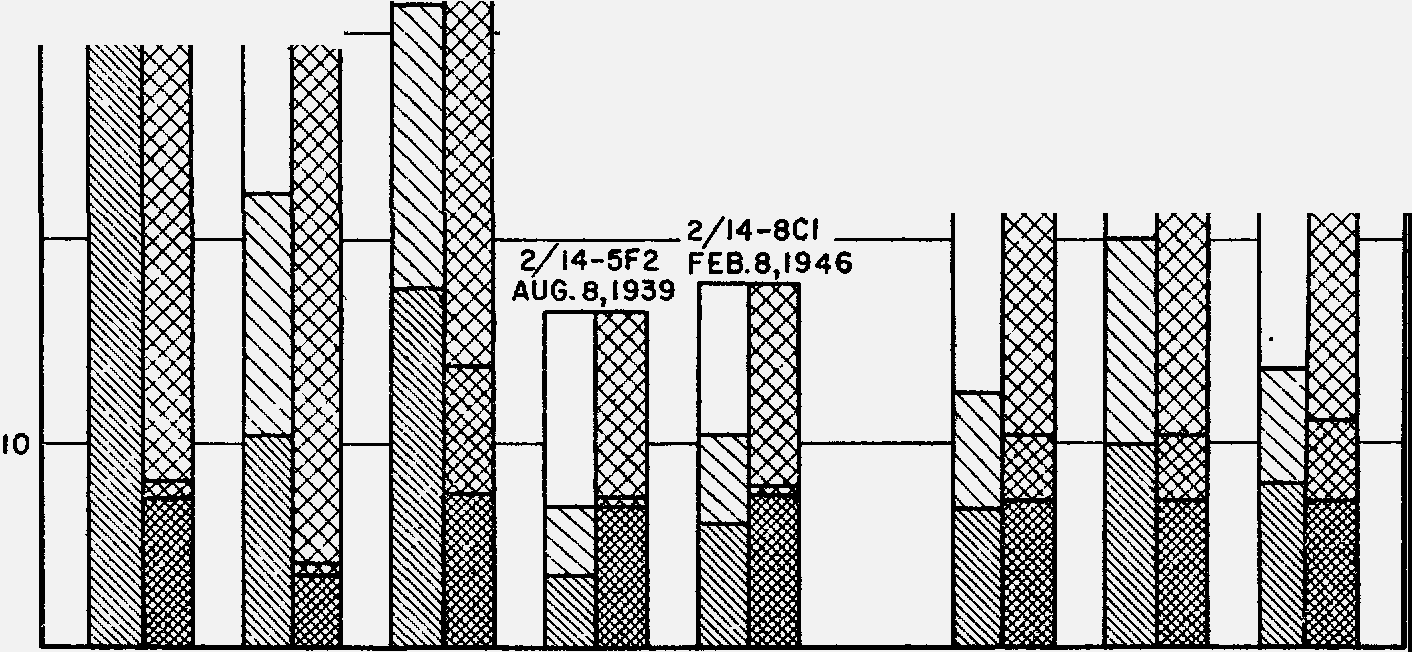
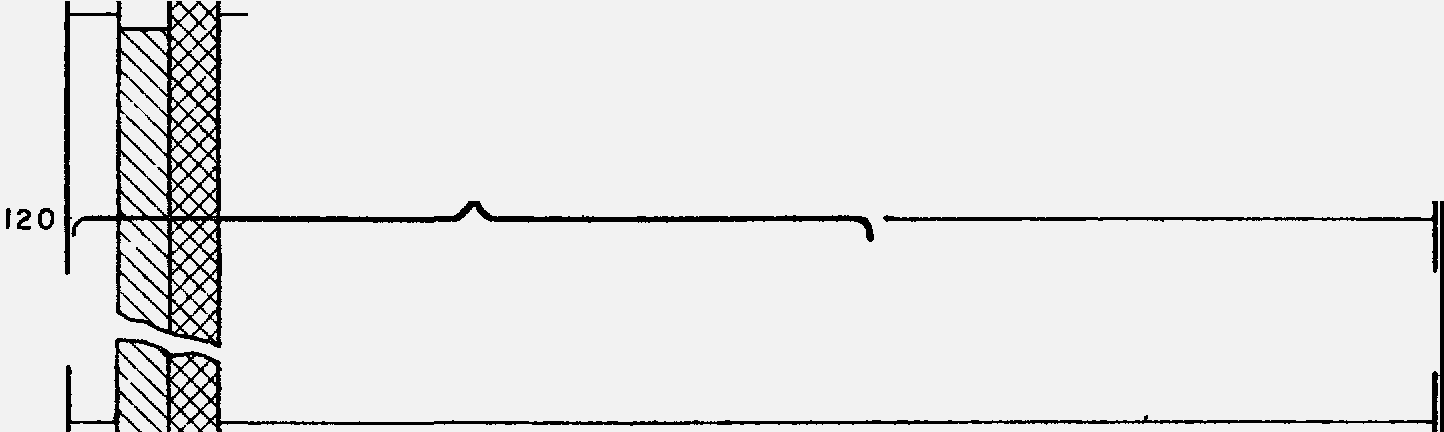
:and any brines discharged at the land surface can readily move down the westerly dipping beds to the Overland Avenue fault.

**CONTAMINATION ON THE NORTH FLANK OF BALDWIN HILLS**

About 300 acres, located chiefly in sec. 5, T. 2 S., R. 14W., was underlain by contaminated waters in 1930-32. The contamination extended northward beyond well 2/14-5F2 and southward into the Baldwin Hills beyond well 8Dl. Inferentially, this area became contaminated some years earlier than the coastal area. By 1931 several wells in 2/14-5P yielded water containing from 1,000 to 5,400 ppm of chloride. Because this contamination apparently is due to blending with oil-field brines, as will be explained, the contamination could have started at any time after 1924, which was the year of initial development in the Inglewood oil field. Analyses from three highly contaminated wells in this area are available: analyses 2/14-5Nl, March 23, 1932; 2/14-5Pl, October 22, 1931; and 2/14-5P3, October 2, 1931. Their chemical character is shown on figure 12. Of the

208 GEOLOGY, HYDROLOGY, ·TORRANCE-SANTA **MONICA AREA**

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2/14-SNI MAR. 23 1932

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WELLS ADJACENT TO THE NORTH FLANK OF BALDWIN HILLS

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, OCT. 22,1931

WELLS ADJACENT TO THE WEST FLANK OF BALDWIN HILLS

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OCT. 2,1931

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2/I4-ISFI , MAR.25,I932

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FIGURE 12.-Chemical character of contaminated waters from wells in Ballona Gap ad• jacent to the west and north flanks of Baldwin IIills.

analyses given, only 5P3 shows an appreciable amount of sulfate; however, in relation to the concentration of dissolved solids, that

·sulfate content is proportionally far less than in most of the contami­ nated waters toward the coast. Because the brines from the Ingle­ wood field are low in sulfate-ranging from 13 to 56 ppm (table 31}­ the low sulfate in the contaminated waters is a reasonably good indication of the source. Although well 5Pl contained 2.9 ppm

.and well 5P3 contained *3.5* ppm of borate, this constituent does not

.assist in isolating the source, because no analyses of borate in Ingle­ wood brines are available.

Although it is possible that the contamination could have origi­ nated from Ballona Creek, such an origin is unlikely because of the following three important factors:

1. Because of the position of the contaminated area shown on plate 16 and be­

-cause of the position of the more highly contaminated wells, a source to the south rather than to the north is the more logical.

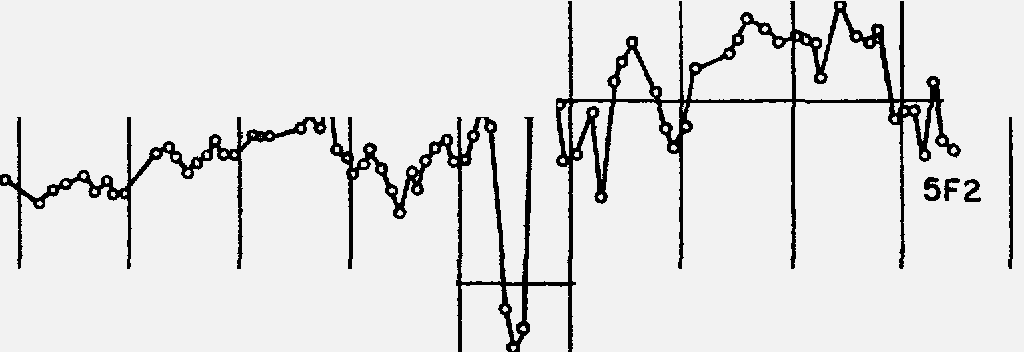
1. Existing analyses of water samples from Ballona Creek upstream from the

-contaminated area fail to show the presence of waters sufficiently saline to cause the observed concentration in the contaminated wells.

1. Contamination from Ballona Creek would have resulted in definite impair­ ment of the waters from one or more of the Sentney plant wells of the Southern California Water Co.

Hence, it is concluded that contamination here has been the result of discharge of oil-field brines from the Inglewood oil field.

Although the wells in 2/14-5P were strongly contaminated by 1931, recurrent chloride determinations from two wells, 2/14-501 and 5F2, plotted on figure 13, suggest that the concentration at these wells was not appreciably higher in the early forties than it was in 1931. Well 501, 0.2 mile east of the Sentney plant of the Southern California Water Co., taps essentially the same range as well 5D6 (Sentney plant,

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FIGURE 13.-0hloride content of waters from wells 2/14-5Cl and 2/14-5F2. Analyses chiefly by Los Angeles County Flood Control District.

well 6), and is about at the north edge of the contamination. Well 5F2, within the area of contamination, is about 0.2 mile south of 5Cl. It is 260 feet deep and taps the upper part of the San Pedro formation. Well 5F2, although of irregular chloride content, showed an increase in salinity into 1939, then it showed a decrease. Well 5Cl may have reached a peak at about the same time as 5F2; chloride determinations. on 5Cl from 1941 into 1945 show a decrease in chloride into 1944,. then a leveling off at about 50 ppm. Well 5F2 yielded contaminated water containing very little sulfate and is assumed to be contaminated by oil-field brines.

To determine the current status of salinity in the area shown as. contaminated in 1930-32 (pl. 16), an electrical-conductivity traverse was made on well 2/14-5Pl in July 1946. This unused well is located about 1,750 feet southeast of Ballona Creek and about 1,500 feet north of the flank of the Baldwin Hills. The measured depth was then 179 feet below land surface. The casing is perforated in gravel,. 20 to 32 feet below land surface. As computed from values of specific conductance, the dissolved solids in the water within the casing, from water surface at 13 feet to 88 feet below land surface, ranged from 4,600 to 4,800 ppm. From 89 to 176 feet below land surface, the dissolved solids ranged from 7,400 to 8,000 ppm. In 1931 a sample from the well contained 2,856 ppm of dissolved solids; thus, at least at this one well, the salinity concentration has intensified appreciably during the 15-year period. Well 5Nl, 1,000 feet northwest of 5Pl, yielded water containing 8,528 ppm of dissolved solids in 1932; this well was not found in 1946, and its salinity at that time could not be determined.

WELLS AT THE SENTNEY PLANT OF THE SOUTHERN CALIFORNIA WATER CO.

In the NW} sec. 5, T. 2 S., R. 14 W., analyses of water from the Sentney plant wells of the Southern California Water Co. show that they yield waters with erratic fluctuations in chemical concentration; these analyses strongly suggest a blending of waters of different and distinct types. Although, as of 1946, all the active wells yielded presumably native water, distinct vertical differences in chloride concentration occur; water with the lowest chloride content is yielded from the lowest part of the water-bearing beds. Well 501, 0.2 mile east of the Sentney plant and perforated below 277 feet, yielded water containing 44 ppm of chloride in 1945. Well 5D6, perforated below 326 feet, yielded water containing 49 ppm of chloride in 1945. Well 5D4, for which the perforated interval is not known, yielded water containing as much as 219 ppm of chloride in 1936. The records of chloride content of water yielded from seven wells of the Sentney plant have been plotted on figure 14, together with the record of

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FIGURE 14.-Chlorlde content'of waters and recor(of perforations for seven··wclls at t'lie Sentney"plant, Southern California Water Co. **1-L**

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perforations for these wells. Three conclusions may be drawn in part from the figure:

* 1. Well 5D6, which taps the middle and lower parts of the San Pedro formation, yielded water of the best quality, but as of 1943 the quality approached that of water yielded from the upper part of the formation.
  2. Essentially no difference in chloride concentration exists between waters in the "50-foot gravel" of Recent age (well 5D9) and in the underlying upper part of the San Pedro formation. However, the former has yielded water definitely higher in sulfate than that from the San Pedro formation. Since 1944 analyses of water from well 5D9 tapping only the "50-foot gravel," have shown an increase in dissolved solids, which has been due chiefly to an increase in calcium and in sulfate.
  3. For the respective zones tapped, only a comparatively small range in chloride content exists-as of 1944, from about 65 to 150 ppm. For the span of the records, no definite progressive contamination is indicated, with the possible exception of well 5D4, which has not been pumped since about 1936.

The heaviest production from the Sentney plant is from the upper part of the San Pedro formation-which here includes the main aquifers. Well 5F2, which is 0.4 mile southeast and was definitely contaminated in the thirties, also once yielded water from the upper part of the San Pedro formation. Because a steep cone of pressure relief has been maintained at the Sentney plant for many years (pis. 9-12 and 14) it might be expected that, at least by 1946 wells at the Sentney plant would have become contaminated from the south­ that is, from the same source that caused well 5F2 to become saline. The fact that these wells have not yielded definitely contaminated water suggests a hydraulic 'discontinuity between the Sentney plant. and the contaminated water body to the south. However, the hydro­ graphs for wells 5D5 and 5F2 plotted on plate 14, suggest that no hydraulic separation exists. Accordingly, it is concluded that the bulk of the northward-migrating contaminant was withdrawn through wells 5F2, 501, and possibly other wells, in the thirties and early forties, and that a small marginal interception was withdrawn through wells 5D4 and 5D7 in the middle thirties (fig. 14).

Under native conditions, inferior waters occurred in sec. 32, T. 1 S.,

R. 14 W; in 1931 wells 32Ml and M3 yielded water containing 227 and 304 ppm of chloride, respectively. It is believed that these waters have migrated in part to the Sentney plant wells and have caused some of the observed fluctuations in chloride.

From existing analyses of water from the Sentney plant wells, it is inferred that as of 1946 the active wells were not contaminated, and that the recent fluctuations in chloride are not an indication of incipient contamination, but instead, they are a result of blending with inferior waters present to the north and east.

CHEMICAL CHARACTER OF WATERS 213'

**RATE OF ADVANCB OF TBB COBTAMDl ATIOB FRONT**

In Ballona Gap the greatest advance of the contamination front in the last 16 years has been in the Charnock subbasin. From 1930-32 to 1945-46 the front has advanced about 1 mile, and in 1946 it was about 0.6 mile from the Charnock well field of the Southern California Water Co. This advance is estimated at an average rate of about 350 feet per year; the direction of advance is to the northwest and is in response to the hydraulic gradient developed by withdrawals from the Charnock field. If the front continues to advance at the same average rate, it will reach the Charnock field in 8 to 10 years. However, as the front moves closer to the field, it is expected that the rate of move­ ment will be accelerated by the steeper gradient.

*AB* of November 1945 (pl. 12), the hydraulic gradient to the well field from the northwest was about 30 feet per mile; from the southeast, about 15 feet per mile at the saline front. Thus, if the transmissibility of the deposits to the north and to the south is equal, about two-thirds of the supply is derived from the north and one-third from the south. The water now yielded from the Charnock well field contains about 50 ppm of chloride, about 700 ppm of dissolved solids, and 400 ppm of hardness (table 30). The saline waters just south of Ballona Creek in the Charnock subbasin contain. as much as 500 ppm of chloride,' 2,000 ppm of dissolved solids, and 800 ppm of hardness (table 29·) If such saline waters e-tentually shouid reach the Charnock plant wells and should be·withdrawn with the native waters in a proportion of 1: 2, the resulting blend would contain about 200 ppm of chloride, 1,100 ppm of dissolved solids, and 500 ppm of hardness.

In the coastal area, contamination has advanced along a·bout \_ a

3-mile front, chiefly in secs. 14, 15, and 16, T. 2 S., R. 15 W. Part of the advance as shown on plate 16 is conjectural because of the scarcity· of wells that could. be used to locate the front more precisely. How­ ever, for the 16-year period the greatest advance appears to be along the west boundary of sec·; 14 and in sec. 15, where it was from 0.7 to

0.9 mile-. This· represents an average yearly rate of about 260 feet,

although ior mast of the front the rate is probably not more than half so gr at.-: ·

**CONTAMIN TJON ]fROM PLAYA D I,, REY TO REDONDO BEACH**

In the coastal reach from Playa'.del Rey southward to and somewhat beyond Redondo Beach--:--essentially the 11-mile reach from the Bal­ Iona escarpment to the Palos Verdes Hills-salt water has invaded the main watef'-4heacing zone ,and now extends inland from half a mile to nearly 2 miles (pl. 16). Locally, this contaminated- water contains as much as 5;000 ppm of dissolved solids.

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Under the native conditions of coastward ground-water movement it ·is believed that waters of good or fair quality existed to the coast along essentially all of the reach from Playa del Rey to Redondo Beach. As of 1904, Mendenhall (1905b) canvassed 13 wells from Manhattan Beach to Redondo Beach that were less than 0.7 mile from the coast. Of these, all except three yielded water containing less than 600 ppm of dissolved solids. Only one well, in 3/15-36H (Mendenhall 273,\_ Redondo), yielded water containing more than 1,000 ppm of dissolved solids. North of Manhattan Beach no wells had been drilled near t)le coast as of 1904-except near Playa del Rey in 2/15-34E (Mendenhall 80 and 81, Redondo), 0:4 mile inland.from the coast. There, the main water-bearing zone yielded water containing 710 ppm of dissolved solids as of 1904. .

So far as known, contamination within this coastal reach was first noted between 1912 and 1918\_-in -well 4/14-6Fl, at Hermosa Beach and 0.6 mile inland, from the coast (p. 244). In the reach of greatest qurrent inland advance at El Segundo, conta ination was first re­ ported in 1921 in wells·of the Standard Oil Co.-in 3/15-13D and 14A (pl. 16). Well 3/15-14A2, about 0.6 mile inland from the coast, yielded water containing 90 ppm of chloride in 1920; this -water was considered essentially native t,o th range tapped. Beginning in 1921, its quality deteriorated rapidly; however (fig. 20).

From 1920 to the early thirti\_es, -withdrawal from the Torrance-­ Inglewood subarea of the west l>asin increased ·substantially., larg<tly because of the construction of a number of well fields supplying new industrial plants. As has been shown, w ter levels. were lowered to and below sea level throughout most of the subarea. As a result of this lowering of water level, contam4lation of wells had occurred along most of the coastal reach from El Segundo to Redondo Beach by 1932. The inland front of contaminated waters containing more than 100 ppm of chloride as of 1930-32 is shown on plate 16. At that time the greatest inland extent of the contaminated waters was about 1.3 miles at El Segundo; the least extent was :µot more than half a mil '.near Century Boulevard and at Hermosa Beach: . Along the full; p'.'"pii!e reach, the area then underlain by contaminated waters was, about.

*5,000* acres, or nearly 8 square miles.

As of 1946, the front of waters containing more than 100 ppm of chloride, as shown on plate 16, ranged from half a mile inland near Century Boulevard to 1.7 miles at El Segundo. At Redondo Beach, the front then was 1.1 miles inland from the coast. From 1932 into 1946, the greatest advance of the saline front occurred between El· Segundo and Manhattan Beach and was as much as 0.5 mile. How­ ever, the average advance of encroachment between Playa del Rey and Redondo Beach in the 14 years was about 0.3 mile. and the in-

crease in the area underlain by contaminated water was about 1,700 acres.

The withdrawal of water along the coastal reach is largely concen­ trated at five· well fields or local centers of pumping. Analytical data relating to the active wells in these fields have been taken-more or less continuously for many years. Thus; the rate of contamination, the chemical character ·of the contaminated waters, and the source or sources of contamination can be appraised best by analysis of condi­ tions at these- several well fields.

**WELL FIELD AT PLAYA DEL REY**

Just south *of* the Ballona escarpment in the vicinity of Playa del Rey, water is yielded only from the main water-bearing zone of the San Pedro formation, which here immediately underlies the dune-sand deposits and which, at least locally, is in hydraulic contact with them. At well 2/1&-- 4A2 (Palisades del Rey Water Co. well 4) the main water-hearing zone is about 130 feet thick, and its top is about 30 feet above sea level. The log for this well is considered to be representative and is- shown qn plate 30.

The Palisades del Rey Water Co. pumps water from two fields. The field in 2/15-34K is about 0.4 mile from the ocean; there two wells have been drilled, of which one (2/16-34Kl) is now active. The other field, in 2/15--34A and 2/15--27R, is about 0.9 mile from the ocean and about 0.5 mile from the escarpment; there four wells have been drilled, and one (2/15-34Al) is now active. Of the two fields, that in 2/15--34K is the older; well 2/15-34Kl (Palisades del Rey Water Co. well 1) was

drilled in 1924. The first well in field 2/15-34A (2/15-34Al) was drilled about m 1930.

Waters yiel ed from the two fields were chemically alike and ranged from sodium, calcium· bicarbonate to sodium bicarbonate ,vaters, although in the availab\_le analyses sodium always made up at least 44 percent of all the bases·. In these waters under native conditions, the sulfate content was usually less than 40 ppm. Good series of chloride determinations are available for wells 2/15-34Al and 34Kl and are plotted on figure 15. As shown in these chloride analyses, both wells became definitely contaminated by 1945, and well 2/15-34Al was incipiently contaminated in the early thirties. Contamination now is much more s rious at well 2/15-34Kl, not only because the chloride content is neatly twice; that at well 2/15-34Al, but also because the rate of contamination increase is many times greater, as indicated by the slope of the chloride graph. ·

A striking difference in character change of the two waters is shown by the graph of bicarbonate in water from the two wells (fig.15). In 1929, both wells yielded water containing over 300 ppm of bicarbonate.

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FIGUBE 15.-0hloride and bicarbonate content of waters from wells 2/15-34Al and 34Kl (Palisades del Rey Water Co, wells 3 d 1).

By 1932, the bicarbonate in well 34Kl had decreased to about 150 ppm; well 34Al remained about the same through the period of record. Since about 1940, well 34Kl has shown an increase in bicarbonate to almost 200 ppm. The loss in bicarbonate in water from this well is accompanied by a loss of bases, chiefly in calcium and to a minor degree in sodium. It is interesting to note that the bulk of the bicarbonate loss in well 34Kl occurred during a period-of very slight chloride increase. A possible explanation of the chemical behavior of this well is that the aquifer tapped by the well was being partly recharged by local rainfall on the sand-dune area. The San Pedro formation here is known to be in local hydraulic contact with the sand­ dune deposits (p. 125, pl. 13).

Because the chloride increase in water from well 34Kl has become pronounced since 1945, with no corresponding gain in bicarbonate, it is tentatively concluded that the well is now within the area con­ taminated by ocean water. Furthermore, because the well is now within the area in which a regional inland gradient exists, it is expected that it soon will yield water unfit for use.

**WELL FIELD OP THE CITY OF BL SEGUNDO**

**PERTINENT GEOLOGIC FEATURES**

At the well fields of the city of El Segundo in sec. 12, T. 3 S., R. 15 W., two distinct water-bearing zones in the deposits of Pleistocene age are tapped by wells. Recent deposits here consist solely of sand dunes and are non-water-bearing. The upper of the two Pleistocene aquifers is the "200-foot sand" of the unnamed deposits of upper Pleistocene age; here it ranges from 30 to 40 feet in thickness. The lower aquifer is the Silverado water-bearing zone and ranges from 70 to 140 feet in thickness. At the main well field of the city **of** El Segundo in 3/15-12L, only the upper 30 to 40 feet of the Silverado water-bearing zone is sufficiently coarse to permit perloration of well casings; the lower part, which is as much as 100 feet thick, consists of fine sand and some silt. In the NE¼ sec. 12, the logs of three municipal wells indicate a much more irregular lithology. Here also, the upper 30 to 40 feet of the Silverado water-bearing zone is permeable sand and gravel; however, in two of the three wells a basal gravel is present which is sufficiently permeable to yield water. The Silverado water-bearing zone is separated from the "200-foot sand" in the upper Pleistocene deposits by an impervious clay layer which is 15 to 40 feet thick. Both aquifers here dip gently southward (pl. 30).

**SUMMARY OF NATIVE WATER QUALITY**

Inland from the coast, toward the axis of the syncline underlying the Torrance plain (pl. 2), it has been possible to distinguish between the quality of the water in the unnamed upper Pleistocene deposits

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and that of the water in the Silverado water-bearing zone beneath, because chemical analyses are available for waters from certain wells tapping the upper zone only and from other wells tapping the Silverado zone only. In sec. 12, T. 3 S., R. 15 W., however, all wells tap both zones and thus yield blends of waters from the two aquifers. Neces­ sarily, therefore, a description of native conditions here will be confined to these blended waters. An analysis of water from well 3/15-12Ll, sampled March 4, 1930, is- selected as representative of the native water-throughout the local extent of the tapped water-bearing zones. From this analysis and from others, made before contamination had become more than incipient, it is inferred that these· waters ranged about from 390 to 425 ppm in dissolved solids and contained less than 100 ppm-probably from 85 to 92 ppm-of chloride. The early

{1929-30) analyses of water from wells of this field, particularly those from well 12Ll, show an interesting fluctuation in sulfate content. For example, the analysis of 12Ll for February 13, 1931, s:µows that sulfate is absent. Other analyses of water from 12Ll for that period show that sulfate ranged from a trace to 35 ppm.

**PROGRESS OF WATER-QUALITY DEPRECIATION**

Table 21 lists all the wells drilled by the city of El Segundo and gives their status in 1946. Of the ten wells listed, seven were drilled at the main field near the city's water treatment plant at Grand Avenue and Maryland Street; only two wells, 12L5 and 12L7, were active in 1946. Of the other three wells, two are about 0.4 mile northeast of the main plant, and well 12Bl, the latest one drilled, is about 0.2 mile :Oorth of the first-mentioned wells. All three are now active. Chloride analyses for wells 12Ll, 12L3, and 12L6, plotted

TABLE *21.-History and chloride content of public-supply wells of the city of El Segundo*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Well | | Date drilled  ---  1920  1924  1930  1938  1939  1939  1939  1942  1944  1945 | Chloride content | | Date aban- doned | Reason for abandonment |
| USGSI | City of El  Segundo | Initial 2  analysis 1  --- | Latest a analysis |
| 3/15-12LL  12L2 --  12L3  12L4 ---  12G2  12Gl •  12L6  12L5 ----------------\_-- --  12LB7l ----------------------- |  |  |  |  |
| 1 | 100 | 304 | 1939 | Caved in. |
| 2 | 98 | 123 | 1937 | Do. |
| 3 | 104 | 211 | 1940 | Do. |
| 4 | 430 | 430 | 1938 | (4) |
| 5 | 113 | 138 | (•) |  |
| 6 | 128 | 86 | (•) |  |
| 7 | 157 | 886 | 1945 | Became saline. |
| 8 | 116 | 245 | (•) |
|  |
| 9 | 151 | 219 | (•) |  |
| 10 | 82 | 86 | (•) |  |

1 United States Geological Survey.

2 Earliest analysis available. a Latest analysis available.

4 Abandoned at time of drilling; water too saline for use. a Active in December 1946.

**CitEMICAL CHARACTER OF WATERS 219**

on figure 16, show the development of contamination at the main field. Because of the fluctuation in chloride content for well 12Ll in 1930-31, it is thought that contamination was then incipient; by 1936 the increase in chloride content was positive. However, only in well 12L6 did salinity increase to a degree that made the water unusable. Wells 12Ll and L3 were abandoned because **of** mechanical difficulties; doubtless, the salinity of the water yielded by these wells would have increased appreciably above the amounts shown on the graph if pumping had been continued.

The two active wells at the main field as of 1946 (nos. 12L5 and 12L7) both yielded water containing more than 200 ppm of chloride at the end of that year. As shown by the graphs (fig. 16), the chloride content was about stable to mid-1946, and then it increased substan­ tially. It is believed that if these wells are pumped almost continu­ ously, within a relatively short time the chloride will increase at an accelerated rate-similar to the increase shown by the graph for well 12L6 in 1944-45 (fig. 16). Both of these active wells tap the same water-bearing zones that are tapped by wells 12Ll, L3, and L6 (which were abandoned earlier). As shown later (p. 224), although both water­ bearing zones are about equally contaminated, the upper of the two zones may be slightly more saline. Figure 16 also shows the chloride concentration of waters from wells 12G1 and 12G2. In contrast to chloride graphs for wells at the field in 3/15-12L, the graphs for both wells in 12G show a decrease in salinity (to a greater extent in well G2 than in well Gl). Well 12Gl yields more water from a stratigraphi­ cally lower part of the Silverado water-bearing zone than any other city well. The monthly combined withdrawal for the two wells also has been plotted on figure 16. It will be noted that the chloride decrease has occurred over a period when withdrawals were nearly constant.

**CHEMICAL FEATURES OF CONTAMINATION**

As described earlier, at the main field of the city of El Segundo the trend of contamination is toward ever-increasing salinity and resultant abandonment of the wells; however, at the more recently developed field to the northeast in 3/15-12G, the trend since about 1941 is toward a decreasing salinity. In well 12G1 the water has almost re­ turned to its native character. For all the wells of the city of El Segundo, the following description treats the manner in which con­ tamination has occurred and suggests a possible source of this con­ tamination. Although the analyses for any single well do not span the entire period of record, a series has been selected arbitrarily to show progressive increase in chloride content. These analyses have been plotted on a trilinear graph (fig. 17) which shows the salinity trend at the main field. Although some departure from a definite

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| WELL | |
| USGS | CITY OF EL SEGUNDO |
| 3/15-1261 | 6 |
| 12G2  Iii: | **5**  I  3 |
|  |  |
| 12L6 | 7 |
| l2L7 | **9** |

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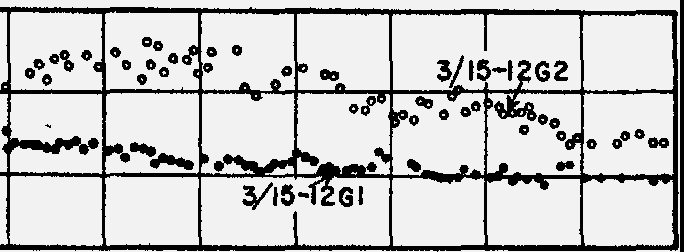
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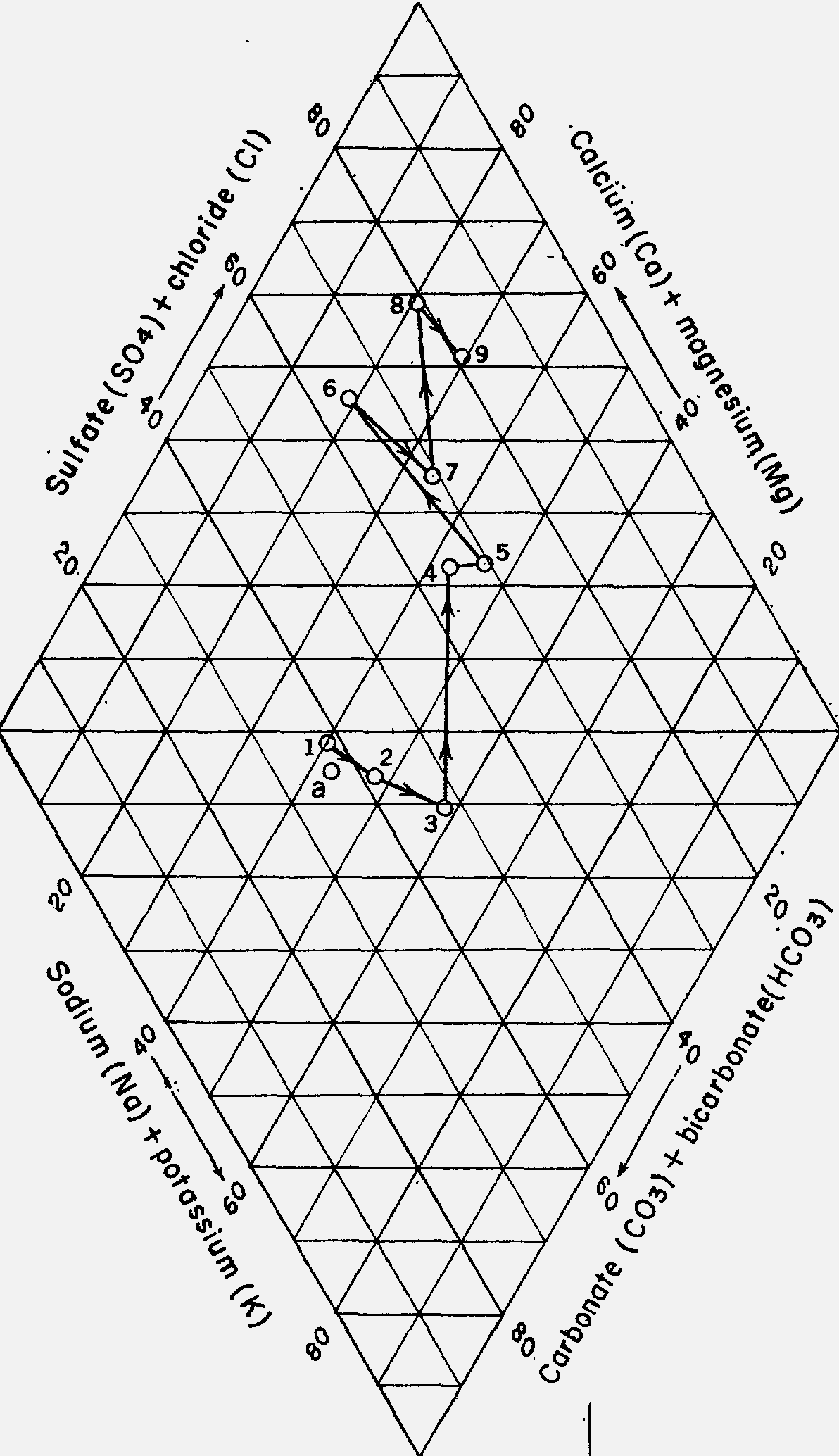
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1930 1932 1934 1936 1938 1940 1942 1944 1946

FIGVRE 16.-0hloride content of waters from seven public-supply wells of the city of El Segundo.

CHEMICAL **CHARACTER OF· WATERS 221**

|  |  |  |  |
| --- | --- | --- | --- |
| No. | Well | Date | Chloride, parts per million |
| -a  . 1  2  3  4  5  6  .7  8  9 | (3/1S:.12G1)  12Ll  12L2  12L2  12L3  12L6  12L6  12L6  12L6  .12L6 | .Feb. 25, 19  ·Nov. 25, 19QQ  Sept. 11, 1930  Mar. 9, 1931  July 24, 1939  Jan. 4, 1940.  Sept. 2, 1942  Apr. 24, 1943  Feb. 25, 1945  Oct. 24,·1944 | 92  92  104  123  157  181  208  220  420  520 |

**FIGUBE** 17.-Chetnlcal character of native and progressively contaminated waters at the main well field of the city of El Segundo.

trend occurs, in general, as contamination progresses, the water is enriched chiefly in chloride and in calcium. Inasmuch as no)nown calcium-chloride contaminant is known to exist locally, it is assumed that the contaminant is a sodium-chloride saline in which base ex­ change has occurred during blending with the native water.

**To** determine the source of contamination at this field, use is made of the chloride-bicarbonate ratios of the progressively contaminated waters for which the analyses have been plotted on figure 17. Figure 18 shows these ratios plotted against the chloridecontent;hypothetical

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|  |  | 2/15-12G2 |  |  | *v•* |
| -<?- Hypothetical ratio, oil-field brine/ | | |
|  | 0  0 | 0  0 |  |  |  |
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CHLORIDE, PARTS PER MILLION

FIGURE 18.-Chloride-bicarbonate ratios **of** progressively contaminated waters at the main well field **of**

the city of El Segundo.

ratios for a sea-water mixture and an oil-field brine mixture with a native water are plotted also. Sea water is strongly suggested as the source of contamination. That is, for the contaminated water con­ taining 520 ppm of chloride, the Cl-HC0 3 ratio is 3.58; for the ocean­ water and brine mixtures with native water, computed to the same chloride concentration, the ratios are 3.21 and 2.49, respectively. The points representing the actual analyses fall on a reasonably well defined curve which approaches the point representing the ocean-water mixtures more closely than that representing the oil-field brine mixture. The analysis used in computing the hypothetical mixture of brine and native waters was furnished by the Richfield Oil Corp. The water analyzed was from Richfield well El Segundo No. 2 (in 3/14-lSG) and was yielded through perforations from 7,243 to 7,319 feet below

the land surface-presumably from rocks of upper Miocene age (pl. 7). The constituents cited below were determined from a sample collected and analyzed by the Richfield Oil Corp. for the Geological Survey; quantities are reported in parts per million (except pH which is reported in percent):

***Parts per million Parts per million***

Silica 81 Iron and aluminum oxides\_ \_ \_ \_ \_ 3

Chloride 9,390

Dissolved solids 24, 561

Hydroxyl

Carbonate

0 Suspended solids

0 Water soluble organic matter

**207**

Bicarbonate 1,946 (approx.) **5,300**

Sulfate 26

1 In **percent.**

pH

1**7 8**

.Although the trend in chloride-bicarbonate ratios suggests ocean water as the contaminant, the other possible diagnostic constituent, sulfate, is not entirely confirmed by table 22. In the table, the actual sulfate content of the progressively contaminated waters is compared with the suHate content that would be present if sea water alone had caused the chloride increase. In most of the contaminated waters sul­ fate is shown to be present in excess; this fact suggests a source of sulfate in addition to that brought in with sea water.

TABLE *22.-Comparison of actual and hypothetical sulfate content in progressively contaminated waters in the main well field of the city of El Segundo*

|  |  |  |  |
| --- | --- | --- | --- |
| Well | Date of sample | Chloride (ppm) | * -Sulfate (ppm-}-1Excess(+}   or deft•  ciency *(* - )  Actual Hypo- of sulfate  thetical 1 (ppm) |
| 3/15-12LL •.•...•.•.•••••..•.••.••••••• Nov. 25, 1930  12L2. Sept. 11, 1930  12L2.••..•..••...•.•...•...•..•...• Mar. 9, 1931  12L3............................... July 24, 1939  12L6..•...........••........•.•.... Jan. 4, 1940  m12t::=L==6=.=.=..=.=.=.=..=.=.=..=.=.=..=.=.=.=..=.=.=..=.=.=..=. iFieb·. J25:,!1945  12L6............................... Oct. 24, 1944 | | 92  104  123  157  181  208  220  420  520 | 14 ·•·•••·•···· ······-····· 19 14 +s  17 18 -1  60 23 +37  90 26 +64  20 30 -10  76 32 +44  97 60 +37  119 74 +45 |

1 Computed from a hypothetical mixture of sea water and a native water *ef* 14 ppm sulfate, for which mixture the chloride content is identical to that of the actual contaminated water under comparison.

In regard to contamination at wells 1201 and 1202, the salinity increase has not yet become sufficiently intense that the source can be identified. It is inferred that the cause of contamination is the same at the two fields. If such is the case, the chemical character of the contaminated waters would be expected to be the same in both areas. As a check on this inference, the analysis of water from well 1202 for February 7, 1942, has been selected for comparison. This analysis represents the most saline water of record taken from this well. The chloride-bicarbonate ratio for well 1202 plotted on figure 18 falls close to the generalized curve. The value of 74 ppm for sulfate

is in excess of that brought in by sea water by about the same amount as in the wells in the main field (in 3/15-12L).

For the main field, the Geological Survey in 1945 conducted a series of pumping tests on well 12L6 in order to determine, if possible, which of the two water-bearing zones tapped would yield water of better quality. Figure 19 shows the electrical-conductivity values

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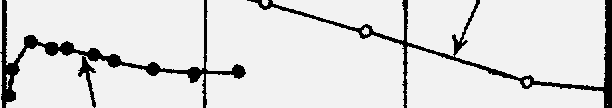
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Pumping test Sept. 5, 194 5;

perforations 2 z **2-248** and L-- ----i =:::i===== ===:!..-

298-318 **feet** below land surface

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FIGURE 19.-Character of water discharged from well 3/15-12L6 (city of El Segundo, well 7) during pumping

tests **of** September 5 and October 30-31, 1945.

obtained from two separate tests, on September 5 and October 30-31, 1945. During the test on September 5, the well yielded water through perforations from 222 to 248 feet and from 298 to 318 feet below land surface. The lower perforations were then plugged, and during the test of October 30-31 the well yielded water from only the shallower of the two water-bearing zones. The test of September 5 is believed to have been too short for the water from the well to have reached constant quality. During the pumping test of October 30-31 the water yielded initially was poorer but after 13 hours of continuous pumping it was of better quality than that yielded during the short span of the September test. The graphs are not conclusive but the results are included here as a matter of record.

**WELL FIELDS OF THE STAHDilD OIL 00. AHD OF THE GEHERAL OIIEIUOAL 00. AT EL SEGUBDO**

The well field of the Standard Oil Co. of California is between El Segundo Boulevard and Rosecrans Avenue and is west of Sepulveda Boulevard, in sec. 13, T. 3 S., R. 15 W. Immediately east of Sepul­ veda Boulevard, in 3/14-18N, are the wells of the General Chemical Co. These two well fields are treated together here because they tap the same water-bearing zones, and conditions **of** contamination are common to both.

In this area, wells tap both the "200-foot sand" of upper Pleistocene age and the Silverado water-bearing zone of the San Pedro formation (pl. *30).* The "200-foot sand" here is about 20 feet thick, and its top is about 150 feet below the land surface and 50 feet below sea level. Commonly it is separated from the underlying Silverado water­ bearing zone by 20-30 feet of impervious silt or clay.

The Silverado water-bearing zone in sec. 13 ranges in over-all thickness from about 150 feet in the northwestern part to about 250 feet in the eastern part (along Sepulveda Boulevard). This thickness includes beds of silt or clay of irregular occurrence. In general, the Silverado zone here spans three more or less distinct parts, which in downward succession are: (1) the principal water-bearing member, which is chiefly sand and gravel and about 100 feet thick; (2) an interbed of silt or clay from 20 to 50 feet thick; and (3) a basal mem­ ber, which consists of alternating thin layers of sand, gravel, and silt, about 100 feet thick. The bottom of the Silverado zone is about 300 feet below sea level along Sepulveda Boulevard (pl. 2). Logs of wells in 3/15-13D and 14A, about 0.7 mile from the coast, suggest that the basal member grades westward into a layer of nearly uniform silt, and that· the thickness of the upper member of the Silverado zone decreases to about 70 feet; the character of the zone here is similar to that at the main well field of Manhattan Beach, 2.4 miles southeast.

**SUMMARY OF NATIVE WATER QUALITY**

In the "200-foot sand," water is inferred to have been somewhat inferior under native conditions. As of 1903-4, a well in the southeast angle of the intersection of Rosecrans Avenue and Sepulveda Boule­ vard (Redondo, no. 150), which tapped the "200-foot sand," yielded water containing 630 ppm of dissolved solids. This well was about

1.4 miles inland from the ocean. Because of the comparatively poor quality of water in the "200-foot sand" in this area, it has been tapped by few wells. For the well fields here discussed, only three are known to have yielded water from this zone-wells 3/14-18N3 and 18N4 of the General Chemical Co. and well 3/15-13Hl of the Standard Oil Co. All other wells of these two companies tap solely the Silverado water­ bearing zone; some tap the upper part, some the basal part, and some tap both.

In the Silverado water-bearing zone, under native conditions, two somewhat distinct water types existed in sec. 13, T. 3 S., R. 15 W. In the western part of sec. 13 and in the northeastern part of sec. 14, the native water was similar to but perhaps of somewhat poorer· quality than that at the city of El Segundo main well field. Both waters contained about 400 ppm of dissolved solids, were calcium, sodium bicarbonate waters and contained substantially equal quan-

tities of chloride; however, the waters at the Standard Oil Co. field may have been somewhat higher in bicarbonate, with a corresponding increase in calcium and sodium. In the eastern part of sec. 13, where nearly all the producing wells of the company are now located, the native water was of somewhat better quality than those described above. These native waters ranged from sodium, calcium bicar­ bonate to sodium bicarbonate in character and contained from 330 to 375 ppm of dissolved solids and from 50 .to 60 ppm of chloride. This difference in quality in the two parts of the field is presumed to result from the deeper penetration of wells in the eastern portion of the section; these waters from the deeper part of the range penetrated agree closely in quality with those that have been yielded from the Silverado water-bearing zone to the east. With respect to sulfate content, a slight difference existed in native waters from the two parts of the field. To the west, they contained about 15 ppm; to the east, the content was probably less than 10 ppm in the upper part and was negligible in the lower part of the range penetrated.

**HISTORY OF WELL DRILLING AND ABANDONMENT**

Since the first two wells of the Standard Oil Co. were placed in operation in 1914, withdrawal of water from the field has been con­ tinuous and has increased in quantity until, as of 1945, the 11 active wells yielded 4,780 acre-feet of water. Table 23 lists the 25 wells drilled by the company before 1946 and shows their status as of January 1946 and the chloride content of their water. For the six producing wells abandoned by 1930, the latest analysis indicated chloride in excess of 200 ppm in each; for the five wells abandoned from 1930 to 1946, only one appears to have yielded water containing more than 200 ppm of chloride at the time of abandonment. At least three of the latter group were abandoned because of mechanical difficulties or gradually diminishing yield. Although the various reports seem inconclusive, it appears that company wells\_ 1 to 8 were abandoned because of excessive salinity. By 1922 salinity became apparent in this area, several years earlier than anywhere else along the coast. For the contaminated but still active wells along the east edge of sec. 13, the salinity increase is only slight; generally an increase in dissolved solids of not more than 25 percent has occurred.

**CHEMICAL FEATURES OF CONTAMINATION**

A study of the analytical data available for the wells in sec. 13,

T. 3 S., R. 15 W., and also for those adjacent to the east, has dis­ closed that the contaminated waters there are of two general types with respect to change in chemical character and time of such change.

TABLE *23.-History and chloride content of wells at the Standard Oil Co., El Segundo refinery*

Well Chloride content (parts per million) Date

Date aban-

drilled doned

Company USGSI Initial 2 Date Latest Date

l\_ 3/15-13DL

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 2\_ ---------------- | 13D2------------- | 1911 | 188 | 1921 | 255 | 1921 | 1922 |
| 3 ------------- | 14A2.-- -------- | 1917 | 90 | 1920 | 950-125 | 1923 | 1924 |
| 4a  **4b** | 14Al  13EL | 4 1920 -----------  1920 89 | | ----------  1921 | -----------  2,400 | ----------  1930 | 1920  1930 |
| **5** -- ------ | 13FL | 1922 | 248 | 1922 | 664 | **1929** | 1929 |
| 6 -------- | 13G\_L ----------- | 1923 | 58 | 1924 | 194 | 1942 | 1943 |
| 7 ----------------- | 130\_2. ----------- | 1928 | **118** | 1928 | 620 | 1939 | 1939 |
| 8. ---------------- | 13F2 ---------- | 1929 | 510 | 1929 | 505 | 1929 | 1929 |
| 9\_ ---------------- | 13RL | 1930 | 60 | 1930 | 60 | 1943 | 1944 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1930 | 92 | 1930 | 92 | **1940** | 1940 |
| 1935 | 92 | 1935 | 202 | 1945 | (1) |
| 1937 | 86 | 1937 | 198 | **1944** | 1944 |
| 1939 | 96 | 1939 | 224 | 1944 | (6) |

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| --- | --- | --- | --- | --- | --- | --- |
| 13H2 | 1940 | 102 | 1940 | 70 | 1946 | (8) |
| 13A3 | 1941 | 86 | **1941** | 160 | **1945** | (8) |
| 13R2 ---------- | 1941 | 170 | 1941 | 104 | 1946 | (8) |
| 13R\_3. ----------- | 1941 | 86 | 1941 | 141 | 1946 | (8) |
| 14-19CL 1943 121 1943 112 1946 (8) | | | | | | |

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|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 19 --------\_-- -- 3/15-13R4. ---------- | 1943 | 72 | 1943 | 109 | 1946 | (8) |
| 20 13R5  21 -- 13J\_2. ------------ | 1944  1944 | 68  **83** | 1944  1945 | 75  92 | 1946  1946 | (8)  (6) |
| 22 13R6\_. | 1945 | 70 | 1945 | 68 | 1946 | (8) |
| 23 ----- 13J\_3. ------------ | 1945 | 97 | 1945 | 119 | 1946 | (8) |

24 --- -- 13A4

1945 95 1946 ---------- ---------- (8)

1 Unites States Geological Survey.

2 Earliest analysis available.

a An analysis is available in which the chloride content is 91 ppm; date of analysis unknown.

, Abandoned after construction because of insufficient thickness of water-bearing strata.

* Presumed inactive, but status not known definitely.
* Presumed active as of Jan.1, 1946.

1. In several of the earlier wells, not bly 3/15-13El, 13Fl, and 14A2, con-­ tamination occurred at a comparatively early date and was characterized by a somewhat sudden increase of chloride and sulfate and by an increase in dissolved, solids to more than 5,000 ppm.
2. In the wells just west of Sepulveda Boulevard, contamination has occurred

to only a slight degree and is characterized by a small increase in chloride, by only a small increase in sulfate, and by a suggested concurrent but irregular decrease in bicarbonate.

These two water types will be described separately and graphs will be presented

to show how contamination has occurred in each case. -

For the first type, in which sulfate has increased markedly, figure 20 shows the extent to which sulfate and chloride increases are coinci­ dent with the advance of contamination. To show that the sulfate content of these waters is more than that which could have been brought in by sea water, figure 21 gives chloride and sulfate analyses plotted graphically for well 13G2, also the hypothetical content of

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FIGURE 20.-Chloride and sulfate content of progressively contaminated waters from wells 3/15-13El and 14A2 (Standard Oil Co. wells 4b and 3).

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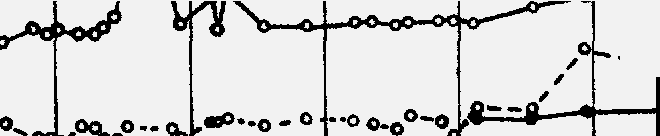
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**FioUBE** 21.-Obloride content and actual and hypothetical sulfate content of progressively contaminated waters from well 3/15-13O2 (Stand,1.rd Oil Co. well 7).

sulfate in the contaminated water if sea water had been the sole contaminant. The graph for this well shows that sulfate increase began in 1933; definite chloride contamination began in 1935. As of 1939, the increase in sulfate was about five times as great as that which would have been brought in by sea water. Obviously a high­ sulfate contaminant must have contributed to the deterioration of the water in these wells.

Thl:, Standard Oil Co. conducted pumping tests in 1923, 1929, and 1930, respectively, for three wells that yielded contaminated water at an early date-3/15-14A2, 13F2, and 13El; a series of water samples was collected from each of the wells until the quality of the effiuent became constant. Each well tapped the Silverado water­ bearing zone. Figure 22 shows the chloride analyses plotted for the three wells. Presumably, the pump had been idle for severaldays prior to each test. The following facts are significant:

1. **The** water yielded initially from each well was highly contaminated, but

the water taken in the succeeding samples improved substantially in quality.

1. For each well, the water representative of the Silverado water-bearing zone at the time of the test contained less than 350 ppm of chloride; this water was yielded only after extended pumping-8 hours for well 13El and about 160 hours for well 14A2.

Accordingly, it is inferred that the water causing the contamination was coming from a source outside the Silverado zone; and that, while each pump was idle, a relatively small amount of the contaminant moved through the well casing and collected within the Silverado zone immediately outside the well casing. With continued pumping, the supply of concentrated contaminant was exhausted, and the water then yielded indicated the concentration of the regional contaminant in the Silverado zone. If the more concentrated contaminant had\_ been invading the Silverado zone directly, the water quality would have deteriorated or remained about constant during prolonged pump-. ing, because the saline water would have been replenished as rapidly­ as it was withdrawn. Contamination of this nature has been en-. countered in Santa Ana Gap and was described in an earlier report (Piper, Garrett, and others, 1953, p. 115-118).

The graph for well 14A2 in 1923 shows a regionally contaminated\_ water contaio.ing about 120 ppm of chloride-little more than the native chloride concentration of about 90 ppm. For the three wells, a local source of contamination apparently supplied a small amount of­ highly saline water; the water yielded after prolonged pumping re-. fleets the regional contamination in the Silverado zone, which con-. tained less than 200 ppm of chloride in the middle twenties and 200 to

400 ppm about 1930. It is inferred that the more concentrated contaminant withdrawn through the wells during the first hours ot

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FwtTRE 22.-Chloride content of waters from wells 3/11H3El, 13F2, and 14A2, in relation to duration of pui;nplng. >

pumping must have entered the Silverado zone by passing down through the well casings from the overlying "200-foot sand." Because the well casings were not perforated opposite this overlying aquifer, the concentrated contaminant must have entered the casing through leaks.

As a further demonstration of the type of contamination occurring here locally, table 24 compares the contaminated water from well 3/15-13El with a hypothetical water formed by a mixture of ocean water and a native water to the same chloride content. The table shows that a large excess of sulfate is present in the contaminated water, also that a large excess of calcium and magnesium is present above that which could be accounted for solely by base exchange fol­ lowing ocean-water contamination. The excess of calcium and mag­ nesium amounts to 14.13 equivalents per million, and is nearly equal to the sulfate excess of 14.26 equivalents per million. Hence, the local contaminant was doubtless a calcium sulfate or calcium, mag­ nesium sulfate water at the time of mixture with the ground water.

TABLE *24.-Contaminated water from well 3/15-1.'1JE1 (Standard Oil Co., well 4b) in comparison with a hypothetical mixture of a presumed native water with ocean water*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Constituents (ppm) | | | | | |
| Calcium (Ca) | Mag- nesium (Mg) | Sodium (Na) | Bicar- bonate (HCOa) | Sulfate (S04) | Chloride  (Cl) |
| Parts per million:  Native water, well 3/15-13DL  Contaminated water, well 3/15-13El;  analysis of June *5,* 1930  Hywpioththneatitcivale mwaixteturre of ocean water Equivalents per million:  Native water, well 3/15-13DL  Contaminated water, well 3/15-13El;  analysis of June 5, 1930  Hypothetical mixture of ocean water with native water  Excess (+) or deficiency (-) of the  contaminated water with respect to the hypothetical mixture | 54 | 19 | 62 | 252 | 12 | 91 |
| 400 | 260 | 1,181 | 230 | 1,020 | **2,400** |
| 96 | 172 | 1,371 | 238 | 335 | **2,400** |
| 2. 70 | 1.56 | 2.69 | **4.13** | 0.25 | 2.57 |
| 19.96 | 21.38 | 51.36 | . 3. 77 | **21.23** | 67. 70 |
| 4. 79 | 14.14 | 59.64 | **3.90** | 6.97 | **67.70** |
| +15.17 | H.24 | **-8.28** | **-.13** | +14.26 | ---------- |

For the wells along th\_e eastern boundary of the Standard Oil Co. property, just west of Sepulveda Boulevard, contamination has been far less intensive, and at least three wells-3/15-13H2, J2, and R5- yielded essentially native water as of January 1946. Graphs showing the chloride content of waters from these wells have been presented on figure 23. Wells 3/15-13Al, !2, and A3 all tap essentially the entire thickness of the Silverado water-bearing zone, which here is only about 100 feet thick. The graph for well 13Al suggests a slight but reasonably consistent increase in chloride from 193\_1 to 1939; those for

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| -  - | **3/15·13AI**  13A2  13A3  13A4  13HI  13H2  13,JI  13J2  13J3 l3RI 13R2  13R3  13R5 | | 10  13  **15**  **24**  12  14  II  21  23  9  16  17  20 | |  |  |  |  |  |  | | 13HI | ( | |  |  |  |  |
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FIGURE 23.-Cbloride content of waters from selected wells of the Standard Oil Co. at El Segundo.

wells A2 and A3 indicate a sharp increase in chloride in the early forties. The greatest recorded concentration of chloride for well 13A2-268 ppm-was accompanied by a sulfate content of 66 ppm; this is considerably more than that which could have been brought in with ocean water. For wells 3/15-13Hl and 13H2, the graphs show that definite contamination has occurred at well 13Hl, and that well 13H2 yielded essentially native water as of January 1946. Well 13Hl taps the full range of the Silvera.do zone, and well H2 taps only the basal part. Thus, the contamination here is in the upper part of the Silverado zone.

Of the three wells 3/15-13Jl, 13J2, and 13J3, well 13Jl taps the full thickness of the Silverado water-bearing zone, well 13J2 taps the middle part, and well 13J3 taps the middle and lower parts. Well 13Jl became contaminated in 1943, and the other two were incipiently

·contaminated in January 1946; here, also, the upper part of the Silver-

ado zone is the most saline. Of wells 3/15-13Rl, 13R2, 13R3, and 13R5, well 13Rl taps about the middle part of the water-bearing zone, 13R2 taps only the lower part, 13R3 taps the upper part, and 13R5 taps both the middle and lower parts. The water from well 13R3 is the most saline; this fact indicates that here again the water in the upper part of the Silverado zone is markedly of poorer quality than that from the middle and lower parts. Contamination in the upper part of the zone in 13R began in late 1941, and therefore, it is roughly

-coincident with the onset of contamination adjacent to the north.

To the east, at the property of the General Chemical .Co. in 3/14- lSN, an analysis of water from well 18N3, in 1930, suggests that here,

:as to the west, waters contained about 60 ppm of chloride under native

-conditions. Of the three wells of the General Chemical Co. for which

-chemical analyses are available, wells 3/14-18N3 (company well 3)

.and 18N4 (company well 4) tap both the "200-foot sand" in the unnamed upper Pleistocene deposits and the Silverado water-bearing

:zone beneath. Inferentially, well 18N5 also taps both zones. Be­

-cause of the low chloride content of water initially yielded from 18N3 (about 60 ppm), that well probably drew most of its water from the Silvera.do zone and drew a comparatively minor part from the "200- foot sand."

To show the progress of contamination at the well field of the General Chemical Co., chloride determinations on waters from the three wells have been plotted on figure 24. The graph for well 18N3 indicates that contamination here reached a peak in 1940 and since

.then has decreased markedly; as of January 1946, water from these wells was only very slightly contaminated.

If the graphs of figure 24 are compared with those of figure 23, it will be noted that this contamination peak occurred not only in well

.3/14-18N3, but also in wells 3/15-13A2, 13A3, and 13Hl, of the Standard Oil Co.; for these latter three wells, however, the peak

-occurred about in 1942, 2 years later than in well 18N3. This con­ tamination seems to be superimposed on a regional trend toward increasing ground-water salinity which, as of 1945-46, was only moderate. In an attempt to discover whether this superimposed

-contamination showed a sulfate-chloride pattern similar to that in

-several of the early wells of the Standard Oil Co. (fig. 21 and p. 231),

-computations were made to determine, for periods of peak salinity, whether more sulfate had entered the wells than could be accounted for if sea water were the sole contaminant. The data concerning

-sulfate excess or deficiency for the four wells is given in table 25. The data contained therein indicate that the sulfate content during peak salinity was in excess of that to be expected from an ocean­ water blend, and that the sulfate-chloride pattern was essentially

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FIGURE 24.-Chloride content of waters from wells 3/14-18N3, 18N4, and 18N5 (General Chemical Co.,

wells 3, 4, and 5).

similar to that of the earlier contaminant in wells 3/15-13El and 14A2, about a mile to the west. For wells 3/15-13A2, A3, and Hl (fig. 23), the chloride peaks of 1942 had essentially disappeared as of mid-1943, and for each well the chloride concentration had returned to the projected normal increase in regional contamination. Fur­ thermore, the abn-0rmal chloride concentration began and ended within a period of 2 years in wells 13A2 and A3 and within one year in well 13Hl.

For well 3/14-18N3, the chloride peak of 1940 had essentially disappeared as of 1942. However, as shown by figure 24, the chloride content of waters from the wells of the General Chemical Co. con­ tinued to decrease from 1942 into 1946, this fact indicates that the regional contamination front had not yet reached this well field by the end of 1945. Also, as of 1945, the sulfate content of water from the General Chemical Co. wells was only slightly greater than normal; this indicates that the local contaminant has been almost entirely removed or dissipated.

Probably this high-sulfate contaminant is not the cause of the regional contamination, which has progressed much more gradually, and which, for the active wells near Sepulveda Boulevard, has' re­ sulted in a maximum concentration only slightly in excess of 200

TABLE *25.-&ulfate content of contaminated water from certain wells in sec. 18,*

*T. 3 S., R. 14 W., and sec. 13, T. 3 S., R. 15 W., in comparison with hypothetical sulfate content resulting from mixture of a presumed native water with ocean water*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Well | | Analysis (parts per million) | | | Sulfate con- tent result- ing from mixture with sea water (parts per million)' | Excess(+) or deficiency (-) of the contami- nated water with respect to thehy- pothetical mixture (percent) |
| Date | Chloride (Cl) | Sulfate (SO4) |
| 3/14-18N3•••••••••••••••••••••••••••  3/15-13A2•••  13AH3l•. • | | Apr. 24, 1940  Jan. 23, 1943  Dec. 22, 1942  June 24, 1942 | 246  268  134  364 | 43  66  13  64 | 31  34  lo  48 | +39  +94  **-13**  +a3 |
|  |  |

**1 Based** on a native water with presumed chloride and sulfate content of 60 and 5 ppm, \_respectively.

ppm of chloride-in wells 3/15-13A2. As for the wells of the city of El Segundo, ocean-water intrusion is inferred to have caused the regional contamination, although the change in chemical character of the contaminated waters from the wells near Sepulveda Boulevard has not been great enough to furnish diagnostic proof of such a source. The source of the high-sulfate contaminant is not known. How­ ever, from the occurrence and movement of this contaminant, as described in previous pages, it is inferred that it originated at or near land surface. If waste water containing sulfuric acid were discharged at land surface, it would be neutralized by downward percolation through the soil zone and surface deposits, and it would

pick up calcium and, to a lesser degree, magnesium (p. 231).

From land surface to a depth of about 140 feet, the underlying deposits are permeable dune sand or beach deposits, which rest upon the "200-foot sand" of upper Pleistocene age. Well logs indicate that a bed of silt, 10 to 30 feet thick, underlies the "200-foot sand" and separates it from the Silverado zone beneath. Thus, some of the water discharged at land surface doubtless could have seeped through the dune sand to the "200-foot sand" and could then have moved laterally on top of the subjacent silt bed. The lateral move­ ment would have been in the direction of ground-water flow. Down­ ward movement into the Silverado water-bearing zone would occur only where the silt bed was absent, or where it could move through defective well casings.

It is inferred that the high-sulfate contaminant, which has been described in waters from wells 3/15-13El, 13F2, and 14A2 (p. 227), was derived by downward percolation to the "200-foot sand" and entered these wells through defective or leaky casings. It is inferred further that between the early twenties and the early forties, this high-sulfate contaminant migrated eastward about 1 mile to wells 3/15-13A2 and 13Hl (company wells 13 and 12). In 1935 the con-

taminant reached well 13G2 (fig. 23). Apparently, the "200-foot sand" is not present at well 1302, and thus, the high-sulfate con­ taminant must have migrated into the upper part of the Silverado water-bearing zone before reaching this well. Doubtless at some place west of well 1302 the "200-foot sand" is in direct hydraulic connection with the upper part of the Silverado zone.

Apparently, at the well field of the General Chemical Co. (3/14-18N) the bulk of contamination has entered the casings from the "200-foot sand," and the underlying Silverado water-bearing zone has been com­ paratively free of contamination. For example, a series of samples taken June 2, 1943, from well 3/14-18N3, during a 24-hour period of operation after a 3-month shutdown, yielded the following quantities of chloride: At start of test, 760 ppm; after pumping 1 hour, 360 ppm; after pumping 24 hours, 148 ppm. Presumably, a relatively small amount of contaminated water migrated downward through the well casing from the "200-foot sand" to the Silverado zone and was soon removed by pumping. (For a parallel example, see discussion of pumping tests of wells 3/15-13El and 14A2 (p. 229).)

**WELL FIELD OP THE CITY OP llANHATTAN BEACH**

Of the 11 public-supply wells of the city of Manhattan Beach, 6 were drilled in a small tract near the intersection of Eighth Street and Sepulveda Boulevard in the *NE¼* sec. 25, T. 3. S., R. 15 W. This tract, initially the only well field of the city, is 0.8 mile from the ocean and

* 1. miles south of the large well field of the Standard Oil Co. at El Segundo. With one exception, these six wells tap only the Silverado water-bearing zone, which here ranges in thickness from 30 feet (well 25Hl) to 120 feet (well 25A3). That exception, well 3/15-25Hl, taps 14 additional feet of coarse sand, 240 feet below the lower assigned limit of the Silverado water-bearing zone. Well 3/15-30Dl (city well 8), which is about 400 feet east of this well field, also taps the Silverado water-bearing zone.

The "200-foot sand" in the unnamed upper Pleistocene deposits was reported to be present in only one well at the main well field­ no. 3/15-25Hl (city well 1)-but it was not tapped by that well. About 1 mile east, logs of three additional wells drilled by the city­ wells 3/14-30Hl, 30A2, and 29D3 (city wells 9, 10, and 11)-show that there the thickness of the Silverado water-bearing zone ranges from 120 feet in well 30Hl (city well 9) to 250 feet in well 29D3 (city well 11); the "200-foot sand" there has been tapped by well 30Hl but the other two wells tap only the Silverado zone.

**SUMMARY OF NATIVE WATER QUALITY**

Analyses of water from wells in the main field in 1930 indicate that the water in the Silverado water-bearing zone contained from 70 to

80 ppm of chloride and 20 to *35* ppm of sulfate. It is inferred that this water was essentially native. This inferred native water con­ tained about 250 ppm of bicarbonate and 350 ppm of dissolved solids. The chloride content of waters from six of the municipal wells has been plotted on figure 25. As shown by this figure, the chloride content of water from well 3/15-25Al (city well 3) ranged from 76 to 120 ppm from 1929 to 1931; however, definite contamination did not develop until 1940 (in well 25H2). As of 1944, all wells in the main

field yielded water containing more than 300 ppm of chloride.

By 1946 only wells 25A2 and A3 at the main field were still being utilized; both yielded water containing about *500* ppm of chloride. The three municipal wells near Aviation Boulevard, however, 3/14- 29D3, 30A2, and 30Hl, as of 1946 yielded native water of excellent quality. (See table 30.)

**CHEMICAL FEATURES OF CONTAMINATION**

To show the general change in chemical character of the waters at the main well field because of the progress of contamination, selected analyses have been plotted on figure 26. The graph indi­ cates a trend characteristic of contaminated waters along the seaward margin of the coastal plain-that is, toward an increase in chloride, or chloride and sulfate, and with the ratio **of** sodium to calcium plus magnesium remaining more or less constant; for high-sodium con­ taminants, such as ocean water and oil-field brines, this approximately constant ratio could be explained only through ionic readjustment by base exchange. The starting point (well 3/14-30Dl, analysis of Oct. 20, 1938) represents a water assumed to be essentially native. As revealed by the analytical data (table 30), the drift toward the apex of the graph has resulted almost entirely from an increase in chloride; sulfate has increased very slightly, and bicarbonate has decreased. The slight increase in sulfate renders unlikely the existence of a high­ sulfate contaminant here. Thus, the two possible sources of con­ tamination are oil-well brines and ocean wat'er. The sulfate content of the progressively contaminated waters suggests that of the two sources, ocean water has been the source at this field (fig. 27). On this fig­ ure both chloride-bicarbonate and chloride-sulfate ratios have been plotted against the chloride content, as determined from all available complete analyses of the contaminated waters. Also plotted on the graph are the points showing, respectively, blends of an essentially native water with ocean water, and with a typical oil-well brine. The illustration shows two pertinent features:

1. The points representing the chloride-bicarbonate ratios of the well waters fall slightly closer to the line indicating the ocean-water blend than to that of the oil-field brine blend. For waters with chloride content of more than 450 ppm,

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| WELL | |
| USGS | CITY OF MANHATTAN BEACH |
| 3/14-3001 | 8 |
| 30HI | **9** |
| 3/l5-25AI | 3 |
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| 25A3 | 6 |
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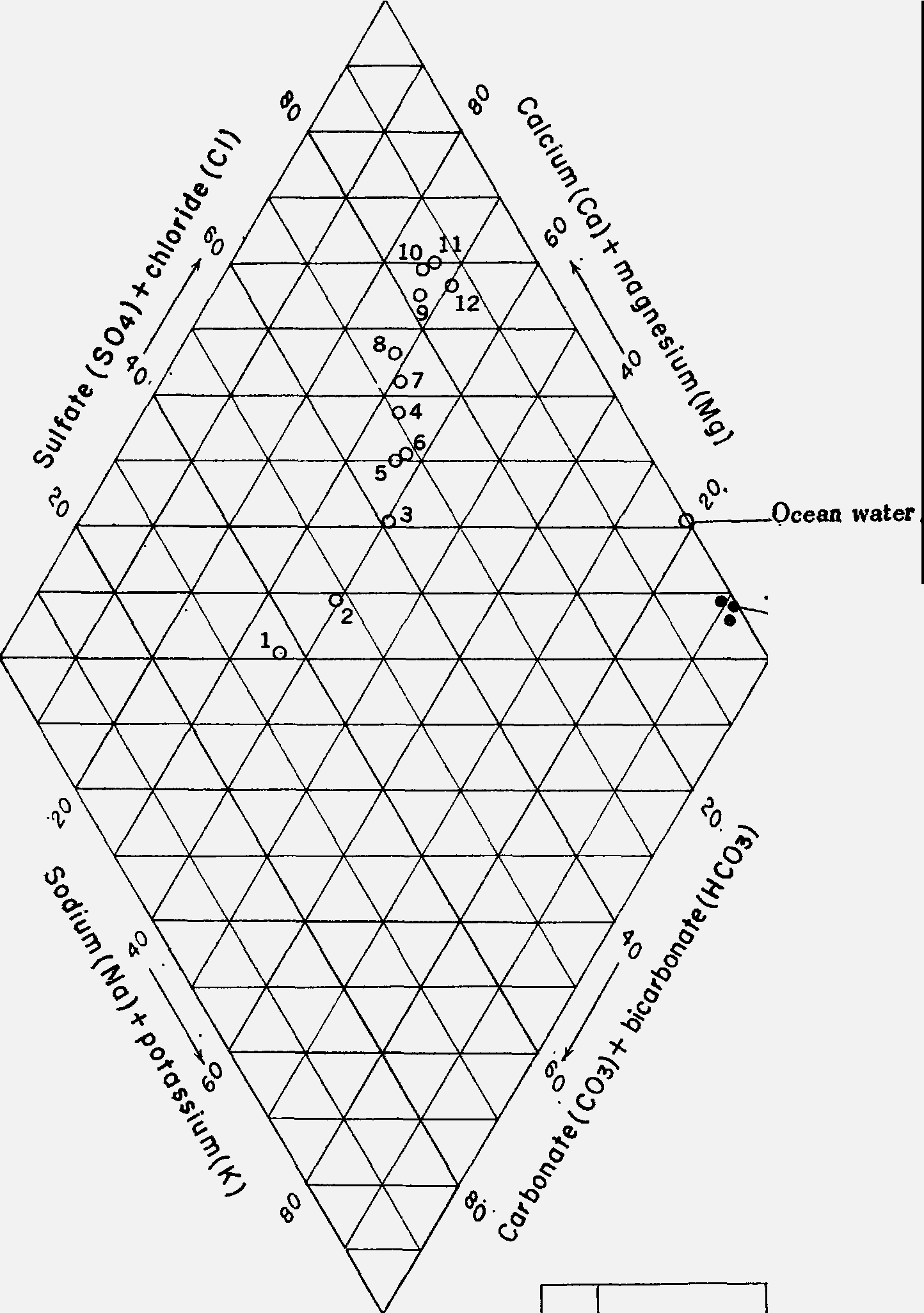
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FIGURE 25.-Chloride content of waters from selected public-supply wells of the **city of** Manhattan Beach.

"Brine from Torrance il Held

|  |  |  |  |
| --- | --- | --- | --- |
| No. | W ll | Date | Chlorid,e, parts per million |
| 1  2 | 3/14-30D1  30D1 | Oct.. 20, 1938  Mar. · 31, 1944 | 67  lll |
| 172 |
| 3 | 30Dl | Aug:· 15, 1944 |
| 203 |
| 4 | 3/15-25Hl | June' .ll, 1943 |
| 212 |
| 5 '3 | /14-30D1 | Sept.,\_25, 1944 |
| 30D1 | Oct. ·24, 1944 | 226 |
| 6 |
| 303 |
| 7 | 30D1 | Oct:. 29, 1944 |
| 371 |
| 8 | 3001 | Feb." 5, 1946 |
| -9. | 3/15-25Al | Aug. 15, 1944· | 545 |
| 10 | Sept. 25,·1944· | 561 |
| 25Al |
| 631 |
| 11 | 3/15-25A2 | Sept•. 15, 194 41 |
| 677 |
| 12 | 25A2 | Sept.- ·25, 1944 |

**Fiot11n:** 26.-Chemical character **of** contaminated waters from selected public-supply wells of the city of Manhattan Beach.

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CHLORIDE, PARTS PER MILLION

Fiou:iuc 17,-neJattoush!p of ohloride, bicarbonate, and sulfate in contaminated waters Crom pubUc-supplY wells of the city of Manhattan Beach.

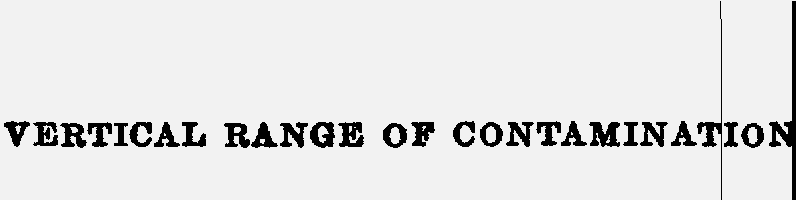
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CHEMICAL **CHARACTER OF,WATERS** 241

the digression of the plotted points from the ocean-water blend represents a decrease of bicarbonate amounting to about 7 percent. For the line indicating the oil-field brine blend the loss would have to be about 13 percent. However, this evidence certainly is not diagnostic with respect to selection between the two sources.

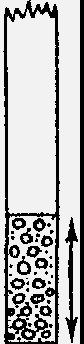
1. For values of chloride above 300 ppm the points representing the chloride­ sulfate ratios of the well waters are alined much clos to the trend of the line indicating the ocean-water blend than to that of the o I-field brine blend. That is, the contaminated well waters contain much more sulfate than could have been brought in by oil-field brines, but slightly less t n the computed amount carried in by ocean water. Of the two features, the hloride-sulfate ratio pre- sents the only definite evidence of ocean-water conta ation.

So far as is known from existing analytical data, brines from the western part of the Torrance oil field contain ost as much sulfate as the inferred native water at the main well fi ld of the city of Man.. hattan Beach. Hence, waters contaminated th such a brine would be expected to show no increase in sulfate wi h increase in contami­ nation. The analyses of the contaminated wat rs do show an increase in sulfate; however, this increase is less than that resulting from a simple blend of native water with ocean water, s shown by figure 27. This lack of agreement possibly could be expl ined to be a result **of** sulfate reduction if substantiating evidence co d be found. However, because **of** the rapidity with which sulfate red ction may occur and the difficulty of obtaining confirmatory anal ses, its occurrence at any given place is necessarily an inferential atter. However, not only does the sulfate content of these waters become greater with increase in contamination, but, as indicated b figure 27, the trend of the chloride-sulfate ratio is about paralle to the hypothetical chloride-sulfate ratio for a simple ocean-water mixture. Thus, it is concluded that ocean water is the contamina t at the Manhattan Beach well field.

*AB* described earlier, all wells at the main fie d of the city of Man­ hattan Beach, except well\_ 25Hl, yield from single aquifer-the Silverado water-bearing zone. Well 25Hl ta s both the Silverado zone and a 14-foot sand, 240 feet below that z ne. In October 1944 and in January 1945, the Geological Surve made conductivity traverses in well 3/15-25Hl to determine: (1)· any range in quality existed between the waters yielded from the two zones; and (2) if any vertical range in quality existed in the wa er entering the casing through the perforations reported to be 221 t 240 feet below land surface opposite the Silverado zone. The da obtained from those traverses are shown on figure 28, from which th following conclusiona have been drawn:

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| Traverse January 3,  1945 after pumping  18'12 hours | |
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| Traverse January 2, 19 5 ofter pumping 53 minutes. Well had been idle for I week previous lo lesl | |  |  |  |
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| Static level obout 152 feel b ow fond surface after pump idle Ilk hours | | | | |  |
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Traverse Oct. 27, 1944

ofter pumping 8 '12 hours. Pumping rate, 275 gpm

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additional perforations 527·541 feel below fond surface. Measured depth

of well 579 feet

Traverse run to 475 feet below land surface; no change in \ conductivity below 400 feet

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ELECTRICAL CONDUCTIVITY (MICROMHOS AT 25°C)'

F10-trRl!: 28.-Conductivity traverses in well 3/15-25Hl (city of Manhattan Beach well 1), Oct. 27, 1944, .and)an. 2-3, 1945.

1. The quality of the water from the deeper perforations (527-541 feet) was somewhat better than the water admitted to the punip intake. The amo1:1nt *ot* water yielded through these perfoiations was small, probably about 25 gpm.
2. Fresh water entered the well from 248 to 256 feet below land surf ace; there,. the conductivity decreased from about 1,500 to 700 micromhos (dissolved solids about from 900 to 400 ppm). The casing reportedly is not perforated at this­ depth; thus the water must have entered either through unreported perforations­ or through a leaking casing.
3. Saline water entered the casing from 230 to 24 feet below land surface The con'centration of thi water was indeterrnin·ate, but the conductivity was greater than 1,850 (dissolved solids,greate'r than about 1,100 ppm).
4. Under nonpumping conditions, thff saline wa r entering through the perforations 221-240 feet below land surf ace mo ed down to displace the fresh water at 248-256 feet and at 527-541 feet. Doubt ssthis saline fluid not only displaced the water in the casing, but it also invaded these lower w,ater-bearing zones while the pump was idle. · · ·

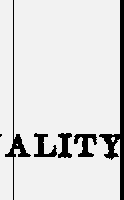
**WELLS** IN **AND NEAR REDONDO BE CH**

To the south of 190th Street, near the coas , the Silverado water­ bearing zone and the "200-foot sand" cann t be discriminated as separate entities. From here southward to t e Palos Verdes Hills, the materials penetrated by wells are perme ble throughout nearly their entire thickness, (pl. 30). Beneath the dune sand, which ex­ tends from land surface about to sea level, the water-bearing material tapped·, by wells is considered to ··be within the Silve:ra;d<:> water­ bearing. zone. Wells have penetrated this zo e to• a depth as great as 400 :feet below sea·l'e'1el'(well4/i4.....i7-E1 an 5Nl). A comparison­

of drillers' fogs of wells in-· the western ·part of s c. 8, T. 4 s.; R. 14 W.;

suggests a local division of the Silvetado zon into an··upper and a lower part, separated by a few tens of feet of cay. Records of water levels in well 4/14-8El, which taps only the pper part, and in well **8Dl,** which taps both the upper and lower par s, show little difference in altitude of water level in the two parts fro the middle to the late thirties. Since about 1941, however, as sho by measurements at these two wells, the water level in the- lower part has been slightly­ higher than that in the upper. Available ch mical analyses suggest, some slight difference in quality of water fro the two parts; also,

even where th.e separating clayey layer is n t present, the deeper,

water is of appreciably better·quality.

**SUMMA:JtY OF NATIVE WATER** U

Water of native quality is represented by nalyses of water from wells of the California Water Service Co. in se . 31, T. 3 S., R. 14 W., and from random wells in secs. 5, 8, and 17, T. S., **R.** 14 W. Accord-. ing to these analyses, the native- waters cont ined- 50 to 60 ppm of chloride, and about 300 to 360 ppm of dissol ed solids; the sulfate content decreased from north to south. In sec 31 the sulfate content

of these native waters was about 40 ppm; in sec. 5, from 15 to 12 ppm; in sec. 17, from about 7 -ppm to only a trace. The native waters range from sodium, calcium-bicarbonate waters in the northern part of the area to sodium bicarbonate waters in the south. For the cen­ tral part of the area, the analysis of October 6, 1931 of well 4/14-5N2 (table 30) has been selected to be representative of a native water of good quality. Locally, near the coast, inferior waters existed under native conditions according to early records. For example, by 1908, about half a mile from the coast in 4/14-7J, brackish water containing\_ noticeable quantities of hydrogen sulfide gas was reported·at depths of less than 185 feet below land surface. The water below that depth was utilized from about 1905 to 1930 by several public-supply wells **of** the California Water Service Co. It is reported to have been **of** good quality until it became contaminated late in the twenties.

**PROGRESS OF WATER-QUALITY DEPBECIATIOK**

The earliest known occurrence of water-quality depreciation in the Redondo Beach area is indicated by a series. of analyses from well 4/14-6Fl, which was drilled in 1912 by the Southern California-Edison

,Co. The chloride content of the water from that well was- 79 ppm. 13y late 1918 the chloride content had increfU?ed to 462 ppm. The

-public-supply wells of the California Water Service Co. in 4/14-7J

·were abandoned prior to.1931 because of saline contamination. Also, well 4/14-17El, which was drilled in 1929 and perforated at intervals

·from 253 to 400 feet below land surface, yielded water -con,taining

-404 ppm of chloride in October of that year. Thus, as of 1930, the

-front of contaminated water extended inland at least 0.8 mile at

.Redondo Beach.

The general progress of contamination in the Redondo, Beach area

·since 1930 is best shown by the chloride plots for several wells with good analytical records. These have been plotted on figure 29 and

·include well 4/14-5N2, which, since 1932, has an ,excellent record of

-chloride determinations made by the Los Angeles County Flood Con-

-trol District. Definite contamination in this well. began in 1938, and

-it increased so rapidly that the well was abandoned in 1945. Also

]>lotted on figure 29 are chloride determinations on waters from wells

-4/14-8D1 and 8El, which were badly contaminated when abandoned in 1942 and 1943, respectively; well 801, which was incipiently con­

·taminated as of 1946; and well 3/14-31Al, which in mid-1947 still yielded water of .excellent quality. The trend of chloride for well 8O1

·is anomalous; on the basis of trends shown by the chloride ;graphs for

· ·wells 5N2, 8Dl, and 8El, it would be expected that when the chloride

--content increased beyond 100 ppm, the slope of the curve would be­ o1Come much steeper and ultimately would result in the abandonment of

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FIGURE 29.-Chloride content of waters from five wells in the Redondo Beach **area.**

the well. However, for well 801, the chloride content passed beyond 100 ppm in early 1946 but subsequently returned to a lower value (94 ppm). The actual front of contamination has not yet reached well 801; however, during the summer of 1946 that well must have drawn water from a zone of diffusion in which a small amount of blending with the contaminant had occurred.

To the south, water from well 4/14-17El was of poor quality (404 ppm of chloride) in 1929. Well 4/14-1702, half a mile inland from well 17El and 1.3 miles from ihe coast, yielded water of excellent quality in 1946. The front of contamination currently is coastward from this well (pl. 16). Still farther south, analyses of water from well 17Nl suggest that the water was incipiently but not definitely contaminated as of 1930 (the chloride content was 86 ppm). In 1944, the chloride content had increased to 122 ppm and the front of con­ tamination had moved east of well 17Nl.

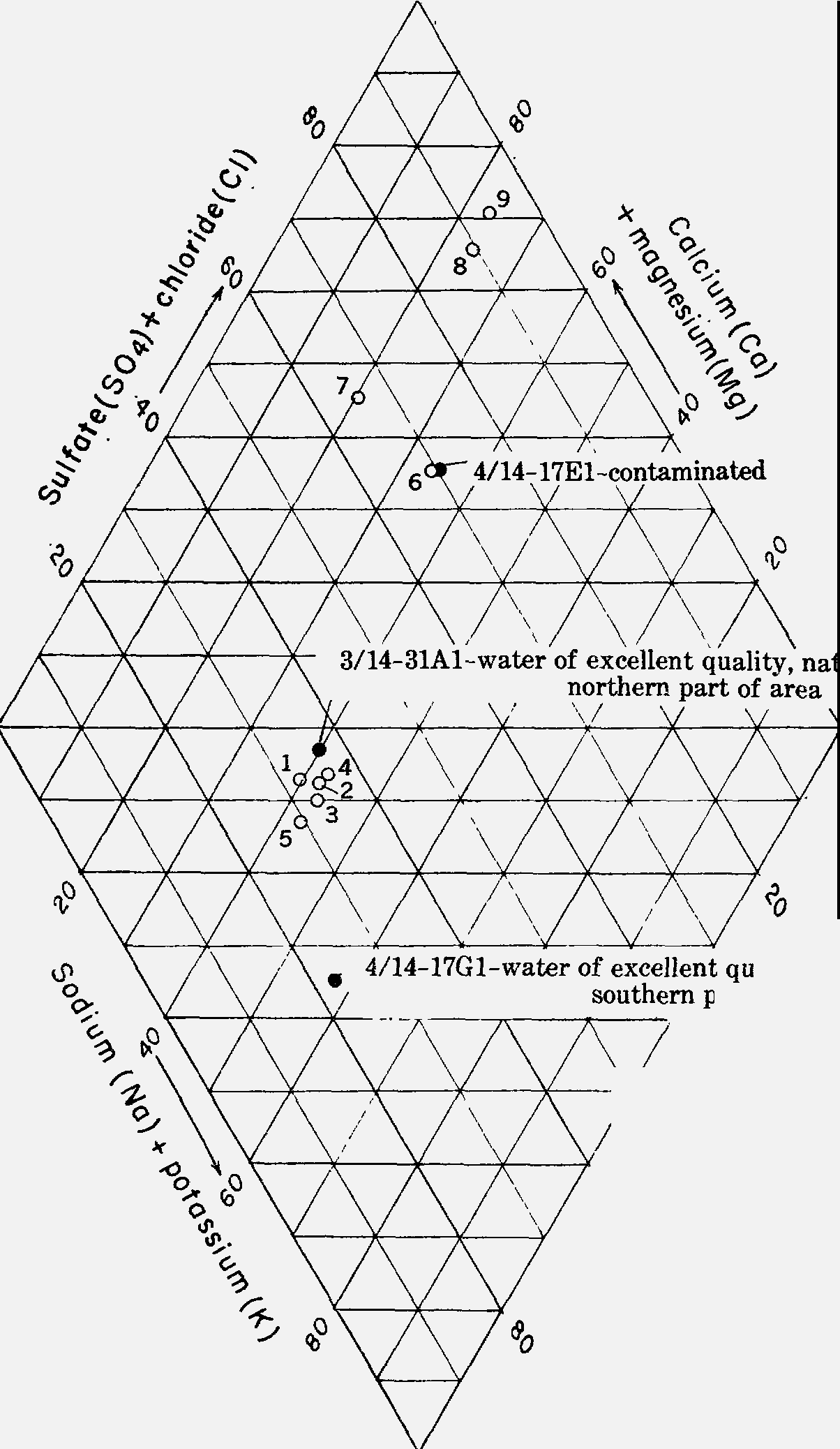
**CHEMICAL FEATURES OF CONTAMINATION**

In accordance with an outstanding characteristic of contamination along the west and south coasts of the Los Angeles basin, the most obvious feature of the contamination in the Redondo Beach area is the regular and comparatively intense increase in chloride. Particu­ larly in the initial stages of contamination, chloride usually increases regularly and consistently, although one or more of the other constit­ uents may fluctuate irregularly. Because an excellent series of chem­ ical analyses is available covering the full span of contamination in well 4/14-5N2 (Redondo Union High School well), and because the

**460508-59-17**

water yielded from that well before abandonment became more saline than waters available from any other well nearby, the analyses have been plotted on a trilinear diagram (fig. 30) to show graphically the change in chemical character that occurred as contamination increased. Also shown for comparison are the points representing native water of excellent quality from wells 3/14-31Al and 4/14-1701 and the point representing contaminated water from well 4/14-17El. The graph shows that the waters from 4/14-5N2 and 3/14-31Al initially were similar; that the water from well 5N2 did not change materially from its initial character until some time between 1937 and 1942; and finally, that the points representing increased contamination define a trend, which suggests the addition of a calcium-chloride or calcium-sulfate saline. Actually, however, the increase in calcium is due to base exchange. On the graph, the points representing the analysis for well 17El and the analysis of August 7, 1942, for well 5N2 nearly coincide, thus suggesting that the two are of similar character. However, certain discrepancies exist, particularly in the relative concentrations of calcium and magnesium.

Evidence relating to the possible source of the contaminant entering well 4/14-5N2 is presented on figures 31 and 32, which shows that of the two possible contaminants-ocean water and oil-well brine-the former is the more likely source. The magnesium increase in the contaminated water, as shown by the pairs of dashed lines in figures 31 and 32, allowing for a moderate increase by base exchange, is more compatible with the amount in ocean water than that in oil-well brine. The amount of sulfate in the brine is not sufficient to produce the observed increase of sulfate. That increase could result from a mixture with ocean water with sulfate reduction of about 45 percent (that reaction is presumed to occur here because of the reported· presence of free sulfide in some waters nearby). In addition, the bicarbonate content of the contaminated water is less than that which would be expected by the addition of brine. Thus, the evidence shown on figures 31 and 32, although not entirely excluding the possibility of oil-well brine contamination, shows that ocean water probably is the contaminant. Moreover, the contamination is more intense to the west, and its front is known to have moved from west to east. If water deterioration were from an oil-well brine-specif­ ically, from brines discharged at land surface in the Torrance oil fie]d (pl. 18)-a decreasing salinity from the ocean to the present front about a mile inland would be unlikely. Few, if any, active oil wells are less than a mile from the coast, and oil-field brines are not discharged within the city limits, which include the area of most in­ tensive contamination.

CHEMICAL CHARACTER OF WATERS **247:**

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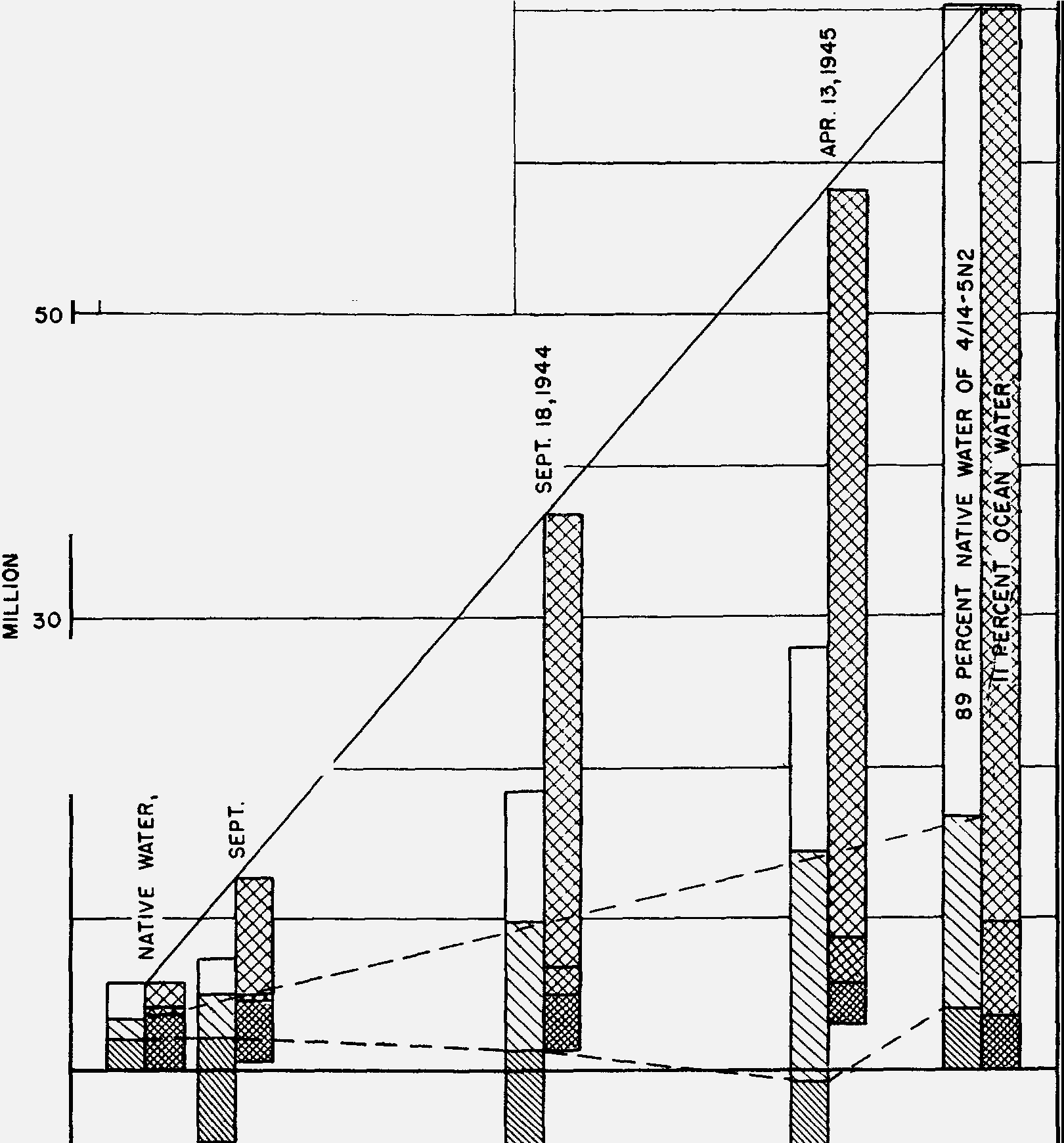
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| --- | --- | --- | --- |
| o. | Date | **Parts** per million | |
| Dissolved solids | Chloride |
| 1  2  3  4  5  6  7  8  9 | Oct. 6, 1931  Mar. 24, 1932  May 11, 1932  Nov. 3, 1932  Sept. 2, 1937  Aug. 7, 1942  Sept. 4, 1942  Sept. 18, 1944,  Apr. 13, 1945 | 303  299  283  301  369 | 57  57  59  62  70 |
| 628 267  647 278  2,280 1,060  3,370 1,770 | |

FmURE 30.-Chernical character of selected native waters and the progressively:contaminated water from well 4/14-5N2 in the Redondo Beach area.

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CALCULATED PERCENTAGE OF NATIVE WATER

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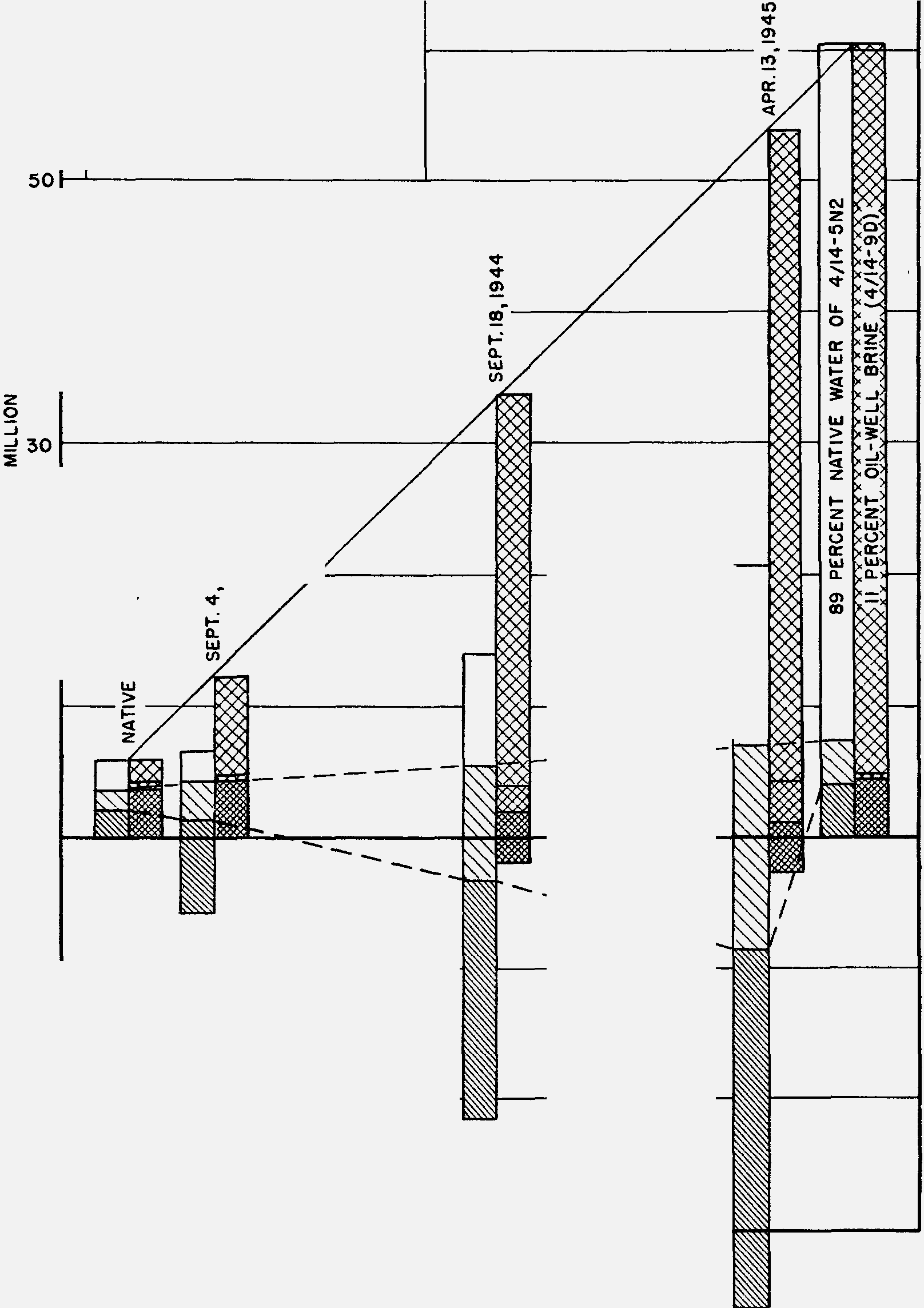
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**FIGURE** 31.-Progressively contaminated waters from well4/14-5N2 (Redondo Union High School well) in relation to hypothetical mixtures of native fresh water with oil-well brine (well 4/14-9D).

CALCULATED PERCENTAGE OF NATIVE WATER

100 99 98 97 96 95 94 93 92 91 90 **89**



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FIGURE 32.-Progressively contaminated waters from well 4/14--5N2 (Redondo Union **High**

School) in relation to hypothetical mixtures of the native fresh water with ocean water.

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Regarding the possibility of contamination of fresh water by oil­ well brine, such contamination is believed to have occurred at well 4/14-9Kl. The chloride content of its water increased from 50 ppm in 1926, to 189 ppm in 1946, and to 216 ppm in June 1947. This well is 2.3 miles from the coast and water of good quality is inferred to be present to the west-the regional front of contamination as of 1946 is shown on plate 16 as 1.2 miles west of this well. However, water levels throughout this area are below sea level, and a landward gradient has existed for many years; therefore, the possibility of ocean-water contamination cannot be excluded. Because this well seems to be the only one contaminated in an area now yielding water of good quality, a local source of contamination is presumed. The chemical data are not diagnostic of the source. It is of interest to note that a brine sump, about 1,000 feet northwest of well 4/14- 9Kl, reportedly has been used as a place of disposal for many years (p. 191). The quantity of brines discharged into these sumps is not known.

**RATE OF INLAND ADVANCE OF THE CONTAMINATION FRONT**

For the reach from Playa del Rey to the Palos Verdes Hills, it has been shown that, as of 1946, contaminated water underlay a coastal strip ranging in width from half a mile to 1.7 miles. Throughout this reach, water levels now (1946) are below sea level, and a land­ ward gradient prevails (pl. 12). There is no known physical barrier to the continued inland advance of contamination across essentially the full width of the west basin, at least to the eastward margin of the area in which landward gradients exist.

With respect to the problems of use and conservation of the ground­ water body in the west basin, the rate of encroachment of saline waters is of critical concern. It has been shown that, throughout the area here treated, the ocean is the principal source of the con­ taminating waters. Thus, the supply of contaminant is unlimited, and the rate of advance is dependent upon the permeability and effective porosity of the conducting aquifer-chiefly the Silverado water-bearing zone-and thegradient of the water level or piezometric surface within that aquifer. The rate can be estimated by use of an average permeability coefficient and effective porosity and an average water-level gradient. However, the front will advance most rapidly in the most permeable gravel layers, and in places where cones of pumping drawdown intersect the body of contaminated water and cause relatively steep landward gradients. Thus, because conditions may range widely from the average, it appears that an appraisal from empirical data is the most reliable. However, two methods of pro­ cedure are possible. First, the field travel time of the saline front from one actively pumped well to another can be determined by

periodic chemical analyses. Second, the average rate of encroach­ ment can be estimated from the regional advance of the saline front as shown on plate 16. Both methods will be presented in this study; however, both are subject to qualification.

With respect to the first method for three specific localities within the coastal reach, the landward rate of saline advance is known reasonably closely from periodic analyses of the water from pairs of actively pumped wells:

1. At El Segundo, wells 3/15-13G2 and 13Hl (Standard Oil Co. wells 7 and 12, respectively) both tap the upper part of the Silverado water-bearing zone. From the chloride plots of figures 21 and 23, the initial contamination at well 13G2 was in January 1935, and at well 13Hl it was in August 1938. Thus, the saline front moved 900 feet east in 3.6 years, or at an average rate of about 250 feet a year.
2. At the main well field of the city of Manhattan Beach, contaminated water first reached wells 3/15-25Al and 25A2 (city wells 3 and 7) in June 1942 and June 1943, respectively (fig. 25); water from well 3/14-30Dl (city well 8) first showed contamination in May 1944. Thus, it took an average time of about
   1. years for saline water to advance 500 feet eastward from wells 25Al and A2· to well 30Dl-that is, an average rate of about 350 feet a year.
3. Near Redondo Beach, contamination first became appreciable in wells 4/14- 8D1 and 8El of the California Water Service Co. in mid-1939. In March 1946, incipient contamination first reached well 4/14-8Cl (Dominguez Water Corp. well 12-A), some 1,350 feet eastward from wells 8Dl and 8El. Here, it took about 6.8 years for the contamination front to move 1,350 feet, or at an average rate of about 200 feet a year.

Thus, for the three specific places along the west coast south of Playa del Rey, for which evidence is available from actively pumped wells, the average rate of landward advance of saline water between these wells has ranged from 200 to *350* feet per year. However, it must be considered that these rates of advance have been calculated for the time it took the front to·advance from one actively pumped well to another. Also, they cover different time periods, and are reckoned from unknown, but presumably unequal, gradients. There­ fore, these rates are inferred to be more rapid than the regional average and cannot be considered to be representative of the rate of inland movement in the reaches where the cones of water-level depression of actively pumped wells do not intercept the saline front-that is, in reaches where the flatter regional gradient prevails.

The change in position of the saline front for the 15 years from 1931 (1930-32) into 1946 (pl. 16) can be utilized to estimate the yearly rate of advance. In such an appraisal, however, two considerations which complicate the estimate should be kept in mind:

1. The positions of the saline front both in 1931 and in 1946, as shown on plate 16, are relatively uncontrolled except at or near certain pumped wells whose waters have been analyzed often enough to furnish reasonable control. In

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reaches between these wells, such as that between Redondo Beach'and Manhattan Beach, the saline front of 1946 has been drawn in a conservative position, and the front may have been several hundred feet inland from the indicated position[at that time. Thus, rates of advance, calculated from the average change in position of the front along such a reach, furnish only rough approximations.

1. Although the hydraulic gradient has been landward along the :full reach from Playa del Rey to the Palos Verdes Hills since the early thirties, the magni­ tude of the gradient has ranged seasonally (from spring to autumn), from year to year, and especially from place to place, as shown by the water-level contours of plates 9-12. These changes in gradient have been discussed more fully on pages 90 to 93. The rate of movement of the saline front changes in direct proportion to these changes in hydraulic gradient.

The reach between the Palos Verdes Hills and Hermosa Beach is the one in which the change in hydraulic gradient is easiest to deter­ mine, partly because the water-bearing deposits are thickest here, and the change in gradient has been relatively uniform across the reach. In the 15 years from 1931 to 1946, the saline front (pl. 16) moved inland an average distance of about 1,500 feet. The hydraulic gradient from 1931 into 1941 was reasonably uniform and ranged from about 3 feet per mile in the spring to 4 feet per mile in the autumn. Thus, the average inland gradient was about 3.5 feet per mile. From 1941 into 1946, the yearly average gradient increased from about 3.5 feet per mile to 5.5 feet per mile, and for the 5-year period it averaged about 4.5 feet to the mile. Thus, from these data, in the reach from Hermosa Beach to the Palos Verdes Hills, the rate of advance of the saline front was about 90 feet per year from 1931 into 1941, increased to about 140 feet per year by 1946, and averaged about 120 feet per year from 1941 into 1946.

For the reach from Hermosa Beach to El Segundo, the landward

hydraulic gradient ranged widely from 1931 into 1946. As of 1933, it was flatter than the gradient in the area to the south (pl. 9); as of 1941, it was somewhat steeper (pl. 11); and in the autumn of 1945 it had increased to as much as 20 feet per mile locally-as measured by the distance between the -10 and -20 contours (pl. 12). For this reach from Hermosa Beach to El Segundo, the saline front (pl. 16) moved inland an average distance of 2,300 feet in the 15-year period. The change in gradient has been so irregular throughout this reach that it is not considered feasible to attempt an evaluation of the average gradient for selected periods. However, from fragmentary chemical data, it is estimated that the saline front advanced about 1,150 feet from 1931 into 1941 and advanced the same distance from 1941 into 1946. Utilizing this approximation, the suggested average rate of advance was about 115 feet per year in the thirties and about 230 feet per year from 1941 into 1946. As of 1946, the rate of advance probably was as much as 300 to 400 feet per year in the areas of steepest landward gradient along this reach.

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In the reach from El Segundo to Playa del Rey, where the hydraulic gr dient l;\long the saline front has heen not more· than 1 to 2 feet to the mile prior to 1945, the data of plate 16 suggest that the landward advance of the saline front probably has not exceeded 30 to 40 feet per year prior to 1945. As of 1946, the hydraulic gradient had steep­ ened to as much as 3 feet to the mile (pl. 13, hydrographs for wells 2/15-34Hl and Kl), and the rate of inland advance probably had increased to about 60 to 80 feet per year.

**INFERIOR WATERS OF THE GARDENA AREA WATERS FROM THE UNCONFINED BODY**

As discussed earlier, in the Gardena area the shallow deposits extending to a depth of as much as 60 to 80 feet below land surface generally contain inferior unconfined waters. As shown by plate 16, the area underlain by these inferior waters extends about 17 square miles. However, to the southeast-that is, to or beyond sec. 31,

T. 3 S., R. 13 W.-the extent of the shallow water body is indefinite. It is believed, from water-level records, that a number of wells in sec. 31, ranging in depth from 30 to 70 feet, tap unconfined water. Still farther south, specifically in sec. 19, T. 4 S., R. 13 W., it is believed that wells 70 to 90 feet deep and wells about 180 feet deep tap different parts of an essentially common zone correlative with the "200-foot sand." This belief is based mainly on hydrologic information rather than on chemical data; the water from the shallow wells is inferior in quality to water from the deeper wells.

The available chemical evidence indicates that the shallow waters throughout the area under discussion have been inferior since at least 1903; however, the tendency toward salinity increase is too slight to be indicative of contamination. In 1903, wells shallower than about 60 feet yielded inferior water with a dissolved-solids content ranging from more than 1,000 ppm to more than 2,300 ppm. Wells 60 to 80 feet deep yielded water containing 650 to 750 ppm of dissolved solids. According to analyses of waters from the shallow wells in the Gardena area over the period 1943-45, the chloride content was usually less than 400 ppm except in sec. 26, T. 3 S., R. 14 W., where at least seven wells yield water containing more than 400 ppm; of these, well 3/14- 2602 yielded water containing 2,150 ppm of chloride and about 3,900 ppm of dissolved solids. For sec. 31, T. 3 S., R. 13 W., wells less than 80 feet deep yielded water in which chloride ranged from 28 to 267 ppm and dissolved solids ranged about from 310 to 924 ppm; the few analyses made since 1941 suggest only a very slight increase in salinity during that time.

Therefore, in summarizing water-quality conditions in the Gardena area with specific reference to the unconfined body, the following fea-

tures are pertinent: (1) Unconfined water in the shallow deposits apparently was inferior under native conditions, (2) an extreme range in quality existed across the area, and (3) existing chemical data for any given well point to the tentative conclusion that, in general, the quality of water is not deteriorating.

**WATERS FROM THE UNNAMED UPPER PLEISTOCENE DEPOSITS**

The native concentration of waters in the "200-foot sand" in the unnamed upper Pleistocene deposits is also determined in part from chemical data collected during the Mendenhall survey in 1903. Then, the concentration of dissolved solids in water from wells 150 to 250 feet deep in the Gardena area ranged from about 350 to 460 ppm. However, in sec. 24, T. 3 S., R. 14 W., at least six wells yielded water considerably above that upper limit, and two of these SL'{ wells yielded water containing more than 1,800 ppm of dissolved solids.

Similarly, in sec. 27, T. 3 S., R. 14 W., a well 230 feet deep yielded water containing 1,730 ppm of dissolved solids (Mendenhall 325, Redondo). In sec. 36, T. 3 S., R. 14 W., a well 250 feet deep yielded water containing only 340 ppm of dissolved solids (Mendenhall 1006, Redondo).

According to field analyses in 1943 by the Geological Survey, the "200-foot sand" in the Gardena area then yielded water ranging from 22 to 774 ppm of chloride and from 320 to 1,750 ppm of dissolved solids. The maximum value cited is that from a well only 175 feet deep which does not penetrate the full range of the "200-foot sand"; hence, that water probably is not representative of that aquifer. In general, however, the chloride content ranged from 60 to 80 ppm. In sec. 31, T. 4 S., R. 13 W., three wells tapping the "200-foot sand" or correlative deposits yielded water containing, respectively, 159, 205, and 138 ppm of chloride. For these weJls, the dissolved solids, as computed from electrical conductivity, were about 640, 1,000, and 600 ppm. Here, wells tapping aquifers below the "200-foot sand" yield water containing less than about 53 ppm of chloride.

It is believed that under native conditions water yielded from most of the "200-foot sand" in the Gardena area contained from 50 to 90 ppm of chloride. Locally, however, as the foregoing discussion indi­ cates, some of the waters were inferior in1903 (Mendenhall survey) and in 1943 (Geological Survey water-sampling program). On plate 16 is shown an area of some 470 acres just northeast of Gardena­ largely confined to sec. 19, T. 3 S., R. 13 W.-in which waters from the "200-foot sand" have become contaminated in recent years. These boundaries include an area in which the chloride content of the waters yielded from the "200-foot sand" is now greater than 100

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ppm; earlier analyses are available to show that there has been a trend toward increase in chloride in recent years. The fragmentary evidence shows that, in sec. 19, chloride has increased in some wells tapping the "200-foot sand" and, as of 1943, at least five wells tapping that aquifer yielded water containing more than 100 ppm of chloride. However, because complete analyses of water from wells tapping the "200-foot sand" in this area show no more than a nominal range in chloride content, nothing can be said concerning the source or type of contamination.

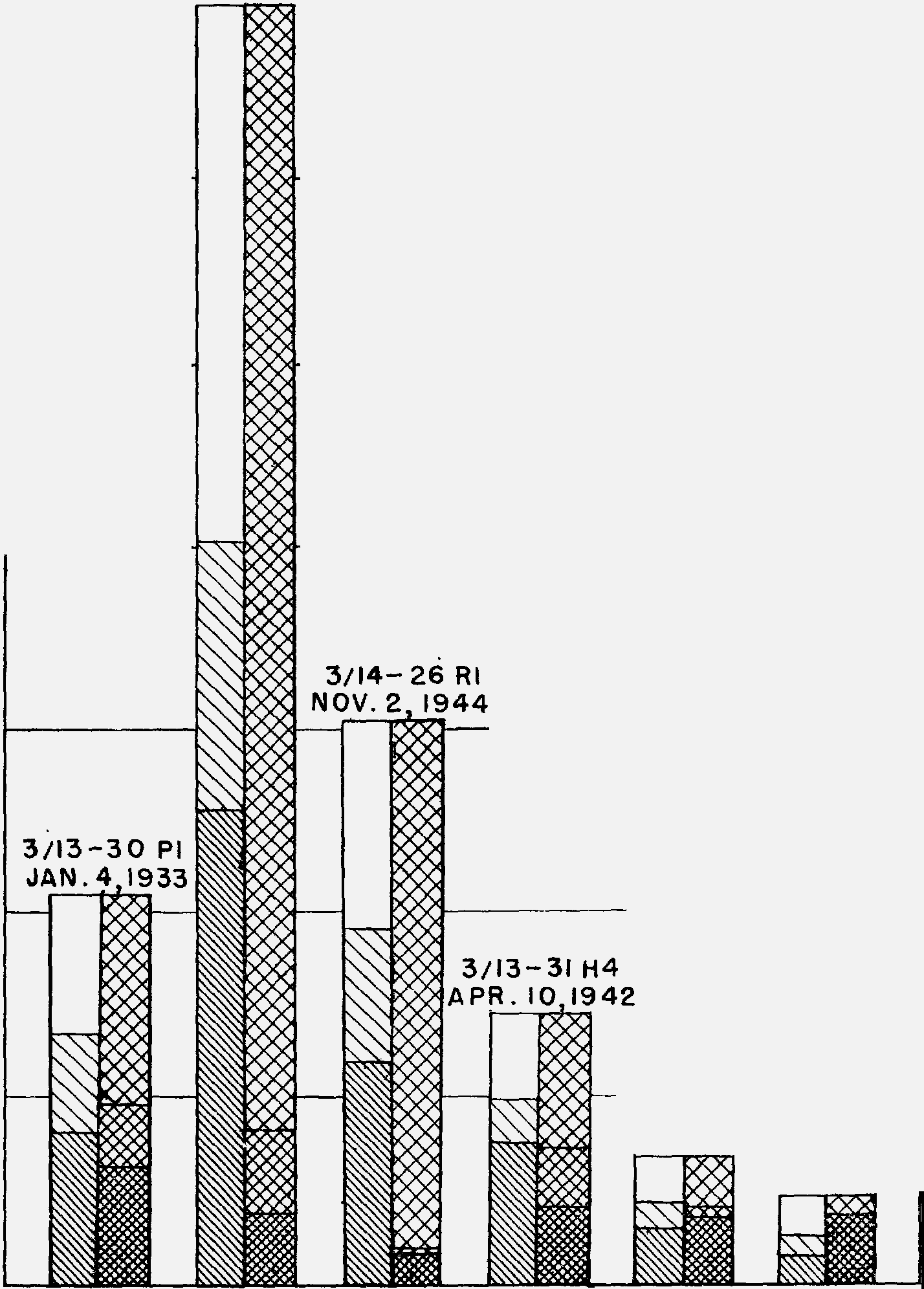
A comparison of the chemical character of waters from the shallow, unconfined body, from the "200-foot sand," and from the Silverado water-bearing zone is made on figure 33. Here are shown graphical representations of virtually all the available complete analyses of water from wells in the Gardena area. As indicated by the illustration, the water (mostly unconfined) from the shallower ranges is a calcium, sodium chloride water; that from the "200-foot sand" is a calcium, sodium bicarbonate water, and that from the Silverado water-bearing zone is a sodium, calcium bicarbonate water. The range in dissolved solids for the analyses shown is from 924 to 3,900 ppm for the shallow water body, 377 ppm for the "200-foot sand" (well 3/14-26Jl), and

241 ppm for the Silverado water-bearing zone (well 3/14-35Rl). Figure 33 shows that the waters from the two underlying zones are of much higher quality than that from the shallower body. Because of the higher head in the semiperched body, it is essential that wells in the Gardena area which tap underlying zones and which are to be abandoned be plugged with cement or with other impermeable ma­ terial, so that the waters in the semiperched body cannot eventually circulate into and contaminate the water in the underlying zones. If the well to be abandoned is not plugged, ultimate failure of the casing, caused by corrosion by the saline waters, will allow such circulation and the resulting contamination.

**CONTAMINATION** IN **DOMINGUEZ GAP**

Much of the following material has been abstracted from the report on chemical characters of waters in the Long Beach-Santa Ana area (Piper, Garrett, and others, 1953, p. 167-197) and from earlier pages in this report. Because the Dominguez Gap is an integral part of the west basin, the more general features of water character and water contamination are reviewed here. No field work has been done in the Dominguez Gap since release of that earlier report, how­ ever, and thus the conditions summarized here are those which existc,d in the gap in 1943.

WATERS FROM THE SHALLOW DEPOSITS OVERLYING THE "200- FOOT SAND" IN



THE TORRANCE PLAIN,

NEAR G·ARDENA

3/14-26 G2 FEB.II, 1946

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FHH,RE 33.-Chemical character of native waters yielded from the shallow, uncon­ fined body, from the "200-foot sand," and from the Silverado water-bearing zone beneath Torrance plain near Gardena.

**SUMMARY OF NATIVE-WATER OCCURRENCE AND QUALITY**

In Dominguez Gap, three principal aquifers are actual or potential sources of water for wells. In downward succession from the land surface, excluding the shallow, unconfined body, these are:

1. The lower division in the alluvial deposits of Recent age, known as the Gaspur water-bearing zone. It is about 40 to 70 feet thick, its base is about 90 to 150 feet below land surface, and it is over­ lain by flood-plain silt which is probably somewhat permeable. The water in this zone is only imperfectly confined; probably there is some interchange of water between it and the overlying unconfined body. The native waters in nearly the full reach of the Gaspur water­ bearing zone were of the calcium bicarbonate type and contained from 350 to 600 ppm of dissolved solids, from 25 to 60 (or possibly more) ppm of chloride, and from 190 to 275 ppm of hardness. In general, each of these quantities decreased southward, or toward the coast.
2. The Silverado water-bearing zone of the San Pedro formation. This water-bearing zone is separated from the Gaspur zone by 175 to 550 feet of silt, clay, and fine sand of low permeability. It is **a** body of uniform gravel and coarse sand and ranges in thickness from 500 feet at well 4/13-2302 (city of Long Beach, Silverado well 1) to as little as 180 feet between Anaheim Street and the coast (pl. Ul for extent of the Silverado water-bearing zone in the west basin and fig. 2 for thickness). Water of the Silverado zone is effectively con­ fined by the overlying deposits of low permeability. The water is a typical sodium bicarbonate water; dissolved solids ordinarily range from 200 to 325 ppm and chloride ranges from 20 to 30 ppm. Hard­ ness is about from 80 to 120 ppm in waters from the upper part of the zone, but it is about from 35 to 80 ppm in waters from the central and lower parts of the zone, Southwestward beyond the Dominguez Gap and toward the Palos Verdes Hills, the dissolved-solids content increases to about 400 ppm and the chloride content increases to at least 100 ppm. (Seep. 180.) The increase in dissolved solids is due to blending with locally occurring connate water. The ·water is of the type that is yielded from wells 5/13-6Dl and 6D2. It is a sodium chloride water in which the chloride content has ranged between 364 and 510 ppm for the period of record. These chloride analyses are shown on figure 34. The chloride analyses of water from wells 4/13- 30Gl and 31El also are shown for comparison. The chloride content of these has ranged between 25 and 67 ppm. These two wells show little, if any, effect of blending with the connate waters.
3. The upper division of the Pico formation of Pliocene age, which,

in its lower part, inc1udes several layers of medium- to coarse-grained sand of fair permeability. It is separated from the Silverado zone by

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FrnuRE 34.-Chloride content of waters from wells 5/13-6D1 and 6D2, also from wells 4/13-3001 and 31El, showing effect of connate water in the Silverado w.:iter-bearing zone adjacent to the Palos Verdes Hills.

impermeable beds of silt and clay, ranging in thickness from 200 to 650 feet. The permeable beds in the upper division of the Pico forma­ tion contain essentially fresh water, not now tapped by wells. For the vicinity of Dominguez Gap, the quality of the water from the upper division of the Pico formation is known from analyses of water from two wells: 4/13-12A2, in the northern part of the gap, and 5/13-3H, just northeast of Terminal Island. Both wells contain sodium bicarbonate waters. The water from well 12A2 contained only 689 ppm of total solids and 58 ppm *of* chloride (see also p. 183); the water from 5/13-3H contained 750 ppm of total solids and 130 ppm of chloride. Except for their high sodium percentage, these waters are suited to many ordinary uses and are fairly comparable in quality to some waters currently used for irrigation and other purposes.

**REVIEW OF CONTAMINATION**

Of the three water-bearing zones described, gross contamination occurs solely in the uppermost-the Gaspur water-bearing zone. In that zone, contamination may have begun as early as 1913 at the coast. By the middle twenties, water of depreciated quality had been drawn from many wells tapping the Gaspur zone within half a mile of the coast.

By 1931, contamination in the Gaspur zone had become intense; in addition to the coastal contamination, two other areas of contamina­ tion existed farther inland: one area was along the west margin of the Gaspur zone near the intersection of Alameda and Domingue?.

Streets, in sec. 10, T. 4 S, R. 13 W.; and the other area was along the eastern margin of the zone between 223d Street and Wardlow Road, about 4 miles inland from the coast. These areas (pl. 16) are sepa­ rated from th coastal area of contamination by a reach of compar­ atively fresh water in the Gaspur zone. The detailed conditions of contamination within these three areas have been shown in the ante­ cedent report (Piper, Garrett, and others, 1953, p. 178 and pl. 17). In all three depreciated areas, the contamination has been chta,racter­ ized primarily by an increase in chloride and in sodium.

For the coastal contaminated area, the source doubtless is ocean water, which presumably is in hydraulic continuity with the water body of the Gaspur zone at an offshore outcrop and which occupies dredged channels of the Long Beach harbor. Wells near the coast yield contaminated water with a comparatively low calcium-mag­ nesium ratio; this fact indicates that an oceanic source is responsible for that contamination.

For the area of contamination along the west margin of the Gaspur zone near the intersection of Alameda and Dominguez Streets, evi­ dence (not presented here) suggests that the focus of contamination may lie to the west in upper Pleistocene deposits which probably are in local hydraulic continuity with the Gaspur zone. This contamina­ tion is believed to have been caused chiefly by downward percolation of contaminated waters from above and partly by surface discharge of oil-field brines on the southwest flank of Dominguez Hill (Piper, Garrett, and others, 1953, p. 70 and 191). Here, contaminated waters from wells contain high sulfate concentrations as well as high chloride concentrations-the sulfate-chloride ratio is appreciably greater than that of ocean water. The high sulfate concentration is believed to have been derived from the overlying shallow and unconfined waters, in which the native sulfate content presumably has been augmented by the addition of industrial wastes high in sulfate.

For the area of contamination along the east margin of the Gaspur zone between 223d Street and Wardlow Road, the increase in salinity is characterized by moderate or, in some cases, slight increase in sulfate concurrent with gain in chloride. Presumably, the contam­ ination here has resulted from overland discharge of waste waters from the oil operations on the Signal Hill uplift and from the dis­ charge of brines to the Los Angeles River from the sumps of Oil Operators, Inc.; at times, this discharge has made up the total flow in the river. For these two inland areas, the postulation that con­ tamination has entered from, or is transmitted through, overlying deposits to the Gaspur zone is based in part on three facts: (1) Because of the somewhat permeable character of the deposits overlying the Gaspur zone, they allow downward percolation; (2) south of

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Spring Street, the water in the Gaspur zone is under a lower head than the unconfined water in the shallow deposits; north of Spring Street, the water levels in the two bodies are essentially the same but the unconfined water is more saline and has a greater density; and (3) the sulfate content of the very saline unconfined waters in sec. 10,

* T. 4 \_S., R 13 W., is a source of high sulfate-chloride contamination in
* the Haspur waters at the west edge of the zone; at the east edge of the zone, the presence of saline waters at land surface has been long established, and the effect of these on the concentration of the uncon­ fined waters is well known. For example, a sample of water collected November 18, 1946, during dewatering operations for a proposed sewage pumping plant at Willow Street, just east of the Los Angeles River, contained 1,260 ppm of chloride. This site is 1.9 miles north of the farthest inland reach of tidal water in the Los Angeles River. For analyses of waters in the two areas of contamination, see Piper, Garrett, and others (1953, table 30, analyses 4/13-1003, 14Ll, 14113, 14M8, and 14Q2).

Underlying the Ga.spur zone, but separated from it by impermeable layers, the Silvera.do water-bearing zone has not as yet been contam­ inated. However, several wells tapping the Silvera.do zone-4/13- 20Ll, 21Rl, 31E2-yield water containing somewhat more chloride than exists there normally; presumably, these wells are inadequately cased through inferior waters in the upper Pleistocene deposits which there overlie the Silvera.do zone. As long as these wells are pumped, lateral movement of the contaminated waters in the Silvera.do zone is retarded. On the flank of the Palos Verdes Hills, the water yielded from well 5/13-6Dl is decidedly inferior in quality and is presumed to be a native diluted connate water. (See p. 180, also fig. 34.) Con­ tamination of the Silvera.do zone may eventually develop from heavy pumping of wells tapping the zone, which would thus encourage the northward and eastward movement of this inferior native water.

Because it is so widely contaminated in Dominguez Gap, the Ga.spur water-bearing zone is not now intensively pumped in that area. However, because the pressure level in the Silvera.do zone beneath is from 40 to 80 feet below the pressure level in the Ga.spur zone, there is grave danger that the Silvera.do zone will become contaminated by downward circulation of saline water from the Gaspur zone, chiefly through abandoned wells that penetrate both zones. Therefore, in each case of abandonment of a well tapping the Silvera.do zone in Dominguez Gap, the casing should be plugged with cement or other impermeable material to prevent downward circulation of water from the Gaspur zone after corrosion has developed leaks in the casing.

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**CONTROL OF SALINE ENCROACHMENT**

**NEED FOR RESTRAINT OF ENCROACHMENT**

In preceding sections of this report it has been shown that saline encroachment from the ocean is the principal source of contamination

· in the west basin, and that contamination by industrial and oil-field wastes, although substantial, is localized chiefly in the vicinities of Dominguez Gap and the Baldwin Hills. In part, disposal of oil-field brines and industrial wastes at the land surface or in stream courses has been eliminated in recent years by the responsible agencies; also, Los Angeles County recently has passed an ordinance prohibiting disposal of wastes in such a way as to be injurious to the ground-water supplies. Doubtless this ordinance will reduce the discharge of saline or acid wastes at the land surface in the future.

The continued inland advance of ocean water at present, or accel­ erated, rates would result in ultimate destruction of the ground-water basin beneath the Torrance-Inglewood subarea. It is true that, at the present rate of landward advanGe of the saline front, many years would elapse before saline waters from the ocean would move entirely across the basin. As salt waters were drawn across the basin by con­ tinued excessive draft, however, well fields would be abandoned progressively as they were engulfed by salt water. IBtimately, the widespread encroachment would force a reduction in draft, and water levels in the basin would rise to sea level; however, the rise in water levels to sea level probably would not occur until the basin was essentially fully underrun by salt water.

If water levels on the inland side of the Newport-Inglewood barrier remained about at sea level, underflow across the barrier would diminish in proportion to the rise of water levels on the coastward side and would cease if the levels were equalized. In such circum­ stances, the only continuing replenishment to the Torrance-Inglewood subarea would be by penetration of water from the land surface, which is estimated to constitute about half the current fresh-water replenishment. Except in the two water-table reaches of the Silverado zone and correlative aquifers along the west coast, replenish­ ment from land surface would penetrate into the shallow water body and into the upper Pleistocene deposits. Even if water levels in these deposits ultimately should be raised many feet above sea level, it is believed that confinement of the Silverado zone is sufficiently effective to trap saline waters in the confined segments of that aquifer. Indeed, the saline waters on the coastal side of the barrier then would threaten to encroach inland beyond the barrier, and from Long Beach to the Baldwin Hills the water users of the main coastal basin would in turn be faced with the need for effective control along the

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barrier, just as the water users of Orange County face that need. Such a condition, even though it could not occur for several decades, should not be allowed to develop. It would appear that the people of the west basin will benefit from conservation of ground water and maintenance of head in the main coastal basin, and the people of the main coastal basin have a direct interest in the protection of the west basin from ultimate destruction by saline water.

The pending adjudication of water rights in the Torrance-Inglewood subarea was instituted because *of* recognition that the water supply was being excessively depleted and was being replaced by sa]t water. The California Division of Water Resources has been appointed referree to investigate physical facts involved in the action, including the amount of water that may be safely withdrawn or diverted annually from the basin, and the limitations on pumpage from the basin which would permit the recovery of ground-water levels therein to the elevation at which infiltration of salt water would cease, within ny given period (Gleason, 1946). The Division is now (1948) engaged in an intensive and thorough study of the problems at issue in the ad judication. 16

In these circumstances, the following discussion of methods for control of saline encroachment is limited to (1) pointing out certain general conditions that exist with respect to the problems of control,

,and (2) indicating possible protective measures that it maybe advisable

*to* investigate more fully prior to the adjudication of the water rights.

**METHODS OF CONTROL**

**GENERAL ASPECTS**

In most ground-water basins bordering on the ocean, if water levels have been drawn below sea level and ocean water has encroached beneath the land, the most effective long-term program for restraining or driving back the saline waters depends upon raising water levels throughout the basin to a sufficient height that fresh water at the

.saline front will displace salt water seaward. If such levels are to be maintained, a long-term basin-wide balance of draft and replenish­ ment must be attained. Such raising of water level above sea level throughout a basin ordinarily does not appreciably affect the quantity of replenishment.

In the Torrance- Inglewood subarea of the west basin, however, about half the replenishment currently (1946) is derived by underflow across the barrier features of the Newport-Inglewood uplift. The quantity of this underflow varies in proportion to the differential in water levels across those features. Thus, if restraint of ocean water

t6 The California. Division of Water Resources completed its intensive study for the adjudication in **1952.**

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ultimately should be achieved by raising water levels above sea level throughout the basin, and if levels on the inland side of the barrier features should remain at sea level, the coastward pressure differential would be eliminated and the underflow across the barrier features would cease. Then, the only replenishment would be the result of infiltration from land surface, by natural or artificial means, or by recharging through wells. Because the ground-water supply of the main coastal basin in Los Angeles County, as estimated by Gleason (1947, p. 159) is currently overdrawn by about 12,000 acre-feet per year (21-year base period), and because draft for domestic and industrial use in that area is increasing, it appears unlikely that water levels inland from the barrier features will be far above their present position for many years to come. They may drop many feet below

.sea level, however, at times of prolonged drought.

Therefore, it appears that the natural ground-water yield from the Torrance-Inglewood subarea would be substantial only if salt water

-could be restrained by local control near the coast and if at the same time, water levels immediately coastward from the barrier

-features could be held sufficiently low to maintain a substantial pressure differential across those features.

**CONTROL ADJACENT TO SALINE FRONTS**

There appear to be only three physical possiblities for local control

-0f the saline waters. Possibly none of these would prove economically feasible, but the methods are appraised briefly in following paragraphs. In order of probable increasing feasibility they are: (1) the con­ struction of artificial subsurface dikes or cutoff walls, (2) development

-0f a water-level trough coastward from the saline front 1 and (3) maintenance of fresh-water head above sea level immediately inland from the saline front. These same three possibilities have been discussed in an earlier report concerned with restraint of sea-water

-encroachment from Long Beach to Newport Beach (Poland, 1959).

**CONSTRUCTION OF ARTIFICIAL SUBSURFACE DIKES**

Movement of saline water farther inland could be wholly prevented if it were practicable to construct impermeable subsurface dikes or cutoff walls across the full cross section of the water-bearing materials at the saline fronts. Such dikes probably could be constructed by injecting some form of grout or emulsified asphalt into closely spaced wells. Along the west coast from Playa del Rey to the Palos Verdes Hills, however, a dike about 12 miles in length and as much as 500 feet thick would be necessary. Presumably, at least several thousand wells would be required to accomplish such an operation. Along the 4-mile reach of the south coast between the Palos Verdes Hills and the Los Angeles River, wells as much as 1,000 feet deep would be re-

quired. Therefore, the work required to seal both coastal reaches would be very costly and probably would be impracticable from an economic standpoint.

**DEVELOPMENT OF A WATER-LEVEL TROUGH COASTWARD FROM THE SALll\TE FRONT**

The saline front along the west coast probably could be held back by installing ancl pumping a line of wells seaward from the front in order to develop a water-level trough deep enough to maintain a seaward hydraulic gradient continuously along the front. Such wells should be placed as far coastward as possible, while still main­ taining the seaward gradient at the saline front. It would be neces­ sary for the wells to be spaced close enough to each other to intercept all inland moving salt water. Establishment of such a water-level trough would result in substantial drawdown of water levels inland from the saline front before stability would be achieved. Such a water-level trough would draw substantial amounts of fresh water from the inland side of the trough; waste of this fresh water would reduce, and possibly eliminate, the useful yield of the ground-water basin. The water discharged from the wells would be highly saline, and doubtless, it would have to be discharged coastward from the line of wells-possibly piped to the ocean. If so, many miles of pipe line would be required.

For the 4-mile reach from the\_ Palos Verdes Hills to Long Beach, the position of the saline front is not known. Thus, before a line of wells could be constructed to intercept the northward advance of saline waters from beneath San Pedro Bay, an exploratory drilling and water­ testing program would be required to determine the position of the front inferred to be present in the Silverado water-bearing zone in the vicinity of Terminal Island.

Obviously, a large number of wells and pumps would be required to establish and maintain such a trough. .Also, the cost of pumping waste water would be very substantial. The most serious feature, however, is the waste of fresh water, which could not be avoided in such an operation. For these reasons, it is extremely doubtful that economic justification for such a program could be established.

**MAINTENANCE OF FRESH-WATER HEAD ABOVE SEA LEVEL**

The most feasible method for local restraint of saline encroachment appears to be maintenance of the fresh-water head at an effective height above sea level at, and immediately inland from, the saline front. The effective height above sea level would depend upon the depth to the base of the permeable deposits. For coastal waters in contact with the ocean, the thickness of a fresh-water lens floating on salt water is a function of the height of fresh water above sea level and the specific gravity of the salt water. This is known as the

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Ghyben-Herzberg principles; it has been described and applied by Brown (1925). For ocean water with a specific gravity of 1.025, the thickness of the floating fresh-water lens would be 41 times its height above sea level-that is, it would extend 40 feet below, for each foot above, sea level.

Thus, along the saline front from the Palos Verdes Hills to Hermosa Beach, where the base of the Silverado water-bearing zone is as much as 500 feet below sea level (pl. 30), a fresh-water head about 13 feet above sea level would be required to displace ocean water to the base of the Silverado zone. Along the full reach to the Ballona escarp­ ment, the depth to the base of the water-bearing beds ranges from 500 feet to less than 100 feet; therefore, locally, as little as 3 feet of fresh­ water head above sea level would suffice. Along the south coast inland of Terminal Island, where the base of the Silverado zone locally is as much as 1,000 feet below the land surface, heads as much as 25 feet above sea level would be required to displace the salt water. Because the contact of the Silverado zone with the ocean is believed to be about 8 to IO miles south of Terminal Island, encroachment of saline water under the Ghyben-Herzberg principle may be delayed considerably even under favorable geologic conditions.

To achieve an effective fresh-water head along the saline front from the Palos Verdes Hills to the Ballona escarpment, two steps would be essential: (1) Discontinue pumping draft inland from the saline front for as great a distance as practicable; (2) practice artificial recharge along and immediately inland from the front. Such recharge could be undertaken on the north flank of the Palos Verdes Hills by in­ troducing water in pits or trenches excavated in sand of the San Pedro formation (Silverado zone), where it is exposed or close to the land surface (pl. 2); similar methods possibly could be used in the sand­ dune areas that overlie the main water table south of Hermosa Beach and north of El Segundo. North of El Segundo, spreading from one or more trenches at the land surface might suffice to build up an effec­ tive level (3 to 5 feet above sea level). In the central pressure area from Hermosa Beach to El Segundo, and probably in much of the area south of Hermosa Beach, recharge presumably would have to be obtained chiefly through wells or deep shafts.

So far as known, recharge through wells to form a fresh-water dam along the west coast for the purpose of conservation and restraint of ocean-water encroachment was first proposed by Dockweiler (1932,

p. 21 and 83-86) in a report to the Los Angeles County Flood Control District. He proposed that water be diverted from the Los Angeles River at Del Amo Street through a canal to a storage reservoir, and after desilting and treatment, the water be injected into a line of 16 wells about 400 feet deep and spaced about 350 feet apart, in the Re-

dondo Beach area so as to form a fresh-water ridge parallel to the saline front. The recharging capacity of the wells (20-inch diameter} was estimated to be about *I½* to 2 million gpd per well, and the con­ templated salvage of water, previously wasted to the ocean, was 10,000 acre-feet per year.

Possibilities for replenishment of the basin by recharging reclaimed sewage water through wells have been discussed by Goudey (1946,.

p. 23-32)-who has included an estimate of the cost of recharge by such means, based on the proposed introduction of 53,000 acre-feet per year of reclaimed sewage water into the ground, with a design capacity 50 percent in excess of this to provide for additional recharge as ex-• traction increases.

It is not within the scope of this investigation to explore the design possibilities of a well-recharging system, either as a line of wells to, produce a fresh-water ridge, or as a widely distributed system to build up water levels generally through the basin. However, it is. believed advisable to point out that recharging through wells is still in the experimental stage (Meinzer, 1946). Thompson (1942) has prepared a brief outline of principal reports on the subject prior to 1941.

So far as known to the writer, recharging through wells has not been practiced widely nor with much success in southern California. Specific examples have been described by Lane (1934) and by Mitchel­ son and Muckel (1937, p. 10 and 74-75). However, recharging through wells has been extensively practiced in the midcontinent area and in the East for disposal of oil-field brines and for repressuring of oil sands by ws,ter drive. It has also been used with considerable suc­ cess on Long Island, in connection with the return of cooling water to the ground; Brashears (1946) has reported that in the summer of 1944 over 200 recharge wells and several recharge pits were returning water at a combined rate of about 60 mgd.

The Silverado water-bearing zone in the Torrance-Inglewood sub­ area is a thick and permeable aquifer. Yields of as much as 1,000 to 2,000 gpm with moderate drawdowns, ranging from 10 to 50 feet, are common. (See table 5.) Along the saline front from Redondo Beach northward to the Ballona escarpment, the land surface almost everywhere is more than 100 feet above sea level; therefore, recharging heads as much as two to three times as great as the average draw­ downs could be applied. It seems reasonable to expect that, if clear, stable water were available for recharge, infiltration rates in excess of I cfs per well might be obtsined for substantial periods of time.

However, clogging of recharge wells can develop from several causes, such as silting, blocking of sand and gravel pores by air or other gases liberated by drop in pressure, bacterial or other plant growths, and

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chemical precipitation. Therefore, to furnish specific basic data it is suggested that, when suitable water can be obtained, experiments be made to determine how rates of recharge through wells compare with rates of pumping and whether effective recharge can be maintained for substantial periods of time in single wells. Possibly, certain wells­ now abandoned (about at the saline front) could be utilized. After­ such information has been gained from several wells-of both plain-. and gravel-packed construction-a program for possible artificial re­ charge through wells could be analyzed on a much firmer basis than. is now (1948) possible.17

**BASIN-WIDE RAISING OF WATER LEVELS**

If it is decided ultimately that restraint of saline encroachment by local control is economically impracticable, it would appear that t.he only other alternative for preservation of the ground-water basin is· to raise water levels above sea level throughout essentially all the· basin. Doubtless such a program could be accomplished over a period of time by reducing withdrawals sufficiently below replenish­ ment, and possibly by supplementary artificial recharge. Obviouslyr the time required to raise levels would depend in part upon the· magnitude of reduction in withdrawals and the amount of artificial recharge, if any. If water levels are raised above sea level through­ out most of the basin, some continued underflow across the Newpo.rt­ Inglewood barrier could be induced by a concentration of pumping operations along the coastward side of the barrier so as to drn.w water levels below the inland levels. Without such underflow, and without artificial recharge, the perennial yield of the basin would be only a small fraction of the present withdrawal.

17 Since release of the present report to the open file (in 1948), the Los Angeles County Flood Control District in 1950 made experiments to test the possibility of preventing or retarding saline intrusion afong­ tbe coastal margins of the west coast basin. These experiments included the use of an abandoned well as "IU injection well, the operation of a spreading basin in the sand-dune area east of Redondo Beach, and the '>peration of a spreading basin and bored-pit injection wells near El Segundo (Laverty, Jordan, and van der Goot, 1951).

As a result of the investigations, the California Legislature provided $750,000 for investigation and study

,ritb the objective of formulating plans and design criteria for the correction or prevention of sea-water in­ rusion. Most of this money was used for the installation and operation of an experimental recharge 1,est

:1t Manhattan Beach in the west basin, operated by the Los Angeles County Flood Control District under nontract with the State. The findings obtained from the funds appropriated by the State legislature are- 1iescribed in a report by the State Department of Water Resources, now (1956) in preparation. The re­ ''Ults of the operation of a line of recharge wells at Manhattan Beach have been described briefly by Laverty and van der Goot (1955), who have made the following conclusions (p. 907):

The investigation of the prevention and control of sea water intrusion bas established that, for an area 1vitb comparable geologic and bydrologic condition to the west coast basin: (1) Prevention and control can be successfully realized in a confined coastal aquifer by recharge through wells. (2) Recharge can pressurize "confined aquifer continually through a given reach, thereby reversing a preexisting landward gradient md nreventing further sea water intrusion. (3) Recharge will provide significant replenishment to the inli.nd 'Tound water basin with only a relatively small oceanward loss of fresh water. (4) Recharge can be per­

. 1rmed in an aquifer previously degraded by sea water intrusion and-within the physical limitatiom as

, stablished at the test site-will not have any consequential deleterious effect on inland pumped supplies.

···1 fact, all evidence collected to date indicates that the degraded portion of the aquifer can be reclaimed

* 7 recharge through wens.

In the vicinity of Dominguez Gap, raising the pressure level of the Silverado water-bearing zone above sea level would be the only wholly effective procedure for protection of -that aquifer from contamination now present in the Gaspur water-bearing zone. That contamination now is moving slowly southwestward into the unnamed upper Pleisto­ ene deposits and, under present conditions of depressed water level beneath, ultimately it would invade the Silverado zone extensively.

**WELL RECORDS**

Records of the water wells in the Torrance-Santa Monica area are given in tables 26 and 27. Table 26 contains brief tabulated descriptions of essentially all the active or potentially active water wells, and of those abandoned wells for which data are available pertinent to the objectives of the investigation. All wells described in table 26 are in the coastal zone of the Torrance-Santa Monica rea. Part of the descriptive date resulted from a field canvass of water wells by Allen Sinnott and A. A. Garrett, from October 1943 to June 1945. These data supplement antecedent information made

.available to the Geological Survey by many agencies, both public and private.

The field canvass of water wells in the Torrance-Santa Monica area was carried northwestward from Dominguez Gap to .the vicinity of Santa Monica-specifically to the north boundary of T. 2 S., plus

·secs. 31-33 in T. 1 S., R. 14 W., and sec. 36 in T. 1 S., R.15 W. Thus, for the full reach of the coastal zone of the Torrance-Santa Monica area as shown on plate 2 (about 240 miles) the field canvass by the

·Geological Survey has covered all but 22 square miles between Santa Monica and Beverly Hills and contiguous to the Santa Monica Mountains.

Descriptions are included in table 26 for 1,843 wells in the coastal

.zone; about 590 of these wells were not covered by any of the data

.antecedent to the field canvass by the Geological Survey. Of the 1,843 wells, 474 are in the area east of Vermont Avenue and south of Artesia Street, which was canvassed during the investigation *of* the Long Beach-Santa Ana area.

Table 27 presents a tabulation of the data available for wells in the 40 square miles of the in]and zone and in the 22 square miles

-of the coastal zone flanking the Santa Monica Mountains and not canvassed by the Geological Survey. None of these wells has been

-visited by the Geological Survey, and the data here classified have been obtained wholly by local agencies. For these 62 square miles, the 225 wells listed in table 27 probably include about all wells for which Jocal agencies have collected logs, chemical data, or periodic

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water-level measurements; the table also includes most of the wells n9w active in that area.

Locations of all wells listed in tables 26 and 27 are shown on plate

2. In the canvassed area, **all** wells that could be found were focated either by a pace traverse, by Brunton compass intersection, or by an odometer traverse. In a few cases, such as the well field of the­ city of Inglewood at Centinela Park, the wells were located by using· a planetable -and telescopic alidade. Those abandoned wells which could not be found in the field canvass were located by means of the master maps of the California Division of Water Resources. Original records of the field location and canvass are in the files of the Geologi­ cal Survey.

For the 62 square miles of the Torrance-Santa Monica area not. covered by the field canvass of the Geological Survey-specifically, the 22 square miles of the coastal zone flanking the Santa Monica Mountains and the 40 square miles of the inland zone-locatfons of wells were plotted directly from the master maps of the California. Division of Water Resources, the Los Angeles County Flood Control District, and the Los Angeles Department of Water and Power.

The three principal systems of numbers for water wells in the area. are (1) the serial-numbering system of the California DiviBion of Water Resources, (2) the location-numbering system established by­ the Los Angeles County Flood Control District which haB been adopted by several other agencies, and (3) the numbering i,ystem of the Geological Survey, based on a projection of the recta.ngular~ land-survey lines (described on page 11). In addition, the Los. Angeles Department of Water and Power applied a location-num-­ bering system to several hundred wells within the area in connec-­ tion with its former extensive program of measuring depth to water. The serial- and location-numbering systems have been described in an earlier report (Sinnott and Garrett, 1946).

In tables 26 and 27 the wells for which data have been mad€1 avail--­ able to the Geological Survey by other agencies are those which are numbered in each of the three systems or carry numbers of the Los.

· Angeles Department of Water and Power as well as "USGS" num-­ bers. All wells canvassed initially by the Geological Survey, nnd for which there are no previous data, may be readily identified in ta.ble 26 by USGS numbers only.

Table 28 presents a lithologic description of typical water wells in\_ the coastal zone. Field analyses of waters from wells in the coastal zone are given in table 29. Chemical analyses of native and con-· taminated waters from wells in the area are presented in tables 3Q.· and 31.

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| See footnotes at end of table. |  |  |  |  |  |  |

TAB4E *26.-Description of water wells in the*

Type of pump: Al, air lift; C, centrifugal; J, jet-centrifugal; P, plunger; T, deep-well turbine. Power: Use of well: A, abandoned and generally destroyed; Dom,,domestic; Ind, industrial; Irr, irrigation; Obs, Analyses and measurements: C, three or fewer "complete" chemical analyses; Cr, four or more "complete" of cuttings; W, miscellaneous water-level m asUJ'ements; Ws, periodic measurements at about semi­ ments at about weekly intervals; Wr, water-le el ·recorder operated currently. Symbol followed by

[Minor area at north end of coastal zone

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones t | |
| USGS | Serial No.2 | Loca- tion No.2 | LADWP  No.a | Owner or user | Q;)  'O  .:.:.l,:.:.\_.,  **J**  :::----- | +:,'  gQ;)  .cl  A | r...  Q;)  *+->ri,*  Q;)Q;)  s-§  - g  A | A  .£  ..o..-.-.-..-  .d %  =::;.  Q;)  A | "'  Q;)  A,..\_  ,b,l"'io  .----  c,  cl  8 |

T. JS., **R.14 W.**

Formerly G. A. Cor-

Adohr Milk Farms

telyou. ·

32JL •. B-12r 26360

151 50

99 362

95 425

7 ------ ------

26

12

32Kl

Water Co.

City of Beverly Hills:

32ML

228

------

110

204

226

276

26

52

---------- Formerly Ballona

.,.

6

8

12

13

58

185 23

238 88

32M2.. B-12aa 26261 ---------- Cadillac well, la 91 415

or 2.

32ML B-12t 2626E - --------- La Cienega, well 2. 92 340

16

26-16

---- ------

120

5

218

*22*

92 --------- -------- ------ ------

278 16

32ML B-12fl'

32RL\_ B-12p

32R2.. B-12q

33CL. B-120

2626M

2636A

2636B

2645A

---------- La Cienega, well

---------- Formerly Ballona

2A.

---------- do

Water Co.

---------- Formerly Julius

3302-.\_ ---------.... --------- 22-0-31

93 464

91 520

112 388

Houser.

Houser Ranch.. ------ 114 425

12 ------ ------

12 ------ ------

12 -----... ------

16 ------ ------

|  |  |  |  |
| --- | --- | --- | --- |
| 1/14-31BL. | B-12m | 2615 | --------- |
| 32DL | B-12 | 2625 | ---------- |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| B-12s | 2636D | -- -------- | Sentous well L---- | 91 | 310 | 26-16 |
| B-12v | 2626G | 22-0-24 | Cadillac well L--- | 91 | 354 | 16 |

**T. 2 S., J . 13 W.**

2/13-30NL\_ B-51b 1413 ll-A-20 Mrs. Ida E. Barrett \_ 140

31BL. B-52h 1424

3202-.\_ B-52i 1414A

31KL. B-57a 1425A

31CL ll-A-18

ll-A-17 --C--it·ydo Los Angeies•..\_ 132

133

ll-A-19 do .• 133

Southern California 130

Water Co., Broad­ way plant, well 1.

165

395

506.0

243

7

16

12

Plant, well 1.

Davis.)

*coastal zone of the Torrance-Santa Monica area*

E, electric motor; I, internal combustion; M, manual; S, steam; W, windniill. observation; PS, public supply.

analyses; Cp, three or less "partial" analyses; Cpr, four or more "partial" analyses; **L,** driller's log or record annual intervals; Wm, periodic measurements at monthly or less frequent intervals; Ww, periodic measure- "d" indicates measurements discontinued. ·

excluded; locations of wells not verified in fieldJ

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | r-..  .*<*:*lJ* ,  ,,,*<*;*lJ*  s.s  s  0 | ol!::  "O  $  <e'--'°  A | s0.  ::,  il; | Use of well | Analyses and measurements | Remarks 1 |

**T. l S., R.14 W.**

GraveL

A Wsd W-468, well 18. Obs Cpr, **L,** Ws \_

A **L** W-139, well 585 (Santa

Monica).

GraveL Obs Cr, **L,** Wm \_

do -- \_

do \_

do \_

Gravel and sand A Cp, L, Wsd \_

Sand and gravel ------------------

do \_

-------------------- PS Cr, Wm

*i*

s gravel ------- A Cp, **L,** Wsd \_

Gravel

LACFCD, well 2626J,

-------------------- Obs Cr, Wm \_

A L \_ A L \_ A **L \_**

A Wmd \_

W-139, well 575 :santa Monica)..

W-139, well 576 (Santa Monica). \_

W-139, well 533 (Santa Monica).

**T. l S., R.14 W.**

--------------------

--------------------

--------------------

--------------------

-------------------- 355 30. 5 T, E PS C, Cp, Wm \_

GraveL A L, Wmd \_

A Wmd \_ GraveL 720 52 Obs Cr, **L,** Wm \_

do --··

-------------------- A W \_

-·------------------ A Wmd \_

--------=--=--:-:-:-:-:-:-:-:-:-:::::::: ::::::: :::::::::: -AA::::::::::::: W**t;**m:df =:::::::\_

-------------------- T, E PS C, Cp, Wd \_

do -- \_

Wsd \_

Wmd \_

Obs **L,** Wmd, Ws \_

A Wmd \_

Wmd \_

Obs Wmd, Ws \_

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of weUs | | | | | Well data  .. | | | Water zones 1 | |
| UBGB | Serial No.2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | (I)  'd  ::s:::.\_  :..1.  -< | I  .a.c:  (I)  A | s..  (I)  :i  .a.,-,,aa  ....----  A | j  0 ......  ;;j  ----  A | ""''  =(I) ......  ,1,4  g  ..c:  8 |

T. 2 **S., R.13 W-Continued**

588 44

32QL.• B-57k

32Q2-.. B-570

32Q3 •. B-57L

1435 Formerly C. L.

1435B Formerly Nicholas

Powell.

1435A, 11-0-29

Kirst.

City of Los Angeles,

122 575

120 550

**121** ---------

16

10

14

------ -------

------ ------

------ -------

32RL. B-62c 1445B

-----------

99th Street plant:

32R2.• ---------- --------- ----------

WellL

Well 2.

118

118

620

610

16 305

535

20 309

326

537

32R3.. B-62o 1445E

Well 5. 118

38

17

15

15

18

927

20

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2/13-32NL\_ | B-57 | 1425 | ---------- | Golden plant, well 1. | 125 | 550 | 12 | 270  300 | 5  10 |
|  |  |  |  |  |  |  |  | 387 | 10 |
|  |  |  |  |  |  |  |  | 479 | 20 |
| 32N2 | B-57n | 1425B | ---------- | Golden plant, well 2. | 125 | 656 | 16 | 290  466 | 17  25 |
|  |  |  |  |  |  |  |  | 569 | 14 |

**T.2S., R.14 W.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2/14-3HL •• | ---------- | ----------- | ............................. | Artesian Land and Water Co.  Blue Bird Laundry and Dry Cleaning.  Formerly Artesian Water Co.  do -------------  do • --- -----  City of Los Angeles Formerly F. Rimpau  Dr. Olson ("Keating well").  Formerly F. Rimpau  Anita Baldwin Estate. Baldwin VJllage  City of Beverly Hills: Castle wen 2••  Castle well 3•••••\_ Standard Oil Co•••••.  City of Beverly Hills, Castle, well 1.  Southern California Water Co.:  SentWneeyllpLl\_ant:  wen 2 | 123 |  | 12 | ------  ------  ------  ------  ------  ------------  ------  ------  ------  118  182  -.,.-----  269  385  530  201  265  296  166  193  214  149  210 | ------  ------  .................  ------  \_..,  ------  ... -..---  ------  ------  ----2-9--  37  ------  **8**  7  25  50  20  17  22  15  51  30  47 |
| 3Kl ••• | B-15q | 2667B |  | 111 | 200 | -------- |
| 3K2••• | B-15e | 2667A |  | 112 | 233 | 7 |
| 3M!... | B-15c | 2657 | ---------- | 100 | 307 | 12 |
| 3M2 ••• | B-15d | 2657A | ---------- | 103 | 801 | 12 |
| 3QL •.  4Al.••• | B-15 B-15f | 2667  2656 | 22-D-10 | 111  99 | 661  297 | **10**  12 |
| 401 •••• | B-12z | 2646 | 22-0-27 | 99 | 1,240 | 12 |
| 401•••. | B-15n | 2657B |  | 100 | **125** | 12 |
| 4ML ..  4Nl •.• | -------------------- | --------- | 22-0-32  ---------- | 118  104 | 150  300 | **10** |
| 5BL •• | B-12f | 2636 |  | 83 | 317 | 26-16 |
| 5B2•••.  5CL •• | B-12bb B-12dd B-12a | 2636E  2626K  2626A | 22-0-16 | **83**  82 | 430  752 | 18  12 |
| 502....\_ | B-12u | 2626F |  | 81 | 333 | 26 |
| 5DL •• | B-12b | 2626B |  | 88 | **274** | **16** |
| 5D2••• | B-12c | 26260 |  | 88 | 269 | 18 |

See footnotes at end of table.

*zone of the Torrance-Banta Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Oontinued | Pumping data | | | Miscellaneous | | |
| ... Character of  material | IS  0.•  ;,,,,i  o | =  0 ......  ii  .*a*..*,'-"*  A | a'  ::,  P-t | Use of well | Analyses and  measurements | **Remarks'** |

**T.2** S., **R.13 W.**

\_

do ----------------------------------

do 500 50. 5 T, E PS Cr, Cp, L,

Wmd.

Gravel and sand

do ---------------- ------------------

do A Wd

A L W-139, well 018 (Re-

A Wmd \_

dondo).

Medium graveL T, E

PS Cr, L, Wmd \_

Gravel ---------------- ------------------

Grai:------------ ------- ------- -· T, E PS c, L

d1o

T, E

PS C, Wwd \_

do Wm. \_ do

T, E PS C, Op, L, Wsd,

Gravel 430 95

T. 2 S., **R.14 W.**

Wsd W-139, well 4€, (Santa

Monica); W-468,

T,E

Dom, Ind C, Op \_

A L \_

A L

A L \_

Obs L, Wm \_

well 14.

W-139, well 4ll1 (Santa

Monica).

W-139, well 47' (Santa

Monica).

W-139, well 48 (Santa

Monica).

A L W-139, well 5 : (Santa

A Wmd

Monica).

A L W-139, well 57'7 (Santa

Sand and gravel shells.

Sand and gravel

I, 010 31

T, E

A Wd \_

Irr C, Op, L \_

----------------------------------

Monica).

-·-·····------------ ---------- A Wsd \_

-------------------- T, E PS Cr, Op, Wm \_

Gravel and sedi- C, Cpr, L, Wsd.

ment

do

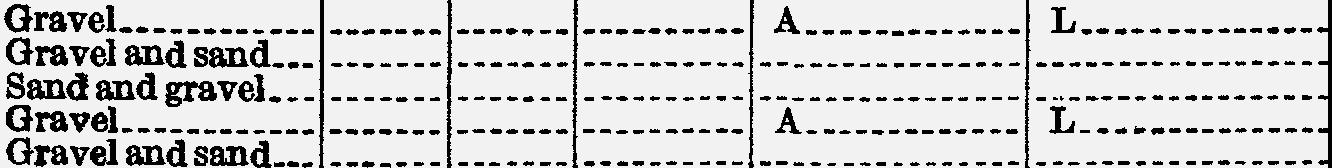
Sandand gravel

Sand, gravel, and T, E PS C, Cp, L, Wm,

clay. Wwd.

Gravel

Sand and grave} ----------------------------------



**46050&--59--19**

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| usos | Serial No.2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | Cl)  "O  .:.:.s,:.:.:.\_,  **:i**  -< | ..  ig  p.C.l  Cl)  A | ...  Cl)  +->'<i,'  <D<D  s-2  !§  A | .As  o,-..  p.**j**  <D  A | "Cl')  .::.:,;-  -M<D  0  .Cl  8 |

5D6 B-12y 2626H

**T.** 2 **S., R.14 w.-Continued**

Well 6·--·--···

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 2/14-5D3  5D4 ••• | B-12e 2627A  B-12ee 2626L | 22-C-17 | Well43---·--.--- | 88  88 | 279  --------- | 12  -------- |
| 5D5 ••• | B-12n 2626D |  | Well 5------··· | 88 | 266 | 30 |

88 810 16

------ ------

------ ------

152 8

172 25

209 48

326 16

492 18

5D7-•• --------...- --------- ----------

5D8 ••• ---------- --------- ------..---

5D9 ••• ---------- --------- ----------

5Dl0.. ·--·------ -----·--- ----------

Well7 -··-·····

Well 8•.•.•••.•

Well 9•.• · ·-

Well 10•••

88 287

88 425

88 54

88 290

158 24

190 17

225 37

70 18

160 64

248 34

342 13

362 8

23 5

34 20

121 11

145 4

11!4 4

188 36

5EL.\_ B-12L 2627E Formerly Cassernia, 94 --------- -------- ------ ------

well 3.

5E2-.\_. B-12k 2627D Formerly Cassernia, 92 59 -------- ------ ------

well 2.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 5FL.\_ | B-12i | 2627B | Formerly Pedro·-·--·- | 102 | 152 | 12 |
| 5F2 . | B-12d | 2627 | 22-C-13 Shell Oil Co\_.• \_. | 95 | 200 | 14 |

5ML B-12j 2627C 22-C-12 Formerly Cassernia,

well 1.

5NL •• B-13g 26270 Forthman Nursery··-

5p1\_ B-13e 2628A -··---·-·· Moynier Ranch\_.\_ ..

5P2 •• --------·- --·------------·---\_. do·-··-·--·-··-·---

98

105

115

178. 8 ··-··-··

15

37

65

127

20

16

10

36.

25'

12

5P3\_. B-13c 2628 22-C-8 \_. do·------··-·---·-- 123

5P4\_. B-13aa 2628C 22-C-9 Rindge Ranch·-···-·- 110

69.2

417 12

59 6

68 12

5p5 -·-··----- ··------- 22-C-10 Armel Moyer ·· 99

6BL. --·-----·- ·---··--· ---··----- LosAngeles County•. 100 47

7 ·····- --·-··

6HL .. -----·--·· ··--·-·-- -·-··-···· LACChemicals, Inc.- 93 190

12 60 12

108 22

**7Kl.\_.** ····-···-· ···-····· ······-·-· Standard Oil Co.,

"Vickers 2-4."

210

7ML. B-13a 2609A 22-C-5 Mrs. J. D. Machado.\_

67 500

12 ·····- -··-·-

7M2. ··-··-·-·- -··-···- --··-

UharietL -•.• \_ - - ...... 57 26

Metro•Goldwyn• Mayer Corp.:

7PL•.- --········ ·-·- ·--

Old well..•...•.•.. 53 102

10 --·--- ----·-

7P2•\_.• ········-· ···- ·-

Newwell..•••••\_..

57 265

16 122· 6

175 12

8CL •. ········-- -··---·-- ···-··---- A.Fernella·--··-···-·- 165 185

8DL •• B-13h 2628B -··------- Forthman Nursery... 125 25

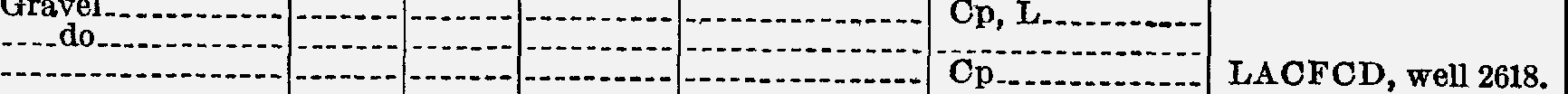
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 9AL ••. ··-·-··--· --·--··--- Baldwin Estate·--·--- | | 100 | 438 | 12 | 256 | 182 |
| l0FL\_ B-16i 2668B 22-D-18 Sunset Fields golf | | 116 | 572 | 14 | 220 | 10 |
| course, well 3. | |  |  |  | 360  386 | 19  . 36 |
| 10F2•••••••.•..•• ······--- ··-------- | Rancho La Cienega\_•. | 112 | 402 | | | |
| l0Ll••• -···-···-- ·-······· 22-D-5 | Sunset Fields golf | 118 | 417 , 12 ----· - --·- | | | |
|  | course. |  |  |  |  |  |

See footnotes at end of table.

*zone of tne Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones t-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | pt,...  rn:-:8:,  :g;.as  o | 0*Ii::* .......  '0  *!*o*:*s*:*'*:*-'  A | a0.  :::,  ll,,i | Use of well | Analyses and measurements | Remarks 7 |

**T. 2·S.• R. 14 w.-Oontinued**



· A Cp, L, Wd

ll L

A Cr, Cp LACFCD, we 2627 ..

Sand and graveL\_ do

do

Sand and graveL\_

Sand, gravel, and

400-

150

T, E PS Cr, Op, L, Wm\_

T, E PS Cr, Cp, L, Wm\_

-sacilla.yn.c'fgraver-- ---3\_50 ------- -- T, E\_-- P Cr, Op, L LAOFOD, well2626N.

do

i:d :t:==:=::: ::::::= - - - --- -=- :::=:::::::: - •- :::::::::::: LACFCD, well 2626P.

FinegraveL ·

Sand and fine ·

gravel. ' ·

Sand.andgraveL ------- ---------- ---------------- -C--,-L--------------

Clay and grave}

LACFCD, well2626R.

Sand and gravel--- T, E PS C, Cp, L LACFCD, well 2626S.

doo ·---- ---------- ---------------· --\_

do A

C-p-, L \_

A L \_

GraveL A . L \_

do

efdgravel::: ::::::: ::::::: :::::::::: :::::::::::::::: ::::::::::::::::::

-------------------- A Cr, Cpr, L,

, A .

OpW, mL,dW. sd \_

-::::::::::::::::::::::::::::::: '. :::i:::::::::::::- ;; :w \_

do

-------------------- A L, Wmd \_

-------------------- ------ A Wsd \_

· \_ A Wmd \_

No casing in well.

W-139, well 606 (Santa Monica) W-468,

well 15.

P,W

Dom, Stock Cp, Wmd \_

C Dom

Cp LACFCD, well 26090.

---·--------·------- 350 T, E Dom, Ind C, Op \_

Sand and graveL\_ 550 75 Jnd. C.L. \_

do ----- 0--

-------------------- P, W· Stock C, Op \_

-Sa-n-d, -g-r-a-v-e-l-,-a-nd 1-25-

.---..-

LCp · \_

i:dcleayl:.----------- ---- - ------- ---------- \_Dom,·rrr Cp, ws \_

Gravelandsand ·

----- - - .----. - - ----- - ------ - -------- .. · L ·----------

-----·-------------- ------- ---------- ---------------· L, Wmd

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| usos | Serial No.1 | Loca- tion No.» | LADWP  No.a | Owner or user | Cl)  "O  ::s:::.\_  :1  ::=-  **,cs** | i  @,  .Cl  A | ...  ..C.l).....  a!  -o-s-.S-  A | .0s.  o.-..  :i;j  o.---  Cl)  A | <O  <O  =Cl) ......  :i  .-C-l -- |

..

**T.** 2 **s.. R.** 14 **W.-Continued**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2/H-10L2- lH6g | | 2668A | 22-D-6 | Sunset Fields golf  course. | 118 | 531 | 12 | ------ ------ | |
| lOQL. B-16j  1401••• B-16c | | 2669  26790 | 22-D-19  22-D-4 | Los Angeles Invest- mdeont Co. | 130  127 | 454  608 | 16 | ------ ------  10 | |
|  | |  |  |  |  |  |  | 334 13 | |
|  | |  |  |  |  |  |  | 362 12 | |
|  | |  |  |  |  |  |  |  | |
| 1402•• | B-16d | 2679D | 22-D-15 | do | 127 1,015 | | 16 | 410 | 23 |
|  | | | | | | | | 435 | 2 |
| 622 | 10 |
| 656 | 2 |
| 666 | 26 |
| 843 | 21 |

1403

B-16 B-16a B-16b

2679

2679A

2679B

do

127 300to150 12

150 12

417 24

969 4

29 • 12

50 6

14 34

53 73

90 222

252 20

------ =-----

55 3

197 33

252 20

288 17

395 33

132 27

196 7

226 8

378 33

------ ------

------ ------

------ ------

148 36

2'15· 8

183 23

------ ------

\_..,. ----·-

208 22

... ------

------ -------

------ ...-----

95 27

180 11

246 39

150 12

14FL- B-46f

1380

•••••do

129

420 12

**15AL-** B-16k

2679E

•••.•do

123

840 16

18BL.. B-13d

2619

Standard Oil Co 203

388 14 •

18DL- B-13b

18EL.\_ B-34d

2609B

1300

Machado 50

Formerly Lugo 35

84 16

126 12

t 18FL.. B-13f 2619A 22-0-7 Lewis A. Crank 18F2•-• do

22-D-3

22-D-2

22-D-1

10-B-1

22-C-2

131

112

265.8 12

550 12

18PL 33

18Ql B-34f 1311 Holy Cross Cemetery\_ 145 19CL.. B-34i 1311A 10-A-4- Fox Hills Country

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | ClWube:ll i | 41 | 501 | 18 |
| 1902.•• B-34j | 1311B | 10-A-3 | Well 2 | 50 | 500 | 18 |

350 14

19Kl..

Arthur Vallon

60 200 10-8

L- -B----3-4-h---- --------- ----------

1332A

Formerly Stand.wd 157 300 16

Oil Co.

|  |  |  |  |
| --- | --- | --- | --- |
| 10-A-14 | Formerly Los Angeles  Investment Co. | 158 | -------- ----- --- |
| 10-A-16 | F-Orlllerly,E - | 151 | 310 |

2 ••• --·------- ---------

21ML B-38o 1342

21Nl.. B-34g 1332 10-A-13

do

139 236

22AL.. B-421 1371 Formerly Swan 175 210 --------

22BL.\_ B-42) 1361 Formerly Geo. Goeri- 186 152 7

mann.

2201.\_ B-42k 1361A Formerly John May- 174 122 7

bohm.

22Hl •• B-42L 1371A Formerly Margaret 157 --------- --------

Nelson.

22H2-. B-42p 13710 Formerly City of Los 160 263 --------

Angeles, Hyde Park

22H3

B-42m 1371B

well 1.

Formerly*1.* T. Nelson\_ 157 145 7

22Nl•• B-38a 1352A Cit of Inglewood:

Well 8------------- 148 290 18

See footnotes at end of table.

*zone of tke Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | :Miscellaneous | | |
| Obaracter of material | ta  s::i,..  §.a  El  0 | 'Co ....  di.J.\_,  A | s:i.  :E:,l  P-4 | Use of well | Analyses and  measurements | Remarks' |

**T.** 2 **s.• R.14 W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | T,E | Dom, Irr PS | L, Wmd, Ws \_ Wmd, Ws \_ | Tbese three wells were interconnected.  W-1319 well 213 (Reaondo).  W-139, well 214 (Reuondo).  W-139, well 216 (Rooondo).  wcA o':f) l7 |
| Gravel T, E PS 0, L, Wsd,  do Wmd. \_  ==':=, =!J=nd::g::r::a::v:e::L::. ::::::: ::::::: :::::::::: ::P:s:::::::::::::::C:r:, :L:::::::::::::\_ | | | | | |
| do  do  \_San~~do~~:nd gravel::: ::::::: ::::::: :::::::::: :::::::::::::::: :::::::::::::::\_::: | | | | | |
| -------------------- **A** 0, Wmd \_  :::::::::::::::::::::::::::::::::: *?:. ---* i::::::::::::: W Wmd  G-r-ad L P-, E L, Wmd \_ | | | | | |
| Gravel and sand \_ **A** L \_ SandandgraveL  ===== -= ====:::=::: ======= ===:::: --·rr;E·-- ::rn:::::: \_8i> i, :- :  -------------------- T, E Irr Op \_  Gravel T, E Dom, Irr O, Op, L, Sand, gravel, and ------- WmdWs  ------------------  Grcalavyel. and sand GraveL Sand  SandondgraveL .. T, E Dom, Irr C, Op, L, Wm\_ d\_ | | | | | |
| do  do  ----·--------------- T, E Dom, Irr Op \_  -------------------- ------- ---------- **A** L \_  **A** Wsd \_  2: !JndgraveL\_  **\_ A**  \_ O,L \_ San4aoand gravel\_ A L, Wmd \_ | | | | | |
|  | | | | **A ------------------** | |
| -------------------- ---------- **A** L \_  **A** L \_ A L  **A** L. \_  **A** L  \_Grad:-\_-\_:::::::::: ::::::: ::::::: :::::::::: :::::::::::::::: \_Op, L:::::::::::  Gravel and sand ··----- ----·-···· ---·····--·---·- ------------------ | | | | | |

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282 GEOLOGY, HYDROLOGY, TORRANCE-S'ANTA MONICA AREA

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| usos | Serial No.2 | Loca- tion No. **2** | LADWP  No.a | Owner or user | d)  ,i::,  =::i:..  ""  -< | ..  !  :5  85'  A | . ...  'oo'  \_,a,.,-.,5.a.,  :A | 0.  .£  o,-,.  ;;-j--  A | "'  A,..,\_  )  .-c:-: -- E-1 |

T. 2 **S., R.14 W.-Continued**

**2/14-22N2.\_** B-38b 1352B Well9

22N3.• B-38d 1352D Well 11

**22NL.** B-38e 1352E Well 12

22N5.• B-38f 1352F Well 13

142 297 18 86 9

97 13

113 36

173 17

242 23

144 290 18 105 15

176 20

246 21

145 282 **18** 98 17

122 45

170 25

239 21

23

|  |  |  |  |
| --- | --- | --- | --- |
| 146 | 300 | 18 | 184 |
|  |  |  | 246 |
| 165 | 325 | ··-·1s·· | 187 |

8

22N6.•

..,

.., ----------

Well 20 26

22Pl••• B-38u

1352P

Well 19..

150

314

188 20

22P2••• B-42v

1362H

Well 24

161

400

265 27

18 216 11

23

23DL. B-42w

1371D

St. Mary's Academy.•

142

267

,..

23GL. B-46a 1381A

Golden State Creamery.

137-

418 -

--··12·· ------ ---...--

23Hl.. 1381E

City of Los Angeles: ManWhaetllt2an plant:

137

588

16 293 52

457 18

505 62

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23H2•• | B-46e | 1381D | Well 3A••••.•• | 137 | 827 | 20 | 449 | 30 |
|  |  |  |  |  |  |  | 488 | 30 |

720 76

8

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 23H3.. | B-46h | 13910 | Well lA | 136 | 599 | 20 |
| 23NL. | B-42n | 1372 | Formerly J. J. | 152 | 339 | 12 |

Leuzinger.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 24GL. | B-50a | 1401 | 11-A-3 | Earl McCormack. | 139 | 251 | 12 | 70 | 14 |
|  |  |  |  |  |  |  |  | 100 | 17 |

-··oo" ------

24HL.

- --- ..

143

146

162 11

25GL. B-5la

1403

ll-A-21

Formerlfi Eliza

151

125

12 90 20

2502•. ----------

... ----------

Conne ly Farrell. Eliza Connelly ••

152

108

7 ------ ------

27AL. ---------- --------- ----------

King

186

---··s·· ------ ------

27BL.. B-42g

27CL. B-42f

1362B

1362A

10-B-7-

Fred Jex

Inglewood Park Cem tery ·Associa- tion:

191

110

------ ------

27C2.•.

2703.\_

2704

27C5••

B-42u

B-42t B-42r

B-42s

13620

1362F

1362D

1362E

Well 8..•. •.••..

Well 10

Well9 Well4

Well5

159

157

157

157

375

350

350

302

16

14

--------

-------- ------ ------

|  |  |
| --- | --- |
| 157 | 279 |
| 158 | 501 |
| 157 | 335 |

44 96

176 19

235 43

188 11

242 4

252 32

148 22

214 32

12 76

136 30

214 22

2706.\_

2707

B-42c B-42q

1362

1362C

10-B-8-

Well3L •••••••.••••

-------- ------ ------

See footnotes at end of table.

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | **!o**  m:i  !  Cl | 0,-..  ".d,,--  ,S  A | aPo  ::I  Poi | Use of well | Analyses and measurements | Remarks' |

**T. 2 S., R.14 W.-Continued**

|  |  |
| --- | --- |
| Coarse gravel\_, 325 T, E pg Cp, L, Wsd \_  do ------- ------------------  Ci ocalrdseggrraavell=== ===:::: :=::=:: =::::::::: =======:=:::::=: :-:-:-=-:-:-:-:-:-::-=--:-:-:= =-  GraveLand sand 700 T, E PS 0, Op, L, Wsd \_  Sand and graveL-- ------------------  GraveL 500 T, E PS Cpr, L, Wsd \_  cl r:=L: ::::::= :::=::: :::::::::: ======::::=::::: :::::==========:::  OoarsegraveL ------------------  GraveL 400 T, E PS C, Cp, L, Wsd Gravel and coarse ------------------  sand.  Sand and gravel -------------- T, E .Ps C, L \_  do 600 T, E PS C, L, Wsd \_  do 550 T, E PS C, Cp, L, W  -------------------- ------- Dom Ws \_  Wsd | W-139, well 225  (Redondo).  WcA! o fti--468, well 2.  W-139, well 733 (Redondo); W--468, LAwCelFl 3C.D, well 1372A. |
| Sand and gravel.. pg 0, L, Wmd \_  do  gG:r;a:v:eglraanvdesfa"nd ------------------  3,050 40 ---------- \_Ps 0, L, Wsd \_ |
| Gravel and sand \_  -Gravei"·---------- \_2' 700 47 ---------- rs £• L, Wd  -s-an!?icfgravef-- ------- ------- ---------:- Obs : L, Wmd, Ws  **A** Wmd Sand and gravel.. **A.** L, Wmd \_  A Wmd  A c  A L \_  orad landsand ------- ------- ---------- ---------------- \_c, L, Wmd  -sGrruaiv1elci"siieiii ------------------  550\_------- T, E Irr L \_  t;!:i1 c= ======= ======= ---T:-:iif-- -Irr============ -L,-Ws--==========  Sand and gravel\_ A L \_  do  do  ------- -------- --- . ---- \_ \_ \_ \_ A- L . \_  -------------------- A------------- Wmd \_  -------------------- ------- ------- A------------- L \_ |

\_

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water  zones t | |
| USGB | Serial  No.• | Loca- tion No.• | LADWP  **No.a** | Owner or user | G)  ':O:,:;:\_  **::::e1**  -< | ...  *l*  .pcl.  G)  A | I-<  ..G.).,;;;-  G)G)  s-§  ..o..s S..  A | .As.  *i g*'-a3'  G)  A | "'  G)  .bAl .'."..'  ***i***  .cl  8 |

2/14-27Dl

, B-38

1352

**T.** 2 **S., R.** 14 **W.- ntinued**

City of Inglewood:

Well 7-------------1 145 I 300

18 I 78 37

135 24

177 14

27D2,

B-38c

1352C

Well10------------, 155 I 293

18I

245

23443

21

163

30

27D3- \_

B-38g

1352G

Well 14

133

355

18 53 63

166 23

27D4\_ -1 B-38t

1352o

J=..'..

Well 17 1 Inglewood Paik

Cemetery

Assoc1ation:

1671 350

18 I

239 10

195 12

256 55

:::==,.

27Jl ,

:!;1

B-42b

1373A 1

10-B-18

10-H.

Well 7**2** --**\_**

Well 11

City of Inglewood,

163

165

165

275

300

350

--------

--------

16

18

101

84

195

195

256

236

127

76

9

15

8

47

27J2••• B-42

1373

well 16. Formerly R. A.

1,097

244 ---------

234

323

r··-·r··--

Lt--1.B-42h

J 1373\_B \_i----------

Coulter.

Formerly Trueblood.­ Inglewood Park

Cemetery

12

234 350

-------- ------ ------

U::Jijg

--n i -•----------

AsWsoeclila6 tion:

Well 12..

Well 13

CityWoef lIln1g5lewood:

\_ 250 11,300 I 2o-16- 242 20

12 270 16

I

310· 20

515 10

6201 7

------

\_

165 650 16 ------

\_

161 707 16 ------ ------

\_ 136 382 18 136 9

28El , B-388

**1343A**

Well 23 \_

149 19

28Fl••• B-38r

1342A

Well 25 \_

106

120

400

398

18 247 45

18 156 20

274 20

28HL.1----------1---------1 1 FoFrmreemlyanD. .

- 1 - ====m---- --- - --

28L1--- ½ 1:g City of Inglewood: Well 27 \_

162

168

169

131

191

157. 5 191

600

9¼ ------ ------

8 ------

------

10 ------ ------

18 300 7

28ML B-38w

1343B

Well 26 \_

104

548

396 42

18 143 47

267 40

428 22

28Ql-- ---------- --------- ----------

Formerly P. A.

.., .

,oo I 7 I 100 90

29KL. B-34k

29QL. B-34c

1333A

1333

10-A-17

10-A-9

FrManokorAe.bell \_ Formerly **A.**

104 180

101 183

1 1·r===r====

29Q2

30Ll

32Al--

B-35f B-34 B-35e

1333B

1313

1334B

10-A-8

10-A-5

Cortrite.

Formerly Rena Fleming.

Formerly E. Newbury.

Formerly J. W.

Hoff.

100

125

102

200

220 12 •------,------

f :: -Ji.:g5a·-- -iaii , } !: 5

32DL \_ B-35g 1324B

32EL. B-35c 1324A

32E2. \_ B-35h 1324C

32E3-- B-35m 1324E I 10-A-6

See footnotes at end of table.

Formerly B. F. Ever Formerly Bowler \_

F. E. Voorhees \_

William Krutz \_ Formerly Curry \_

E. Newberry \_

102

100

99

99

100

100

129000 I 58 i------------i------------

210 10 ------ ------

16. 4 7 ------ ------

*wne of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones t-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | s::i,o  Ul  Sa  El  0 | =  0,......  '.d,,,l.!...!..  s...  A | 0.  E::,l  P-t | Use of well | Analyses and measurements | Remarks' |

T. 2 **S., R.14 W.-Continued**

|  |  |
| --- | --- |
| ted graveL -----·- -····-- ·-·····-·-• Obs-··-··-·-·· .Wm ;\({ .....  Cemented sand••• ··-···· ··--··· -·-·-·---- ---------····--- --····----·-·-----  Gravel ••••••• ·------ ---------·-·---- -·-------·--------  Sand and graveL. 275 -····-- T, E PS·--·--- Cpr, L, Wsd.• -.  .\_do-···-·-·-·-·- ---···- -·-···- ·-----·--· -···---·-------- -··-···-·-·---·--- | W-139., well 175  (Reaon.do).  W-139! well 177 (Reaondo).  W-139., well 132  (Reaondo). |
| Gravel and sand 400 ··---·· T, E PS·-··------·- C, Op, L, Wsd.•  -·-·-do....\_. .\_ ·------ ------· ----·-·--· ------------·--- ·· -·--·  -·-·-do...• • ---···- ·------ -···-·---- ------·----··--- --·-·-------·-----  GraveL.-·------·· 300 --····- T, E PB--·----·· C, L, Wsd. •  Sand and gravel... -----·- ·---·-- ·-----·--------- ----·-------------  -···-do.\_.. -----···- 420 --·--·- ----·-···- **A--·-·'-·-·--·** L,Wmd---·-···  ·-·--do ·-·-·--· ··--··- ·-···-- ·········- ···-····-··-··-· L, Wsd·-·--·---  1::d dgravel.\_. ··----- ·-··--· --·-·----· -Obs•. ·-··-·-·- -ww.·--··---·-··  ·----do... ---···--·· ··-·--- ---·--- --···-·--- ·-----------··-- ---··-·--·--------  Fine gravel.....•-. 450 -···-·- T, E Irr.--·-·-··-·· Cr, Op, L, Wmd  --··-·--·-····-····- ·-····- -·-·-·· -···---··· A-······-····· Wsd·-··-····-··  **A---·····--···** C, L----·-·-··-·  Gravel -····-···-- .••.••• ··-···· ·--·····-- ··---·------···- L.·---··-----·-·  ---·-do.\_.•. ••••••-- ·------ ----·----- ----------·--·-· ------------------  do .•••\_. • ··-------- --------------·· -----------·------  ·---.do.\_.•• ••\_. • -·-·-·- ------·--· ------·------·-- · --·  -··--do.... • -·----- ---·--- ---------· ·-------------·- ----·-·-----------  **A.·-··--···-·-** L ... ··· ·-  -·-··----------····- --··-·· ••..... T,E Irr··--·--····· L, Ww.·----·---  GraveJ. •\_.• ...•. ---···· -·-··-- ·---····-· **A.·-··--·--·-·** C,Op, L, Wd••.  Gravel and sand ··--·-- ··--·-- ·-----------------  Sand jmd gravel... **600** ·--··-- T, E PS--·-···-·--- C, Op,L----·---  Gravel.\_. ·-··-·· 600 ·--··-· T, E PS·-··-·-·---- C, Op, L..•••--.  Gravel and sand ---·--- ------· --·------------· \_  -······-·····-·-··-- ··-···· ····-·· -----····· **A.·-·······-··** L·-·--··----··--  ·······-·······-···- ---·-·· ···-··· -········· **A·-···-·-··-··** Wmd••• ·-···-··  ···-············-··· .••.••. ···-··· ·-···-···· ····-····-······ Wmd.·-···--···  Gravel....•.•.·--· 600 ·-·---· T, E PS-···-··-··-- C, Op, L-· ·-  Sand and gravel... -·-···- ·--·--·--- --··------------ -··-----·---------  Sand and gravel... 700 ----··· T, E PS.•.••••.•• C, Op, L.·-·-·--  ----.do ·--·-----·- ----·-- ----··- ---·--·--- -----·---·------ --· ­  do ..•. ··----- -·--··- ··--·-- -·-------· ·------· --·­  Sand--and gravel.•. -·-···· ·--···· ···-·-···· A-··--·····-·· L·-·----- ·-  Dom... ·--···- C, Cp....·-··---  **A........-....** C,L,Wmd·-·-·  **A... ·---···-··** Wmd••••.----··  **A\_--··---···-·** Wmd·----·· ­  **A-·--·-····-··** C,L.-·-·-···---  **A\_. . .** ·--··-·-·· -·--·  Obs·--------·· Wmd, Ws..• ----  **A..........\_.\_** C·---······-··-·  ·-··-········-····-· -----·· -·-·-·· T,I Dom, Irr-·--·- C, cl L, Wd •••  **f··---···--···** Wmd\_-··-·-·--- |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water'  zones't | |
| USGS | Serial No.2 | Loca- tion No. 2 | LADWP  No. **a** | Owner or user | Q;)  ':O:s;.\_  **:**:i**:e** | *Z'*  .s  '--"  .cl  i  A | $.<  Q;)  +a'ri:i'  Q;)  s-5  - g  A | .§..'  ;o;.-i-..  **e**  Q;)  A | f/l  .."Q;')  i:lz-  - J  ;,8'--'  E-t |

**T.** 2 **S., R.14 W.-Continued**

2/14-32FL--1 B-35k I 13340 j j City oflnglewood:

Well 2L-----------

--- ----1 "3'27I ..30

97 400

32F2

32.Tl\_ --

B-35j

B-35

1324D

1334

----------

10--A-ll

Wen22

Formerly Sarah

97 403

99 70

1: -- !- --!!\_

32J2 B-35b

1334A

10--A-10

Kummer. Formerly Los

Angeles

98 100. 5

12,

,

32QL-

33BL\_

B-35i B-39c

1335A

1354

----------

10--B-16

Water Service Corp. Formerly Japanese

Gardens.

W. H. Kelso

96 I---------I--------I- ---- 1 "

144 I 301 8 234 I ·41

33LL B-39d 1344A 10--A-12 Formerly Metcalfe \_ 33L2 Haenggi\_ \_

33Ml-- B-35d 1335 Formerly W. H.

Neher.

33PL-- B-39a 1345 10--0-11 Formerly A. R.

McGregor.

34CL\_ B-43a 1364 10--B-13 Inglewood Country

106

104

99

99

147-

230

204

300

450

12 I------•------

16 264 I. 98

3402

Clduob.

\_ 147

835

18, , \_

34Fl Hollywood Turf Club:

Well2 \_

34LL B-43 1364A ------------------------

152

137

450

16 ,------•------

12

34L2

---------- ---------

Well!\_ \_

137

500 10

35AL\_ B-47 1384 Formerly City Brick

Co.

36BL- B-52a 1404 Southern California

Water Co., Manchester Heights plant, well"!.

36HL-1----------1---------1 1 Formerly Mrs.

Bedell.

175

165

151

320

110

12

12 ,

7 ,

, \_

, \_

36KL-1 B-52 1404B I 11-A-22

36QL-1----------1 1 11-0-39

Olivita Mutual Water Co.

Formerly Gaucher \_

175

187

565

16 ,------,----

**T.**2S., R.15 W.

2/15-lBL j B-9e

rn ---- \_

25970

Garnsey Investment Co.

i----------

Southern California Water Co.:

ManWnienlglLplant: \_

122 75

175 358

(8)·

:n 44

B-9p 2596\_A \_

1C3 B-9a 2596

mt:: ========== :::::::::i=:::======

Well2 \_

Well**3 \_**

Well **4 \_**

Well5 \_

176

175

176

175

261

263

304

865

464

16 ,------,------

14

16 116 96

14 112 83

1Fl J , J

J Formerly M. P. Kane\_ j 112 j 250

7 , ,

lPL I B-9c

2597A

J. W. Bearman \_ 88

60. 5

10 ,------,------

1P2

B-lOp

2598

23-D-19

Guy Beringhely \_ 84 80 10

lP3 B-9d

2597B

Formerly Borjorquez

80 66 7

2AL

1. B-9g

2586

Formerly W. K.

187

305

10 143 40

2A2----1----------1 123-D-14

2DL ---------- 23-D-30

Church.

Formerly J. R. Sabichlt 190

300

360

12 ,------•------

See footnotes at end of table.

I

Tom Graham

139 12

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones l-  Continued | Pumping data | | | M.isoollaneous | | |
| Character of ateriaJ  I | ·tiJ  A"'  'rn-caP  g\_s  ::;a  p | A  13:  0 .......  'd  !3:$  GJ'-'  1-1·  A | aA  l:l  'll-t | 'Use of wen | Analyses and measurements | Remarks• |

**T.** 2 **s.• R.14 W.-Continued**

|  |  |
| --- | --- |
| Sand and graveL. 720 •..•••• .T, E PS. C,Op, L, Wsd..  ·-G•r-a.dveol..a.n-d.-s--a·n··d-.-. \_. ~~43~~•0.••.•••• ---T·,--E·--- ··P-S-·----·.. ···- ··C·,--C-p-,-·L-,--W ·-\_    Boulders •• ----·----·-··· --·-·-- .......... -A--···-·-···---· --C-, --C-p-·,-W--m·-d-\_-·••-•· |  |
| -------------------- ------- -·----, - ---------- A--· C, L, Wmd •  A- --- -·---·-- C, Wd-·----··-- |  |
| Sand and graveL A--·--------·- L, Wd W(Ii o'ri t4  -------------------- ---.--- A---·--------- Wmd·-- ·--  C\_ •• \_•• \_. L ACFCD \_well 1344.  -------------------- ------- ------- ---------- A------------- L.-----·-------- wcl! /159  A------------- Wmd \_  Gravel and sand 700 70 T,E Irr-·-··-·----· Cp,L, Wmd.•    Irr.-•····-·•.- -·-·--·-·-·--·--·-  1,500 T, E  . ====== 8: tvci==========  500 ·-···-· T,E Dom, Irr.•r••· ·-····-·-- -·--·  A·-·-·--·-··-· Wsd\_·-···-·--·-  400 ·---··· T, E PS •• ••..\_. C, Wm\_··-··---  A--·····-·-··· Wmd----··-···- W-139, well 713  (Redondo), W-468, well 4.  T,E PS\_·--·-·····- Wsd.·-···-···--  A. .\_•. •••••. Wsd.·- --· | |

**T. 2** S., **R.15 W.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sand and gravel••• | •••.••. | ..•.• - | -··------- | A.-------·····  ps | L------·-------- | W-139, well 678 (Santa Monica). |
| ··----·-----··-··-·· ------- ·------ T, E Cr, Cp, Wm \_  A.--------·--- C, CP ·--·--  Sand and gravel... --·---- --------·· A••• •·--···-·· C ci.Wmd,  •••••dO---··--·-···· ··----- ·-----· ---------- -----------··-·· C, L\_ ·----------  ---------·-····--·-· ···--·- ··--·-- T, E PS-·-----· C, Op,Wm •  A••• ---------· Wmd••••.------  WS --·  ·-··--·------------- ------- ·---··- -------·-- Obs-------· Cp, Wm, Wrd.\_  ·······--····-···--· ------- ·-----· ---··---\_,.- A••• ---------- Wsd.-----------  Sand and gravel--.---··:· ·-··--·····-····· A-----·--·-·-· L•••-•.--··--···  A.·-·-·-·--·-· Wmd\_ ···· ­  -············-····-· ....•.• --··--- T, E Irr---·---···-· Wmd••••·-··--· | | | | | | LAOFCD, well 2596B.  LACFCD, well 25960. LACFCD, well2596D;  initial depth 865 ft., plugged at 464 feet.  W-139, well 820 (Santa Monica); W-468, well 16.  W-139, well 833 **(Santa**  Monica); W-468, well 17.  W-139, well 693 (Santa Monica). |

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TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| - |  | Identification of wells | | |  | Well data  .. .... | | Water  zonest | |
| USGS | Serial No.2 | Loos- tion No. t | LADWP  No.a | Owner or user | <I  '0:::,;:.\_  ::::::51 | ig  :S  A. | <I)  -;;  aQ)iQ)-  !g  A | C.  *S·*  :0;'i'  a-:  Cl)  A | ..  <I)  d..-.  --J--  .d  E◄ |
|  |  |  |  |  | < | A |

T. 2 S., R.15 **W.-Continued**

2/15-2Et...J B-9k 125770 L.. \_J Bob Johnson•••••••••.! 127 I 400 I 14 I 111 11

222 36

21M 14

2E23•••. -B----9-j----- --------- 23-D-27 D. K. Edward•••••••• 127 --------- -------- --·--- ------

**283** 63

2577B ---------- ·--·-do. ·-·---·--·-- 128 359 14 100 84

2EL •• B-9h 2577A Formerly Tom AttrilL 131 116 7

23-D-29- ------ ------

2Fl •••• ------------------------ 134 170 ····ir- ------ ------

2F2\_.

B-9n

2577E

---------- *1.* E. Dullam••••••••••

132

305

------ ------

2Hl •••

2KL ••

-------------------- ------------------

23-B-42

23-D-20

----------

0. B. Patton•••.••••.• Ballona Water Oo.,

well 3.

202

125

**220**

155

10 ------ ------------

2K2•••

14

B-9m

2577D

Petroleum Securities Co., "Palm Crest

146 --------- -------- ------ ------

2Nl ••• ---------

.,

23-D-22

No. l."

L. C. Brown.•••••••••

108

185

12 ------ ------

2N2••• ---------- --------- ----------

Carroll Lorbeer•••••••

108

358

16 ------ ------

2N3 B-9

2577

23-D-23

L. R.-Sltlvens•••••••••

112

305

14 ------ ------

2Pl 2\_.

----.,.------ ------------------ --------------------

McOOY-------·--·-··· 106

398

16 -·iss· ---32-

Carroll Lorbeer•••••••

107

372

14¾

258

110

2P3 •••• ---------- ---------

23-D-21 ••••.do••••••---- ·-

106

305

143.0

16 ------ ------

3AL.•• B-7f

2566A

---------- --·--do•.••••--- -·- 142

380

14 ------ ------

3HL •• B-7d

2567

23-D-26 L. R. Stephens.•••-··· 123

371

14 ------ ------

3Kl.••

|  |  |  |
| --- | --- | --- |
| Formerly Oarl Steph• ens.  Formerly C. M. 1enk•  ins.  Formerly1no. Oarsons\_ | 150  155  162 | 285  102.1 6  191 7 |
| Formerly., G.olden  - To  Formerly Golden  Floral Co;) | 153  153 | 150  151 12  7 |

B-7U

2567A

PauU. Howard Nur• sery.

120

396

14 ------ ------

3NL ••

4BL ••

5BL•••

5Dl••••

5D2•••

B-7s B-4i

B-2 B-2g B-28

2557

2547

2526

2516

2527

--2-3---D---2--4-

----------

----------

----------

Formerly McElroy.••

154

406

{ i--····1···-··

r···r····

--···· ----·-

r-···r···-

5 • B-2b

25270

----------

state Pl\_.<Bfld,

····-- --···-

7B2.---

B-3d

2518A

----------

ning.

Laundry Oo. Baleley.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5FL-- B-2b 252.7A •••••••••• Formerly-P. T. Swen• 146 | | | | | | 132 | 6 | l••••••I•••••• |
| 5F2•••• B-2c 2527B ---------- FormerlyH. T. Maloy\_ 138 | | | | | | 175 | 7 |  |
| 7AL.•• | B-3n | 25180 | 23-0-13 | Formerly Pacific | 94 | 204 | 6 | ------ ------ |
| 7BL •• | B-3c | 2518 |  | Formerly B. L. | 94 | 134 | 7 | ------ ------ |

Formerly W. L.

Arnett.

90 100

--------

------ ------

70 30

7KL••• B-3j

**8Bl** B-3f

25190

2528

----------

----------

Formerly s. Thomas•• Formerly H. C. Bray.

57

148

55

138

(9) 1------1------

. r-----•------

801.••

**802 ...**

**8Ml...**

**'8M2...**

**8M3...**

**8Rl•..**

9Dl •••

B-3m B-3g

B-38 B-3b

B-3 B-5j

B-5m

2528B

2528A

2519A

2518B

2519

2539H

2538

----------

----------

----------

----------

Formerly R. 0. Kep. linger.

Formerly Louis Bach.

W. T. McOinley•••••• Formerly *1.* E. Sim-

mons.

Butterfield•.••...••••. City of Santa Monica, Marine plant, well 4.

Formerly R. 0. Kep-

linger.

139

138

111

80

107

25

144

120

140

300

80

142

139

120

-···--··---·-·r··-··

.1•2 i·-·-··----r--·--·-··

10 125 15

188 ·--2-3-· -·-9-2··

1······-·1··-··-1··-···

9L1•••• 8-5d

**2549A**

23-0-8

Francisco M. Cota••••

32 100 -------- ------ ------

See footnotes at end of table.

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Oontmued | Pumping data | | | Miscellaneous | | |
| Character of  material | -  .,,  §.a  =a a  0 | =  o,...\_  "O  .....,!......  A | s:i.  P-t | Use of well | Analyses and  measurements | Remarks' |

T. 2 s., **R.15 W.-Continued**



Sand and graveL. ------- T, E Irr------------ Op, L-----------

do ---------------- ---------·-·------

do

-------------------- ---------- A Wmd. \_

Sand and graveL.• ------- ---------- A L---------------

do ·--------------- ------------------

-------------------- -----·- ------- ---·--·---

A WL ~~md~~ \_\_

-------------------- ------· ------- T, E Dom, frr Op, L-----------

- - -----------· A**A**

Op, Wmd

Wmd \_

1. L Oil well.

P, W Wmd\_.

-------------------- ------- ------- . T, E Irr L \_

d

- Grave1:::::::::::: ::::::: ::::::: T, E t:::::::::::: - •Wm ::::::::

Sand and gravel--- ··----- \_

**A** Wsd

T,E

Irr C, L, Ws \_

T,E

Irr L, Wmd, Wsd Irr Ws \_

**A** Wsd \_

**A.**

L \_

Wmd

**A** L W-139, well898 (Santa

**A** Wsd. \_ ----------

Monica).

**A** L W-139, well899 (Santa

Monica).

**A** Wsd \_

**A** L W-139, well 890 (Santa

A Wmd, **Wa \_**

Grave}. ----·-- A L---------------

A L

**A.** L \_

**A** Wsd \_

Monica).

W:M:-139, well 004 (&mta onica).

W-139, well 905 (Santa Monica).

W-139, well 952 (Santa. Monica).

W-139, well 931 (Santa. Monica).

GraveL.---------- ------- ------- ---------- A L W-139, well 934 (Santa.

-------------------- ------- ------- ---------- **A\_.** Wsd \_

Monica).

-------------------- ------- ------- ---------- **A** L W-139, well 941 (Santa.

Sand and graveL. 500 ;

Obs Ws \_

**A** Cpr, L, Ws \_

**A** Wsd. \_

Monica).

-------------------- ------· ------,-

T, I

Dom; Irr C, Opr, Wmd \_

**·290** GEOLOGY, HYDROLOGY, TORRANCE-SANTA MONICA AREA

TAB E *6.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | **Water**  zones 1 | |
| **USGB** | Serial  **No.J** | **Loca-** tion **No.s** | **LADWP**  **No.a** | **Owner or user** | **Q)**  **'**:**O**:,;:.\_  :!::::ei | "'  I  *.Q*  g:  A | ...  **Q)**  :i  a'5  \_a.l...l,  **A** | j  ..0..,.....  .gC:l-,S--l | ""''  **Q)**  ;(J)ZJ-  *.*-*Q*---  8 |
|  |  |  |  | < | **A** |

I **,-E**

**T. 2 S., R. 15 W.-Continued**

City of Santa Monica:

182

72

·9N3\_ \_ \_ B-5i

**2/15-**9**-\**N**lN**2**l**

**B**B**-**-**5**5**g**h

2539F

I

Well3 241

,--------------------, **Ma**W**J**ell**'E**2 **!:** ---

24

170

,2.0I 90

•.9N4 B-5 ·

25390

2539

23-C-7

Southern California

Edison Co., Ltd. City of Santa Monica,

Marine plant:

25 146

35 140

25

204

l::::i ::I

"37

29

107

111

9N5.•• ---------- --------- ----------

9N6 B-5b

2539D

Well5

Old well 5

25 162

----ifI

*:\_1 t \_*

9Pl lOFL.\_

B-5c B-8c

2549

2558

23-C-5

----------

Wright Estate FormerlyC.E. Statnon\_

27

135

150

180 8¾

lOOL\_

llCl 1102..\_

B-8f

B-lOd B-lOe

2568

2578D

2578E

----------

----------

----------

Union Oil Co., "New- Un No. I."

City of Santa Monica: Charnock plant:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Well l\_ | 95 | 388 | 18 | 98 | 6 |
| Well 2 | 95 | 393 | 18 | 140  104 | 240  26 |

192 --------- -- --- -- - ,-- ... ---1------

1103

UCL

.. ..,

**B-l0f**

2578F

---------

----------

23-D-17

Well3

Formerly F. W. Pew.. City of Santa Monica:

95

102

386

307

152

18 100

162

10 158

237

35

213

149

11C5•.

B-lOh

2578H

CharWnoecllk5 plant:

102

382

20 140

228

11C6

11c1

nos

**llDl..**

11D2.\_

B-lOi B-lOi B-lOk

B-lOg B-lOb

25781

25781

2578K

25780

2578B

----------

----------

----------

23-D-16

Well6 97 Well7

Well g 95

95

Well4 95

Southern California 98

Water Co., Char-

384

400

390

468

480

18 136

18 156

18 98

160

18 190

18 198

302

244

224

32

220

190

76

38

llEL +--------j 1 23-D-13I

11E2. \_ B-10 2578

nock plant, well 3. SMocuCthoeyrn.\_--C--a-l-i.f-o-r-n-i-a--

Water Co.:

Charnock plant:

|  |  |
| --- | --- |
| 171 | 9 |
| 186 | 204 |
| 196 | 155 |
| *355* | 4 |
| 366 | 10 |
|  | 159 |
| -21072 | 24 |
| 260 | 8 |
| 281 | 149  ------ |

92 ----- ----1- --- --- -1-- -- --1---- --

, ,

Well L-------1 921 393

11E3\_ -1 B-8j j 2578P

Well5

93 405 I

18 I

Ult:

I

452

26--18

18

Well2 ,

-IZ>-D-15r

-r-

1- ---!. --!:=========I

Well6

397 I

:::-r-•ou Ho ..,wi.\_i

:1

92 I 165 12 ,

11F3\_ \_ Southern California Water Co.:

CharWnoecllk7 plant:

91 I•·••-••••I-••-·•·•I••••••I •-

11F4

B-lOc

Well 4

llJl B-lOo

***1112*** B-81

11J3 B-loz

25780

2589B

2589D

2588

23-D-8

-----------------

Sepulveda plant: Well!. Well2

Well3

55 300

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 92 | --------- | -------- | ------ | ------ |
| 92 | 380 | 32-16 | 168 | **178** |
| 55 | 402 | **18** | 164 | 78 |
| 56 | 277 | 16 | 168 | 97 |

16 -··so·

**llLL..**

B-lOr

2578L

Formerly W. T.

**77** 106 7 26

**HNI..**

**llQL..**

**B-10s**

**2579A**

McLaughlin; Formerly McConnell. Formerly John

65

McLaughlin.

78 ---,.---r--., - J

URL. **B-lOV**

**25890**

23-D-6

J. 0. Reinhart 56

i ======i=:====

**11R2..** ---------- ---------

See footnotes **at end of** table.

23-D-7

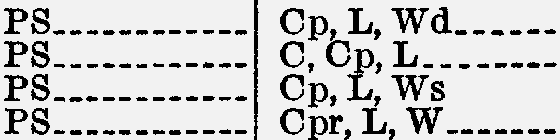
do -- -- --- ---- 56 1

*zone\_ '!f.the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones t-  · Continued | Pumping data | | | Miscellaneous | | |
| :  Character of  material | 1pD. ..  "§''.=s  ::;a  c:, | =:l:  0,.....  "d  :!:  *o,'-"*  A | a0.  ::, | Use of well | Analyses and measurements | Remarks' |

**T. 2 s.. R. 1\_5 W.-Continued**

Graver and sand..



450

A Cp, L, Wd \_

Sand and graveL.

600 ------- ----------

**A** C, Cp, L \_

do

. dq .------------

600 ------- ----------

---.

**A L,** Wd \_

L, Wsd Electrical ground.

do 600 ------- ---------- A--· L \_

do ---------- A · Cr, Cpr, L,**W**

-------------------- ------- T, E Obs Wmd, Ws \_

-------------------- ---------- A L W-139, well **836 (Santa**

Monica).

A

r:: ei!nd avel-- \_I,350\_ T, E -- \_Ps

L

cp, L, w

Oil well.

do 1,350 T, E PS Cp, L, Wsd \_

do ------------------

Gravel and sand•• 1,350 ------- T. E ps Cp, L, Wd \_

do ---------- ------------------

Sand and gravel.•• ------- ---------- A L, Wmd•• ------

Sand and graveL \_ 1,800

-----a ------------- \_1. 3\_50

do

do \_

:Tf,:iE

T, E

do

990

T, E PS Cpr, L, W \_

do -------- 345 24 T, E PS Cr, Cp, L, Wm

Sand

-------------------- A C, Wd \_

Gravel and sand. A C, L, Wd \_ Sand and-gravel·

do 1,125 17 T, E PS Cr, Cp, L, Wm

Sand

Sandoand graveL\_ -A C-,-L,-Wd \_

Coarse sand 1, 155 36 T, E PS C, Cp, L Sand ---------- ------------------

Sand and-gravel

-------------------- ---------- Irr C, Wm \_

LACFCD, **well 25788.**

T,E

-------------------- 2, 100 T, E

do T, E

1,805 32

Irr

PS PS

Cp\_ ------------

C, Cp \_

Cr, L, Wmd \_

LACFCD\_, **well 2578R.**

do A \_

Cr, Cp, L, WscL \_

do T, E PS \_

Cr,Cp,L, Wm

T, E PS \_ Gravel. A \_

A

C, Cp, L, W \_ L\_ - -------------

Cp LACFCD, well 2579.

A L W-139, well 847 (Santa

Obs A

L, Wmd, Ws \_ L, Wmd \_

Monica).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. | | | Water zones 1 | |
| USGS | Serial No.2 | Loca- tion No.2 | LADWP  No.a | Owner or user | Cl)  "d  :='.:::::i..  ;::::.  -< | I  .aCl  CD  A | $., Cl)  9.ig  !§  A | Po  *3*  o,-..  a--]-  CD  A | *a,*  "CD'  s::z,  MCD  **g**  .Cl  E-t |

T. 2 **S., R.** 15 **W.-Continued**

2/ll'r-l1R3 ---------- 23-D-5 Al G. Barnes 12Bl.\_ Metro-Goldwyn-

48 276

77 22.()

14

ao-10

134 57

12B2

----------

Mdaoyer Corp.

\_ **80 520**

12JL B-13 2609 22--0-6 H. Huffman

67 108

10 ------ ------

12

12QL B-lOq 2599A Formerly de Bartolo. 12Q2 23-D-l Formerly Fea

13AL\_ B-13z 26090 22--0-1 Latasa \_

48 152

51

37 622

12 **47**-

10

16

103

13Bl B-lOt

2599B

Elbe Oil Land Devel- 37 --------- -------- ------ ------

13FL.\_ B-298 1290H \_

opment Co. Lester L. Robinson

34 94 16

------ ------

1301 ---------- --------- ----------

1302 B-29e 1290A 9-B-2

Chikesawa 34 12

Formerly J. D. 34 12

- 201 --

------ ------

29 21

13HL \_ B--34e

1300A 10-A-1

LaMtaascahado.

33 167 12

29 12

47 6

1311 ------------------------ 28

77 87

13132 B---3-4-m

-1-30-0-B

-La-t-a-s-a

\_ 28

199 12

13KL\_ B-29r 12900 ------------------------

13K2 \_ B-29q 1290F M. Firsick \_

13K3 do \_

32 200 14 ------ ------

30 212 10 ------ ------

29 214 14 ------ ------

13K4

B-29p 1290E do \_

29

190

12 ------ ------

13ML B-29k 1280J Oyos \_ 29

30

13M2 B-29n 1280L Tom H. Graham \_

13M4 l'r-29 1280 Formerly Kline-

30

30

100

7 ------ ------

12 ------ ------

g

"

11 - sa·

13M3 B-29m 1280K

do \_ 30 89

12 ------ ------

13PL\_ B-29t 1290K

Norton Co.

M. E. Gordon

25 300 8 ------ ------

13P2 ·--------- 9-B-7 Formerly Lytle

Ranch

25 --------- -------- ------ ------

13p3 B-29f 1290B Formerly Leidel. \_ 13P4 B-29u 1290D Thomas Katsuda \_ 13Ql \_

24 200

25 210

24

12 ------ ------

10 ------ ------

=-----

14AL \_ B-lOn 2589A 23-D-3 City of Los Angeles 14A2 B-lOm 2589 23-D-4 J. D. Newman \_

14A3\_ \_ B-29g 1280D City of Los Angeles, Barnes City well 2.

45 550 16 ------

44 300 8 ------ ------

42 462 16 134 291

14CL\_

14EL\_

B-lOy B-25a

2579B

1270

9-B-13 UcshuikdLa\_C-o-, --\_

57 168

48

14 ------ ------

8

14E2 B-25f

14E2 B-25g

1270D

1270E

Formerly Joe VerL \_

Formerly P. J. Doyle

47 178

47 111

12 80 98

12 25 86

14FL\_

l4HL\_ 14JL

B-25b B-290 B-29i

1270A

1280N

1280F

Mrs. Louise Smith \_

W. H. Kempton \_

47 140 12

46 37 7

33 8

14J2

\_ B-29h

1280E

9-B-47 Antonio Moreno \_

37 398 12

14ML. B-25c

1270B Suburban Mutual

42 111 12

14PL \_ B-25d 12700

Wdaoter Co. \_

14P2 Martinez \_ 14QL \_ B-29b 1280B 9-B-10 E. S. Merrill \_

l4Q2\_ \_ B-29j 12800 Merrill Sanatarium \_ 14RL\_ B-29a 1280A 9-B-9 Grosvenor Inglis

Corp.

32 --------- -------- ------ ------

26 50

29 120 12 ------ ------

31 201 10 ------ ------

24 --------- -------- ------ ------

14R2\_ \_ B-29d

9-B-8

L. A. Sanford \_ Southern California

Water Co.:

26 165

16 45 120

15Al \_

PaciWficeplll!ant:

\_ 56 251 12

15A2-.. B-8h 25690

Well2 \_

55 200 14

---74- --i2(}-

15A3 B-8a 2569

15AL. B-8e 2569B

15BL.\_ B-8d 2569A

See footnotes at end of table.

Well3 \_ Well4 \_

Formerly T. L. Gooch.

56 225 10 ---65- --iof

58 150 12 72 78

57 335 3o-16

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Oontinued | Pumping data | | | Miscellaneous | | |
| Oharacter of  material | '°  (I)  I'll  B.s  *=a* a  0 | =  ·0u  ,**a**..**l.\_,**  A | aPo  :::s  ll'4 | Use of well | Analyses and  measurements | Remarks' |

T. 2 **S., R.15 W.-Continued**

|  |  |
| --- | --- |
| A Wmd \_ Sand and graveL Ind C, Cp, L \_  -------------------- A L \_  Sand and graveL Obs Cp, Wmd, Ws \_  A L  A Wd  T, E Irr\_ Wmd  A L  Cp, W \_  G-r-a-ve-L T -A L-, -Wd \_  do T,E Irr Cp, L, Ws \_  do ------------------  Sand and graveL  T, E PS ·-  -------------------- T, E Irr Cp \_  T, E Irr C, Cpr,W \_  T, E Irr\_ Cp, Ws \_  T, E Irr Cpr, Ws \_  T, E Irr ------------------  -------------------- P, W Dom Cpr, Wsd ·-  -------------------- T, E Irr C, Cpr, W \_  A Cpr, Ws \_  -------------------- ------- Obs Cpr, Wm \_  Sand and graveL\_ A L, Wsd \_  1,400 T, E Irr Wd \_  A Wmd \_  -------------------- A L \_  -------------------- A Cp, Wsd \_  -------------------- ------- C, Cp, Wmd \_  A Wmd \_  Sand and graveL\_ Obs L, Ws \_  -------------------- Irr \_ Cp -- ----------  -------------------- ------- ------- T, E \_ C,Cpr, Wmd \_  San :,Ud graveL A \_ LL\_ - ----------\_---  Opr, Wmd \_  Cp, Wsd \_  Cpr, Wsd \_  T,E APS\_------------\_ C, Cpr, L, Wmd\_  Cpr, L\_. --------  T,E PS \_ C,Cpr, Ws \_  Dom Cpr\_  Cr, Cpr, L, Al,E Dom, Irr Wmd.  C, Cpr, L, Ws \_  Cpr, Wrd, Wmd  Sand and graveL•. L, Wd \_  A Wmd Sand and graveL ---------------- C, Cp,L--------  --. ----------------- A C, L \_  Sand and graveL- T, E PS ·: Cr, Cp, L, Wm \_  do ---------- A L \_ | 22-C-l probably"!was Oiol lwd ewlle.ll.  LACFCD, well 1271N.  LACFCD, well2569D. |

\_

**460508--59-20**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. $., | | | Water zones 1 | |
| USOS | Serial No. 2 | Loca- tion No.z | LADWP  No. a | Owner or user | a>  "O  c;:\_  ::=1;:::!-  -< | gi  -B  g.  A | a>  """'oo'  <l)<l)  s-5  !5  A | \_g  0 ......  ;;j  ,.\_,  A | ""''  a>  \_o*Z*,l.*'*.,  .Cl  8 |

**T.** 2 **S., R. 15 W.-Continned**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2/15-1501...  15FL.  15F2•••  1501-.  15HL.  15H2.•  15NL.  15N2•.  15Pl.•.  15P2.•.  15P3•••  15PL.  15RL\_  16DL.  16D2••  16FL.  16JL.  1l6J32.•• | B-8 B-23f  B-23d B-25i  B-25 B-25e B-23e  B-23m B-24g B-24f B-24m | 2559  12500  1250A  12600  1260  1260A  1250B  1250D  1251G  1251F  1251L |  | Formerly J. N. Sprouse.  Venice High School.\_ .  do  Formerly John Lachenmayer.  Washington Park Mutual Water Co.  W. McDonnell........  Formerly Brentwood Dairy.  Frank Coon.•••. •.  F. E. Warner ••. •.  Suzuki..\_ ......·····--  Liscoulie...•••.\_.•....  - --- ----- ..------  ------------ ------ -  Southern California Water Co.:  Lincoln plant: Well 8••.••. •  Well 4••••••.•.  J. H. Evans... -·•·····  Southern California Water Co.:  Pen Mar plant: Well 10••. •.  Zanja plant:  Well lL ••.••• Wm. Hume...........  Formerly Wm. Hume.  Formerly Ocean Park Water Co.  Formerly Garrison  & Smith.  Formerly Ocean Park Laundry.  Formerly Abbott Kinney & Co.  Formerly Ocean Park Water Co.  Formerly E. J. Vawter.  Formerly American  States Water Service Co.:  Well 8•••••. •  Well 6.••••...•..•• Well 7••..•..•.••••  Formerly H. C. Morse.  Zobelein. ··-····-·----  Los Angeles County Flood Control District, test  hole 11.  Clarence MicheL ..  -• .. -do... .---------··  do·-----------·---- | **42**  34  35  44  40  41  25  25  25  23  25  27  27  24  25  23  26  20  22  14  36  45  22  21  80  30  22  22  22  25  10  17  22  22  21 | 133  149.8  224  ---------  203  120  ---------  73  140  125 | 26 | | ------  ------  ------------  **84**  33  93  ------  ------  ------ 62  .............. | ------  ------  ------  ------  42  9  27  ------  ------  ------  78  ------ |
| 9-B-16 | 6 | |
| 9-B-17 | ---------------- | |
| 9-B-15 | 12 | |
|  | 12 | |
|  | -------- | |
|  | 12 | |
|  | -------- | |
|  | -------- | |
| - | - | |
| B-25h  B-5a B-5L B-23  B-23a  B-23c B-23b B-23k  B-3b B-3e B-23j B-23i B-2Sg B-23h  B-5k B-5e B-5f  B-31 B-24  ----------  B-26e B-26k  ---------- | 1260F  25390  2539J  1240  1240A  1250  1240B  1230  2529  2529A  1210A  1210  1220  1220A  2539!  2539A  2539B  2519B  **1251**  ---------  1261B  1261F·  --------- |  | - |  |  |  |
| 23-C-3  9-A-l  9--A-2  9-B-18  9--A-3  ----------  9-B-24  ---------- | 200  164  56  270  277  210  84  251  ---------  107  90  87  89  188  140  206  103  ---------  22  90.5  --------- | 20  20  14  16  18  12  12  --------  8  15  10  (10) -  20  18  18  7  --------  2  14  --------  16 | | ------  50  ------  ------  65  59  ------  75  ------  7  ------  40  35  10  56  6  140  170  10  ------------  51  ------  ------ | ------  105  ------  \_.,.  222  151  ------  100  ------  100  ------  47  54  175  48  122  15  18  92  ,.. |
| 16ML  17BL.  17B2.•.  17El..•  17E2•••  17FL.  1701  1702..  1703..  1704..  **18AL.**  21AL.  22AL.  22BL.  22B2...  22B3••• |
| ------ |
| 131 |
| ------------ |

See footnotes at end of table.

*zone of the Torrance-Santa Monica area-Continued*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones i-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | t  i:;i...  :§:::ia  t3 | .gf  .,, .  1-o  A | ai:i.  ::I | Useofwe11 | Analyses and measurements | Remarks, |

**T.** 2 **S., R.15 W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | A ·--  Obs.-------·-- | Wsd.• ·-········  Cr, Cpr, L, Ws. | wcAcfio ) 9  LACFCD, well 1260E.  W-139, well 27 (Redondo).  W-139, well 922 (Santa Monica).  W-139, well 17 (Reaondo).  W-139, well 12 (Redondo).  W-139, well 6  (Redondo).  W-139, well 947 (Santa Monica).  LACFCD,well1261D, |
| -------------------- ------- -· C, Cp, L, Wmd.  -------------------- ------- --·---- -·-------- A-----------·- L--•--·--·------  Gravel and sand ---·-- T, E PS---· C, Cpr, L, Wsd.  Gravel\_ --·------------·-------- A-----·-·--·-- L••. --·---· ·-  Gravel and sand.. ----·----- -·--·--·--·-·--· ----·---···----·--  -------------------- --·---- ----·-- ---------- A-·----·----·- Cr, Cpr\_·--·---·  ------· --·---·--·--·--- Cpr, Wsd.------  -------------------- ------- ----·---·- A L ---·-··-  Sand --·-·----------------·------------------ Cpr, L, W------  -------------------- --··--- A Cpr, W. \_  Irr .•• Cpr  A ·  -S--a-n-d--a-n--d--g-r-a-v-e-l-.-..- ------- ---------- A.\_-·. LCp, L, Wd••••..\_  -------------------- ------- ------- P, W Obs Cp, Wm \_  -------------------- ------- A C, Cp, L, Wmd.  Sand and graveL. A C, Cp, L, Wsd  do ------- P,M C, Cpr, L,W \_  -------------------- ------- A L---------------  Sand and gravel.\_. A L \_  A L.\_. \_  Sand and graveL A--·---------- L. \_  **A----··--·----** L--·--·-····----  Sand and gravel.•• A---·-------·--····-----·---··--  ---·-do --·---- --•---- **A** L----·-----·-·--  ----.do ---------·--·- **A-------------** L---------·-----  Sant md graveL- --··--- t"··----------£ p, L--------·--  Sand. --------····-·····  do•. . ------·--- -----·----·----- \_  Gravel ancl sand •• A L  -------------------- ------- **A-------------** Wsd \_  -------------------- **A** L, Wsd  Sand and gravel... ··--------- Obs Cr, Cpr, L, W••  T, E Irr CCp'Cpr•••• \_ | | | | | |
|  | T, E Irr••••..•..... | | | | |

-

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| USGS | Serial  No. 2 | Loca- tion No. **2** | LADWP  No.a | Owner or user | '0  ::s:::::.\_  :J  +>!:::-  <I | ...  I  .Cl  i  A | 1-,  i a£  !§.  A | s0.  ;o;.J--.  i'"'  A | "'  *Z'*  §  .-C-l --  E- |

**T. 2 S., R.** 15 **W.-Continued**

2/15-22B4...

22B5••

2201..\_

**B-26a**

B-24c

**1261A**

1251K

··-------

9-B-23

Clarence Michel... 24 207

do \_ *ti* 185

do

\_

16 63

- •

142

22CL\_

2203.••

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 22Dl •• | B-24h | 1251H |  |  | 12 | 182 | 12 |
| 22D2.- | B-241 | 12511 |  | Edgemar Farms \_ | 18 | **122** | 12 |
| 22D3.- |  |  |  | Hollstrom \_ | 18 | 26 |  |
| 22EL.\_ -··-··--·· Los Angeles County 12 20 2  Flood Control Dis-  trict, test hole 22. | | | | | | | |

B-24d B-26

1261D

1261

George Hippert\_ \_ 19 79

Brentwood Dairy 22

12 29

63

14

32

17

16

16

12

150

105

Zobelein 9 Del Rey Land &

|  |  |  |  |
| --- | --- | --- | --- |
| **22E2.--**  22Fl... | **B-24e**  B-24b | 1251J  1251B | 9-B-19  9-B-20 |
| 22F2 | B-24a | 1251A | 9- B-21 |
| 22F3... | B-24k | 12510 | 9-B-22 |

Water Co.:

Well2L••-• --\_-. --\_ 15

Well2 15

150

176

145

··--·- ·····-

12 ·····- -----·

14

12 ------ ------

15 -·------- -------- ------ ---·--

2201 ---------- --------- ----------

Los Angeles County Flood Control Dis­ trict, test hole 21.

12 20,6

22.TL.- B-27j

1262B

9 77.3

12 ------ ------

22J2 B-26h

22J3\_ B-27e

12610

1262

9-B-25

Del Rey Land & Water Co.

Formerly Del Rey

Land & Water Co,

7 151

9 120

12

12 ------ ------

22KL. B-26j 1261D ---------- ------------------------ 7 --------- -----·-- ------ ·-----

22LL•. B-240 1251R DelReyLand &

Water Co.

22PL\_. ---------- ------------------------

22RL. B-27h 1262A State of California \_

7

4

7 52

14 ------ ------

12 ------ ------

8

23AL B-30o 1281J Machado Estate \_ 17

|  |  |  |
| --- | --- | --- |
| 23A2••- B-30q 1281K -------------·-----·----  **23A3-..** B-30m 12810 ---------- ------------------------ | 17  18 | 183 |
| 23A4 9-B-29 Santouse Ranch \_ | 17 | 101 |

12

16

12 ------ ------

23BL.. Los Angeles County

Flood Control Dis­ trict, test hole 7.

23B2..• B-26d 1271B Mrs. N. R. Thomason\_

21 24.1

26 --------- --·----- ------ ------

23CL.. B-26i 1271D 9-B-28 Geo. Sanford \_

23EL. B-26b 1271 ------------------------

23E2 ---------- --------- ---------- ------------------------

Los Angeles County Flood Control Dis­

20 126

13 175

12

16 ------ ------

12 ------ ------·

g ------ ------

23FL\_.

23F2 ·

triTcet:st hole l\_ 15 24

Test hole 19 \_ 16 16

----·· ------

23F3 B-26c 1271A 9-B-26 Harry Chase \_

2

2301..•

-

1i

16 137

13

r:

20 33

80 57

23H02l

-B----3-0--g-.-- -1-2-8-1----- ---------- -M---a-c-h-a-d-o---E-s-t-a-t-e --\_

--i14-

14 54 60

23H2 -- \_

Los Angeles County Flood Control Dis- trict, st hole 15.

17 22

2 ------ ------

23H3•• B-301 1281A

W. H. Bennett...•••••

13 150

12 26

44

9

105

23Jl••• ------··-- --------- ····-··-·· LosAngeles County

Flood·Control Dis-

trict, tes.t hole 13.

16 19

**23J2.**.• B-30J · 1281B

See footnotes at end of table.

Cressy Lo).}ez. \_ \_.

13 123

53 70

*zone of the Torrance-Banta Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Charaeterof material | ! ..  *e>*  "is'°.=a  *=a* a  C, | =i:t  0'""'  "O  ..i..:.,t...S.....  A | ac:i.  ::I  P-t | Use of well | Analyses and measurements | Remarks' |

**T. 2** S., **R. 15 W.-Continued**

Sand and gravel••• --····· -···-·· T, E Irr.·-·------·- CJ] pr

*½.*1

wma, ws.

.::::::::::::::::::::::::::: ::::::: i:I

focir\_-:::::::: 8; pr, Wsd•••.

Gravel and sand.• --·-·--·-·-··- P, W Cpr, L, Wsd.-.•

Fine sand•.••·-·-······-· -·-···· .•••..·•.. ·-·············· ···········•-·····

·A::::::::::::: •

. Grave1:::::::::::: ::::::: ::::::: :::::::::: Cp.::::::::::

Sand-······--·--··-·---- --·--·- -·-----·-- ----·----·-----· -···-···-···-·····

Sand and graveL.• ····-·- ···--·- -·-··----- A•• ·-···-·---- L.• ·-········-··

·----···----·-··-··· -··---- --·--·- ····-·-·-- **A.. ·----·-····** Cp.·---·····- LACFCD, well

1251M.

-···-----·-·-·------ -···--- ···--·- A-----·------- Cpr, L, Wsd.\_.\_ LACFCD, well 1251Q.

Obs. Ce.z.L, Wmd,

wrd, Ws.

T,E

T,E

E

'1', E

-··----·----------·· ----· T, E

T,E

, -··-------·----··--· -----·- --·--·· T, E

----------------·-·- ------- --· T, E

Irr.·-----·-·-- Cr, Cpr, Wsd\_

Irr----·--··--· Cr, Cpr, Wsd\_

A -·-·-· Wmd••• -·--·--·

Obs.·---··-··- L, Ws•••• ·-

Dom, Irr.·--·· Cr, Cpr, Wsd--.

·---·--·-·--···- C, Cpr, L, Wsd.

**A.·---··-··--·** C, Cpr, Wd•••••

A•• •-·-···-··· Cpr, Wsd.......

Irr··------···- Cpr, W···-··-- -

Irr-····-·-···- ········--·-··--··

A--·-----·---- L--·--·---------

8:8i: ::::::

f ::::::::::::

Obs.------···-· Ci,...9Pr.,1. Wrd,

ws, wwd.

A.•• -----·--·- L, Wsd•• ·-···-·

LACFCD, well 1261G.

LACFCD, **well 12620.**

Test hole.

--···--··-·-···-···· ..•.•.• --··-·· T, E

---·- ---·---········ ···-··· ·····-· T, E

···--······-········ -···-·- .••••.. P, M

A•• ·-····-···- L, Wsd•••. LACFCD, well1281H.

A--···-·-····- Cp Wsd.

w

Irr .......•.\_.. C, upr, vvmd..•

Irr ••••.•-···-· Cpr, *t* W•• -•• -

····-·····-·-··- Cpr, vv sd. LACFCD, well **1271P.**

. ::::::::::::::::::::::::::: ::::::::::::::::: ibs::::::::::: t:;!i::::::::: tl8J8g:';':lfih :

Gravel and sand................ T,E Irr--------·--- C,Cpr, L, Wsd\_

Sand and grave} ·-··-·· -·-···· ••••.••••.....•.••.••••••• ··-···············

······-············- .....•........·········- **A.............** C, Cpr..........

A. C, Cpr.••••.•.•.

Gravel and coarse ..•.... ..••••. T, E Irr. C, Cpr, L, W•••

sand.

LACFCD, well 1271E. LACFCD, well 1271F.

••••••.••••••••••••• •••••.• .•••••• •••••••••• Obs•••.•--•··· L, Ws. LAOFCD, well1281M.

2:':aei!ndgmveC·.......······· ..T, E ••. Irr ••. Cpr, L, W••••••

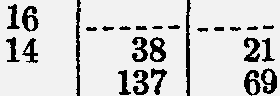
·······-············.............. -··-·····- **A.............** L, Wsd.........

•...•do............. ••••.•. ..•..•. **T,**E Dom, Irr-···-· C, Cpr, L, W•.•

LACJ!OD, well1282M.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  ) .. | | | Water zones 1 | |
| UBGB | Serial No. 2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | Q;  "O  .-:.:.s.:.:.:.\_.  ::  -< | ....  gcD  .Cl  cD  A | J.,  ..Q.;.),;;;-  <D<D  a.g  !5  A | *a.*  .B  0:,-;..  .\_..,  cD  A | *<12*  *<12*  cD  \_AZ-  M<D......  co$  .Cl  E-t |

T. 2]S., R. 15 W.-Continued



2/15-2313... B-31d 12820 9-B-37 Geo. McLaughlin \_

Los Angeles County Flood Control Dis­

13 200

14 J\_ \_

23Kl••

trict:

Test bole 16

\_ 12

18.0

23K2 \_

13 50

23LL

23ML\_

23M2.\_

Test bole 17 \_ Test bole8 \_ Test bole 20 \_

12 19

11 15. 7

12 13

2 ------ ------

2 ------ ------

*2* ------ ------

23M3

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 23Nl | B-27a | 1272A | 9-B-39 Water Co. | 9 | 151 |
| 23PL\_  **23P2...** | B-27b | 1272B | 9-B-40 do \_  . do \_ | 10 | 185 |

B-26f 12710 Del Ray Land &

Henry Kidson \_

Los Angeles County Flood Control Dis­

10 140

10

12 38 24

62 78

14

14

23QL•.

trict:

Test bole 6 \_

10 11. 4

2 ------ ------

23Q2 ---------- --------- ----------

Test bole2 \_

11 24. 2 2

23Q3 B-31f 1282L

23QL. B-31e 1282E

McLaughlin. \_

10 139 14

10 14

23RL\_ B-31b 1282A Joseph Mesmer \_

11 239

16 23 9

47 81

182 30

**24BL. B-30d**

**24CL.. B-30**

1291D do

1291 9-B-30 Mesmer City Corp.,

Ltd.

23 196

20 402

14 34

127

16 170

21

66

225

**2402...**

2403... B-30e 1291E Formerly Joseph

: - 209

24Dl.. B-30r 1281L \_

T.MIoeskmLer.

\_ 18 145

14 ------ ------

24D2 \_

**R.** A. Machado \_ 22 18

24D3

B-30b 1291G

Formerly Machado \_

20 122

14 23 51

24D4

B-30n 12811 \_

Harry Kunisawa \_ 21 14

24EL.. \_

Los Angeles County Flood Control Dis­

17 24 2

**24E2...** Mtarcichta,dtoesEt shtoaltee3. \_ 17 14 24FL Los Angeles Coubty 16 18

Flood Control Dis­

24F2

24F3

trict, test hole 12. · \_ 18

B-30b 1291B Joseph Mesmer \_ 18 79

15 37 4

45 34

------ ------

24F4••. B-30a 1291A 9-B-32 Playa Del Rey ScbooL 2401•. B-30k 1291H 9-B-31 Joseph Mesmer, well5\_

16 71

20

12

16 ------ ------

2402

B-30c 12910

do .

22 97

16 38 43

24LL. B-30f 1291F ----------

**24L2 B-31a** . **1292A**

**24Pl**

do

Formerly Joseph Mesmer.

15 209

12 200

16 44 93

200 6

30 77

**24P2... B-31c 1292**

**26Al**

Bee footnotes at end of table.

Los Angeles County Flood Control Dis­ trict, test bole **18.**

Formerly Kitakata Hog Ranch.

Los Angeles County Flood Control Dis­ triTcte:st bole4 \_

15 24

15 131

9 **7.8**

10 29 96

8

**WELL RECORDS 299·**

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water iones ,\_ Continued | Pumping data | | | Miscellaneous | | |
| Character of material | a  °'"'  "9''.=a  :; s  Cl | o:;:;-  ic:Je'-'  A | si:i.  ::s  **ll'4** | Use of well | Analyses and measurements | Remarks' |

**T. 2** S., **R. 15 w.-Continned**

---------------- Cpr, L, Wmd---

Obs \_ AO\_b-s --\_

A \_

Cpr, L, Ws••• -- LACFCD, well 1272L. Cp LACFCD, well 1281E. Cpr, L, Ws LACFCD, well127.2M.

Obs \_

L, Wmd LACFCD, well 1271L.

T, E

Obs \_

Cpr, L, Ws••• -- LACFCD,well1272N. C, Cpr, Ws \_

Gravel Fine sand

P, *W*

Dom. C,Cpr,LWmd,

Ws

--------------------

-------

T, E

Irr Cr, Cpr, L,

T,E

Irr CpWmd \_

-------------------- A C, Cpr, L, Wsd\_ LACFCD, well 12721.

A C, L, Wmd. LACFCD, well 1282F.

-------------------- T, E Irr Cpr, *W* \_

T, E Irr C, Cpr, Wsd.. \_

Gravel T, E Irr C, Cpr, L, Ws-- LACFCD, well 1282B.

Sand andgraveL ------- T, E Irr ------------------

Coarse sand and

Grcalavye.L . A L \_

Sand and gravel. -

do ------- ---------- Obs C, Cpr, L,

Wmd, Wrd, Ws

T, E Irr

Gravel and sand. ------·--------·- A L \_

Sand -- \_

==================== ======= ======= :f:: g------------ \_Cp, Wsd

--------------------=---=- ======= ======= ========== -AA============= 8L, iW>s =

LACFCD, well 1281G.

T,E

Irr .

Cp \_

A L, Wsd LACFCD, well 1291J.

-&----!-!-!-h-m---d-s-a--i-i-iL-- =-=-=-=--=-=-= =-=-=-=-=-=--= =-=-=-=-=-=-=-=-=-=- - A============= -L,=W- md=====

Obs Cp, Wmd, Wrd,

Gravel. ------- A L Ws \_

Sand and graveL ------- T, E Irr Cpr, L, Ws \_

Coarse sand and shells.

Sand and gravel.. ----------------- A. Cr, Cpr, L, *W* ••

A L LACFCD, well 1292B.

----.do L \_

--·-······--·-·---·- ---···· ------- ---------- A L, Wmd •• LACFCD, well 1282K.

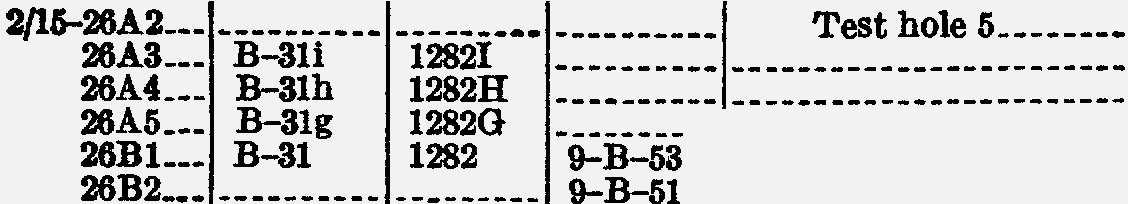
|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ldentUlcation of wells | | | | | Well data | | | Water  zones 1 | |
| usos | **Serial**  **No.2** | Loca- tion **No.2** | **LADWP**  **No.a** | Owner or user | Q)  ":O:,::.\_  =:i  **411** | ...  I  i  A | s..  Q)  :i  -a-5  ci:s.a  A | ss:i.  .s  !-=J | "'  **Q)**  -c:1J  .s:=  E-i |

**T. 2 S., R. lo W.-Continued**

Loyola University \_ Formerly Mesmer

9

9



9

10

155

9

5.25

400

2 ------ ------

18 ------ ------

**26B3... B-27c** 12720 9-B-41

Radnoch.

\_ 10

176

16 29 96

**26B4...** ---------- --------- Los Angeles County

Flood Control District, test hole 14.

10.4 18 2

2601••• B-27f 1272D

Formerly Joseph

Mesmer.

8 249

14 ------ ------

2602••• B-27 1272 8

---47-

26Fl... B-27d••• 1273 Joseph Mesmer.•• -\_-- 13 101.0 10

104

26F2••• B-27L **1273A** Messmer's La Bal- 13

Iona Rancho.

27Fl••• B-24j 1253 Los Angeles County 5

Flood Control District, test well.

**126**

110

14 ------ ------

6 ------ ------

27Rl••

B-271

1263 Palisades del Rey 143

WWatell6Co.:

237

-------- ------ ------

34Al.•• B-28b 1264B 9-B-42 Well3

34A2••• B-28g 1264E 9-B-48 Well4

130 305 18

137 380 18

0 272

0 233

34A3••• B-281 1264F 9-B-50 Well5 134 250 16

------ ------

34A4••• B-28e 1264D Formerly Milham 150 565 15½

Exploration Co.

34CL. B-28f

1254 ----------

do 150

643 15½ ----- - ------

34Hl •• B-28c 12640 9-B-43 Formerly Barnard

Palisades del Ray

131 250 12

0 250

34Kl.. B-28 1264 9-B-46

WWatellLCo.:

82 208 16

91 42

34K2•• B-28a 1264A we112 83 216 14

95 48

158 18

35Cl.•• B-28j **1274** 9-B-44 Formerly Los Angeles 166 **380** 18

Extension Co.

3501.. B-28d 1284 Formerly Centinela 159 261 10

Ranch.

**T.3 S., R.13 W.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| /13-4Dl•••  5AL ••  5A2••••  5Fl ••••  5F2•••\_  5Hl •••  601•••  6Pl ••• \_  6Rl  7Fl •••• | B-62a  B-62b  B-62j  B-58a  -B----6-2-1----  B-53e  B-531  B-58 B-53h | 1445  1445A  1445D  1436  -1--4-4-5-0---  1416  1416A  1426  1417 | ----------  ----------  ----------  ----------  ----------  ----------  ----------  ----------  ll-C-19  ---------- | Southern California Water Co., Clovis plant.  Formerly Powell  Formerly Nicholas and Kirst.  Southern California Water Co.:  AvaWlonelpl 1la..nt:  Well2 Formerly S. L.  Wright.  Southern California Water Co.:  Figueroa plant, well 1.  Hoover plant,  well 1.  Athens Water Co  Formerly Parker --- - | 115  115-  116  113  113  112  138  162  132  189 | 575  300  475  470  300  301  315  325  179 | 14-12  10  9½  14  14  9  12  12  12  -------- | 305  530  --280-  320  396  377  ------  247  271  184  219  ------  135 | 39  25  \_..,  20  62  38  53  ------  9  27  25  96  ------  42 |

3

------ ------

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See footnotes at end of table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Oharaoterof  material | ..  .,,  Eal.a  0 | 'Col-..-.-,  cs.J...,  A | ac:i.  ::, | Use of well | Analyses and  measurements | Rem.arks 7 |

**T. 2** s., R. 15 **W.-Continued**

A \_

A \_

Cp, L \_

C, Cpr, Wsd \_

LACFCD, well **1282J.**

A \_ A \_ Dom, Irr \_

A

Cpr, Wsd ­

Cpi:,\_ Wsd ­

WC,sudp r, L, Wsd\_\_

Sand and graveL

--------------------

------- ----------

A Cr, Cpr, Wmd

**A** Cpr, L, Wsd LACFOD, well 1272K.

A C, Cpr, Wmd, Wrd.

- Sand and graveL 8¥,-cpr L;w \_'\_

· Cpr, **W**

A Cpr.

T,E C,W \_

Sand and graveL- ------- C,E PS Cr, Cpr, L,

do ------- ------- ---------- A L,Wmd. \_

Wmd

Cp, L, Wsd.

-------------------- ------- ---------- A L, **w** Oil test hole.

Sand and

gravel---

320

A L \_

\_ Obs Cr, Cpr, L,

Wmd, Ws.

Do.

-Grav;ie:lnsaadnd ·s-a-n--d~~---~~ ----3-3-5- ---2-1---

0

T, E ps Cr, Cpr,IT., Wmd.

P, E ps C, Cp, L--------

**A** Wmd

T,E Cp, Ws \_

**T. 3 S., R. 13 W.-Continued**

|  |  |
| --- | --- |
| Band and graveL. 560 ------- T, E ps C, L, Wm \_  do. ------- ------------------  A  Gravel. A L  Sandoand graveL\_ 950 ------- T, E ps C, Cp, L, Wm\_ .. | W-139, well 675 (Redondo).  rJ,O!n tf 1436A.  (Redondo). |
| do 720 T, \_E 1s P,L, Wm.----  Gra L----------- 515\_ ------- T, \_E PS C, L, Wm••••--  & :hniisand-- ------- ------- ----------- A - L, Wmd  ·simifM.cigi.aveC --- - ======= : - --- ! ============ t: - :::::::: |

\_

..

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data, | | | Water  Z9nes 1 | |
| USGS | Serial No.2 | Loca- tion No. **2** | LADWP  No. a | Owner or user | ':O:l;\_  :...i.:::,  -< | ig  .cl  A | r-..  *+>"u,*  a.g  \_c:i,.\_EI,  A | .0s.  0,....,  -:-i-  A | "'  -0--$-  .cl  8 |

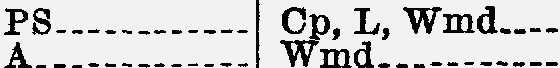
**T. 3** S., **R. 13 W.-Continued**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 3/13-7GL B-53k 1417A 11-C-11 Athens Water Co \_ 7NL B-54d 1418 11-0-10 Formerly General  Petroleum Corp.  7N2 B-54k 1418D Sentinel Oil Co \_  7N3 ••• \_  7PL ••• B-54f 1418B Formerly George Getty Oil Co.  SOL.. B-58g 1437E Formerly S. **L.**  Wright.  **802** B-58d. 1437B ll-C-37 Southern California  Water Co., Delmar plant, well 1.  8GL •• B-63a 1437F 11-0-36 Clara Peopping\_ ------  8Hl..\_ B-58b 1437 11-C-45 Formerly Glass \_  8H2 ••• B-63 1447 11-0-17 Stiller.----------------  8H3••• --------- 11-0-16 Albert Glass, well 2 \_  8LL •• B-58c 1437A Howard Park Co \_  **8L2....** B-58i 1437G 11-0-34 H. N. Edison (form-  B-58e 14370 erly Mrs. Bushby). 9AL••• ---------- --------- 11-D-33 Southgate Water Co•.  9Bl. ---------- -·------- ll-D-31 El Jardin Water Co  9B2 ---------- --------- ll-D-32 do \_  9B3 •••• --------- ---------- do \_  9B4 B-63d 1457B G. G. Talamantes \_  901 •.•. ---------- --------- ll-D-30 Formerly Charles 9EL ••• B-63c 1457A Wright. \_  9FL.\_ B-63b 1457 George White \_    9F23 •••• ---------- --------- SM. iWldrilesdonRangel \_ 9GL Norman Audrey \_  9NL.. B-64a 1448 ll-C-15 General Petroleum  Corp.  9N2... B-64f 1448B ll-C-13 Mrs.H. Saulque 9N3... B-64 1448A ll-C-14 Formerly Charles  Ingram.  9RL •• B-69 1468 11-D-26 Formerly Willow-  brook Park Mutual 16AL.. LoWs AatnegreCleos.County  Flood Control District.  Southern California Water Co.:  Willowbrook  16Hl plWanet:ll t\_ \_  16H2 B-64m 14590 Well2 \_  16H3•. ---------- --------- ll-D-24 F. L. Walton \_  16JL•• B-691 1469F 11-D-45 Johnson Ranch 16J2\_· B-69m 1469J (formerly Woods).  do \_  16J3 B-690 1469H Johnson Ranch \_  16ML. B-64h 1449B Formerly C. J.  16M2 Faulkner.  16M3•• \_ E.G. Kidwell \_  Atkinson Brick Yard.  16NL. B-64b 1449 Elton Porter \_  16PL\_ B-64d 1459 11-D-21 A. T. Veitch \_  16P2' •. ---------- \_ C. S. Phister \_  16QL\_ ---------- --------- ll-D-19 Cressey Park ­  13RL. B-69g 1469E ll-D-18 Mrs. Dorothy Gordon\_ 17B2 B-59d 1438 Emmer Pieper \_  17DL. B-59n 1428A Formerly J. R. Haur- vorth.  17El••- B-59a 1428 Roy F. Wolfgram \_ | 192  177 | 575 | 14  12  12  16  12  10  12  14  5  -------- 12  12  3  2  4  4  4  13  10  4  2  9¼  12  12  6  8 | ------ | ------ |
| 175 | 317 |  |  |
| 168 | 405.5 |  |  |
| 168  116 | 350  557 | 190  334 | 100  16 |
| 120 | 549 | 150  225 | 25  94 |
|  |  | 390 | 159 |
| 110 790  108 531  109 350  108  120 585  128 254  95 ---------  95 500  95  95 310  95  96  94 18  93  : - ·oo··--  93  98 344  92 408  93 160 to  200  86 250  83 21.5  81 220  82 250  82 250  79 243  81 250  79 60  97 131  93 250  104 --236 | |
| ------ | ------ |
| 369 | 136 |
| ------ | ------ |
| ------ | ------ |
| ------ | ------ |
| ------ | ------ |
| 270 | 62 |
| 305 | 47 |
| ------ | ------ |
| 185 | 15 |
| 204 | 15 |
| 180 | 46 |
| 184 | 59 |
| 105  93  96  81  80  120  125  131 | 196  200  219. 0 241  300 | -----  10  8  12  6  12  (9) | 174  ------  ------  ------ 161  ------  ------  230  258 | 45  ------  ------  ------ 78  ------  ------  25  42 |

See footnotes at end of table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones ,\_ Continued | Pumping data | | | Miscellaneous | | |
| Character of material | ..  Cl)  "'  i  0 | =  0 .......  '0.s  m'-"  r-.  A | a  ::,  fit | Use of well | Analyses and measurements | Remarks' |

**T. 3 S•• R. 13 W.-Continaed**



325 T, E

\_ i-

g-r-a-v-e-L

--------------

**A** L \_

-A wL \_

-------------------- ------- ------- ---------- A Cr, L-----------

W-139, well 614

(Redondo).

Sand and graveL. 715 ------- T, E PS 0, L, Wm••••--

do•.• ------- ---------------- --------------·---

L, Wmd \_

A L, Wmd \_

-------------------- P, I Irr \_

Wmd \_

Sand and graveL T

Wmd. \_

L. - -

------------------ Obs \_ Wmd, Ws, **Ww\_**

-------------------- 350 -------

T,E

T,E

ps w \_ pg Wmd \_ A W \_

-------------------- 300 T, E

pg \_

Wsd

-------------------- ---------- A Wmd••• --------

--------------------

P,M

P, M

Wsd \_

ADo--m -\_ WCpsd --\_

--------------------

T, E

Dom, Stock \_

Sand and gravel..

T, E

Dom \_ Ind \_

gCpg, ===L=, ==W==m= d==,===

do Obs \_

Ws

Wmd, WS-------

A Wmd \_

-------------------- Obs Wm LACFCD, well

1458A.

Coarse sand------- 810 L

Coarse gravel. ---------------- ------------------

Sand and gravel... 129 2 T, E pg L, Wmd \_

A L, Wmd \_

Gravel and sand

-------

T, E Dom, frr Cp, L, Wmd.•--

Obs Wm \_

A\_ W \_

LACFCD, well 1469J.

**A** L W-139, well 592

T,E

T,E

Dom Dom. \_

Cp \_

(Redondo).

Sand and gravel. T,E

T, E

ODbosm, Ind.---- CWpm, L --\_

Irr --  ~~W~~-m- ~~d~~ .--**-** \_

Gravel and sand•• T, E Dom, Stock \_

-------------------- ------- ------- ---------- A-------------

A

W>sc1 :- =======

L\_ -

W-139, well 686 **(Re­**

dondo).

Sand and gravel. A L \_

do \_

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| usos | Serial No.J | Loca- tton No. 2 | LADWP  No.a | Owner or user | cP  'd  ::s:::.\_  ::i:e | I  i  A | cP  i  a-2  !5  A | .s  0,....,  *o*:*:-*i*-*  cP  A | ""''  cP  ;Z!' l.  E-t |

**T. 3 S., R.13 W.--C:Ontinaed**

3/13-17FL•• ·-········ ....•...•..•............do.....-----·- 129

17KL. B-59j 1439D ·-·---·-·- Formerly Mrs. 113

Montague.

17Pl... B-591 ··-··-·.. -·-··--·-· Kinsey··-··-···---··-· 121

17P2-.. B-59q 1439H 11-C-6 Montozo\_····-·-··-·-· 122

17Ql B-59g 1439A 11-C-3 H. Hellmers•..•·-··· 121

172

500

121

341

9 126 26

14 119 11

131 8

209 12

231 9

242 23

292 **38**

17QR21••.-.1 B-6549gk I

14439AE I ..ll.-.C..-.4..2•1--F-o·r-mdoer.ly F..l.i•c.k•s..• l . 1101 1326224

I ··-·1·4·-·,-·1··6-9-1•--4·8·-

17R2 .....•......•..•... ····--···- Wm.Banning-........ 113 ·-······· 12-14 -·--·· •. -·-·

17R3\_ - .•........ ·-·-··-·· 11-0-28 Clara Hegins Ranch.\_ 111 ·----···- ·-·-·-

18Cl.\_. B-Mm 1418E ··--·--··- FormerlyMaxJenney. 139 235 6 ,---··-•···---

1802-•. , B-54e

1801.. B-54j

1418A

14180

Union Oil Co.-·--·-·­ Formerly E. J. Miley.

:r641 , 12,

noI 18

*: t--* \_B-Mg •\_ 1419

.\_ ·---·--·--\_Louro Leitch--·---··-

91 150

J:t = === =

1802••1 B-54p I 1418F 111-C-7 I Union Oil Co.•...•\_

19AL.- B-106f 820A 7-A-11 Gordon Ranch-··-·---

131

99

110

384.0

12 ··11a·

19A2. B-59 14:29 11-0-32 W. S. Rosecrans:

121

395

24

248

17

138

19A3-·-1-·---····-1-·-----·-1 11-0-47 Well L.-.-----··-1 121I 390 12

19A4-.- B-59b 1429A ll-C-27 1--------·---·•------·---1 120 318

24 198 71

292 26

19A5•••I B-590

1429B

Well 2------···--..I 120 520

14 ,158 39

290 40

458 39

19BL-1 B-541

1419B I 11-C-1

Well 3--·--···-----I 108 I 731

14 I 17.5

272

692

23

139

21

19DL.I B-54L 114190

19D2•• ---------- ----·--·- ·-·-------

Well3 .•• ----····--1 731203 Well 3----·-------· 81 200

6 1···-·· ------

6 --···-

19FL

··--·----- --------·'·---------l-·------·-----··· 1

81 - ••••••••I••-••-••I-•••-•I••--••

1911.•. I B-106n

820B

Formerly C. N. Bassett.

73 136

7 ••••••I••••••

19J2••. 1---··---·-1·--------1 7-A-53 I Formerly S.S.

McMillan; Mrs. L. Ball.

!......,...\_..

73 140 8

19J3\_•• -----·--·- ·-----··- 7-A-56 S.S. McMillan, well 2.

19J4 ··-·---·-- ------·-- ··-------- --·---·-····-··----·----

19Kl•• B-106r 810 ·--··-·-·- E. J. Jones.. -·•·-···-- 19NL. B-106v 811D 7-A-5 S. Kronberger form-

erly H. D. Burge.

--160·---I-··-·6··1··-···1······

47 83. 0 8 -·-··- -·····

**48** ·-·-·--·· **8** ······ ···-·-

184

19Ql..- ------···· ··--·-··· 7-A-6 John Lawler

--·-·---

45 200

12 1-•··•-I-•-···

19Q2••. ·········- -·-·---·· -··· Spanish-American In­

stitute.

46 200 6

20AL.-1 B-641 14490

Anderson & Park (formerly Schallen­ berger).

112 193

20A2••-1-·---·····'---···---1---·-·-·--1 W.W. Moreland....--! 110

188

6 180 8

Pingree.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20Bl••- B-59m•• 14390 | | ---------- | Formerly Craig & | 114 | 552 |  | | |
| 20B2-•• **B-59f** 1439 | | 11-C-4 | Gardena Heights  Water Co. | 116 | 200 | 16 | 122  154 | 19  26 |
| 20CL.. B-59L | 1439F | 11-C-2 | G. L. Douglas --·· | 105 | 403 | 12 183 16 | | |
| 20Hl.. **B-llld** | **840A** | 7-A-20 | Southern California | 105 | 260 | 12 158 31 | | |

See footnotes at end of table.

Water Co., Wads- worth plant, Well 1.

228 15

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of  material | t.  e)  "a'.'=a  c a | ii,,  0,.....  ti  ...o. --  A | a0.  ::s  ll-1 | Use of well | .Analyses and meamrements | **Remarur** |

**T. 3** S., **R.13 w.-Continued**

GraveL f-------1-------1 P, E

I - - - - - - - - - - - - - - - - - - - - I - - -- - -,- - - - - - - - • - - - - - - - - - -

1 ---T, f--

om , £P--------------

trr::=====-==== d-----------

Sand anu gra.veL\_ ------- ------- ---------- Obs C, L, Wmd, **Ws.**

- \_J - ---- - ------ ----- :\: / : ;;;;; : =-::L, w I-

Ba~~nd and~~ gravel A Cp, L \_

:= === = ======= *\_} - ---*  ::t:::::: fmii=:::::::::: W-139, well 688 (Re­

; t

i::]J] vruI *i;;;=;* '.)\{ ::: :: **1\ ;il**

**-f**

·iidJo J[f ll*(/ ((* ;=:\_:r ::::::::::- t7tl\l

do ------- ---------- ------------------

donoo).

GraveL 770 20 T, E Ind Cp, L, Wmd \_

- i l========== ==::::: =::::::::: :::::::::::::::: ::::::::::::::::::'

[:::::::::::::::: :::: :: ::::::: --T -- - ::: t:::::::::::,

W-193, well 561 (Re­

dondo).

LACFCD, well 810-A.

1- --- - -- -- - -- --------1- ----- -,--- ----1-- - - - - - - - -

P,E

f--------------------1-------1- - I c,"jf"-

A L wd o).ell 550 (Re- A f Wind. \_

Irr Cp, Wmd \_

A CP 1 LACFCD, well 8200.

1--- -- - - - ----- -------1- ------ ,---- ---

Dom Obs

* d \_ md, Ws \_

360 ,-------

P,E

T,E

Dom Cp, Wmd \_ Dom, Cp \_

**A.** L ,

Irr

wc1 ! o'f.8ll 597 (Re-

GraveL .1-------1-------1 C, E

1- - - - - - - - - - -- - - - - - - --1-- --- - -,- - -- -- - 1-- - - - -- -- -

Dom, Stock,I Cp \_

Irr

**A-------------** ------------------

Gravel ------- T, E Dom, Irr Cp, L, Wmd \_

-----! :-· -- \_Obs L, WIJ1.d, Ws

Sand and gravel... 807 18. 5 T, E PS Cr, L, Wm\_,. \_

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| UBGB | Serial No.2 | Loca- tion No. 2 | LADWP  No.s | Owner or user | Cl)  "Cl  =::.  :;:j  ;::e  -< | "'  I  .cl  a;,  A | r-.  a;,  +>'@'  a;,a;,  s.'fail  -A--- | .As  .s  .c-:-l-j .  Cl)  A | "'  Cl)  -o--l--  .cl  8 |

**·T. 3** S., **R.13 W.-Continued**

a11a-:1; =t

20H4•• ---------- --------- 7-A-18

East Gardena Water Co.:

Well2 \_

WellL \_

Well L -·-·

106

105

105

160

174.0

125 70

116 79

14 ··--·· -·-···

20JL

B-lllv

840E

7-A-24

Harry Duncan ..\_

79 335 16

*2012* B-1110

840B

7-A-19

Clyde Morton (form• erly W. S. Martin).

103

187 7

68.0

2013 -------·-- ·····-··· 7-A-23

Gardena Water Sup- ply Co.

84 280

16 ...... ·--···

20LL\_

20L2.• \_

B-lllh

B-lllm

830

830A

7-A-25

Formerly A. B. Moore.

Formerly C. *1.*

Darling.

90 70

77 85

10 ·--··· ---··-

8 -····· ·--···

20L3 B-llls 830B 7-A-13

20LL 7-A-54

20L5•• --------- ----------

20ML B-106a 820 7-A-12

20NL. ---------- --------- 7-A-30

20PL --------- 7-A-26

Ernest Smale ··-·- Sadie K. Wolf.-·-···-·

L. Goutermont.--··---

1R¥:Low.·: ========

Formerly Max H.

Stein.

87 200

77 200

77 190

77 151. 0

51 253

67

6 ·-·-·- ·-·-··

8

6 ·-·-·· -···-· 8 -···-· -·---· 10 --·-·· -----·

20P2\_•• ---------· ·····-··· --·-······ ·-·-··········--··---·-· 66 ·--··--·· ··-·--·· -··-·· ·---··

20P3••• ·-----··-· ----····· -····-·-·· Thomas M. Haines\_.. 57 80

20R\_L

--------·· ----·· 7-A-27

Formerly C. R. 72

Haskin.

2101. -----·--·- ··--·--·· ---·-·---· C. C. Copeland-·-··-· 90

6 ·-·-·· .•: \_

2102••. ----·-···· ·--······ ·-····-·-· Leonard Barnes·-··-··

2103... -·----·--· ··-···--- ···-···--· A. L. Flick....•--·--··

100

95

280

12 ----·· ·-·-·-

8 ·-·--· --·---

2104 ·------··· ··-··-·- ·•--·-----

21DL. -·-·--·--· ··-·•---· 11-C-5

21EL. B-llle 840

McDonald.. --··-··-·­ Park Water Co.

(formerly M. A. Smith).

Enterprise School District (formerly "Conklin well").

95

108

100

236

157. 5

14 ---·-- ·-··-·

12 165 17

21E2 ···---·-·· ··-·---·- 7-A-21

Formerly M. E. Hanselman.

101 75 7

21Fl.. B-lllj

850A

Formerly Samuel Flick.

97 200

7 89

111

21F2\_ - -·--·-··-· ··-···-·· 7-A-22 R. B. Callen·--··-·---

21GL. -··--·--·· --····--· ···--··--· Sherman Sherer·-·--··

2102.. B-lllp 8500 ·······-·- .....do\_·-·-·······-··-· 2103.. B-llle 850 Formerly Mrs. H. C.

Montague.

21HL. B-116n 860B ········-· Formerly Bovee.-·-···

2111..• ·---··-·-- ······-·· ·-···- Compton Sanitarium\_

21NL. ·-······-- ···--·--· ·······-·· Central Heights Im-

provements Co.

100

89

87

90

78

80

102

200

192

192

70

206

12 .•.... ····-·

7

4 -····· -·····

21PL. ---····.......•.... ··-··-···· Freeman............\_. 97 ·--······ ·····-·- ...... ····--

22AL. B-69h 1479 11-D-12 City of Compton\_·--·- 22CL. B-69e 14690 11-D-14 Formerly S. *1.* HulL.

2202 B69f 1469D Formerly Austin

Carrien.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 22DL\_ B69d | 1469B | 11-D-15 | Francis E. Barron•.... | 76 | 260 |  | 170 | 90 |
| 22GL. -B-116J | 870F |  | Formerly Malcom .\_ | 71 | 310 |  |  |  |
| 22HL\_ B-116b | 8700 | 7-B-10 | Formerly Compton | 69 | 256 | 12 | 235 | 18 |
| 22H2.\_ B-116d  22H3 B-116c  22H4 B-116h  22H5 -·-·  221L •• B-116g | Ice Co.  Magnolia plant:  870A .Well L---··-- 69  870 Well 4·-- 69  870D · 7-B-9 Formerly Sampson 70  Tire Co.  ··--··--· -----····· ··--··-··-··-·-·-···-··· ··--··  870E Robison.•• -·---·-·--·- 67 | | | | 350  714  257  717  220 | 12  16  16 | ------  -·····  199 | ------ 38  -----·  15 |

71 258

74 160

74

12 ···-·· ····-·

7 ---··· ·-··-·

City of Compton:

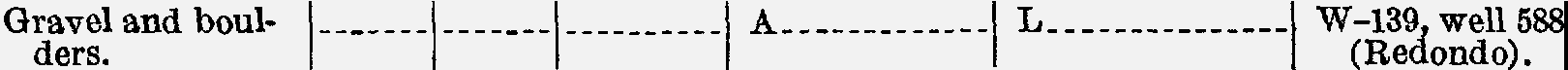
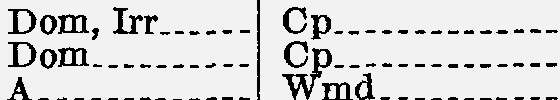
12

See footnotes at end of table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Oontinued | Pumping data | | | Miscellaneous | | |
| **Ob81'8Cter of material** | i::i,..  .,,-d;;;>  isa.a  c:, | 0,......  '0  **cs.\_,**  **1-,**  **A** | p.  **Pot** | Use of well | Analyses and measurements | **Remarks'** |

**T. 3 S., R.13 W.-Continued**

GraveL T, E Irr Wmd \_



Gravel and sand T, E Irr Cp, Wmd \_

------- Obs Wmd, Ww \_

T, E Irr L, Wmd \_

L, Wmd \_

T,E

Irr Cp, Wmd \_

A L W-139, well 551 (Re-

A Wmd \_

dondo).

P,E

P,E

C,E

P,E

Dom \_ Dom, Irr \_ Dom \_

Dom, Irr \_

C, Cp, Wmd \_ Cp,W \_

md, Ws \_ md. \_

T,E

P,W

T,E

T,E

T,E

T,E

T,E

A \_

Dom, Irr Cp \_ Dom, Irr Cp \_ Irr Cp \_ Dom, Irr Cp \_ PS L, Wmd \_

Gravel and sand \_ P,W

Dom

Cp, L, Wsd \_

A Wmd \_

T,E

Dom, Irr Cp, Wmd \_

T, I

Irr - \_ \_ - -

T,E

rom £P, Wsd W-138, well 57

A Wsd \_

{Downey).

T,E Dom, Irr Ind. Cp \_

T,E

T,E T,E,

Irr Op \_ PS Op, L, Wm \_

A Wmd \_

A

Gravel and sand•• A------------- L, Wmd W-138, well 64

A L W(-D13o8w, wneeyll).522

GraveL · A L, Wmd \_

. PS C, L, Wmd \_

Gravel and sanhd pg C, L, Wmd \_

4,. - ...---·-

Wmd

\_

(Downey).

Coarse graveL- \_ A LL ·----\_

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones t | |
| U808 | Serial No.2 | Loca- tion No.t | LADWP  No.a | Owner or user | (I)  "O  .:.:.s.:.:.:.\_.  :-e$  -< | ...  g t(I) A | 1-,  (I)  ...."ri.i'  (1)(1)  \_a'fJ  as....S.....  A | i  ;.csij  .....  (I)  A | fll fll  =(I)  \_.I.......  .cl  8 |

**T. 3** S., R.13 **W.-Continued**

22ML\_ B-116p 8600

22NL\_ B-116 861

Walton.

Formerly H. B.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/13-22Ll •• | B-116L | 860A | --------·- | Formerly Frank | 71 | 530 | 10 | ------ ------ |
| 22L2\_ - | B-116a | 860 | ---------- | do \_ | 71 | 332 |  |  |

74 80

80 110

*7* ------ ------

22N2

B-116q 861A

Schildwacher.

80 700

22QL. B-1161 871

26BL\_ B-121s 8810

----------

Compton Junior Col• lege.

68 562

6 520

° **28**

26B2.

Bl21 881

7-B-22

Formerly R. E. Haw-

: 237 -7-- ------ ------

26B3

----------

..,\_

7-B-23

thdoorne.

\_ 65

130 10

------ ------

26DL\_ B-121b 881A

26Fl- ---------

2601.. B-121L 891B

7-B-21

7-B-32

Robert W. Poe (for- merly Dr. J. A. Monk).

Formerly Spartan

Steel Co. Formerly Summer-

City of Compton

\_

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 61 | 140 | 8 | 80 | 58 |
| 62  60 | 199 | 20 | 84 | 51 |
| 60 | 135 | 10 | 60 | 72 |
| 60  60 | 654 | 6  8 | ------ ------  ------ ------ | |
| 62 | 204 |  |  | |
| 57 |  | 2 | ------ ------ | |
| 57 | 200 | 6 | ------ ------ | |

65 775.0 12 670 **H2**

64 655 12 ------ ------

26Hl

B-12lj 891

land Park.

26Jl. Day \_

26J2 - ---------- --------- Formerly John Hight\_

:tk= -ii-=12ic-- -ssiii

---------- i :t !\J!ft ===

Edison Co., Ltd.

26ML ---------- --------- R. H. DeLano \_

26NL. Los Angeles County

Flood Control Dis­ 26QL. B-122 882 JoteriCcot.mino \_ 26Q2 do \_

26Q3 B-122m 892E Formerly Gardner

59 175

59 --------- -----·-- ------ ------

26Rl --------- E. WMa.teHr aCrot .

\_ 57

26R2

B-122n 892F FormerlyJ. S. Cum- 57

84 , ------ ------------

26R3

B-122o 8920

mings.

H.J. Schwatken

\_ 58 35

27AL.• Bert Phillips \_

27BL. B-116m 871A ·-

27B2•. \_ B-116k 871B Formerly J. J. Harshman.

27CL•• ---------- --------- Richland Farms

67 146

68 8

68 480

73 474

6 ------ ------

12 ------ ------

27NL. B-117 862 7-B-34

Water Co. MacCllntoch \_

97 351

7 ------ ------

28Al\_. ---------- C.H. Hazel. \_ 28BL B-1111 851 Mrs. Alice Morrison

155.0

91 12

96 546 -------- 330 216

28CL\_ B-lllr 8510 7-B-16 Morrison Ranch \_

2802 --------- ---------- Veatch •

2803 --------- 7-B-47 Mrs. Alice Morrison\_. 28D2\_.. ---------- --------- JMakrse. SNc.hoMlt.eVeatch \_

98

97 327

97

99

95 210

6 ------ ------

4 ------ ------

6 ------ ------

:: --- ---------- --------- ---------\_- Car OPP-------------

78 130

1½ ------ ------

2801- --------- 7-B-33 Woodlawn Cemetery\_

92 480

2802 B-lllg 851A C. A. Giacomazzi \_

93 312

96 340

12 ------ ------

-------- 319 21

2803-\_ B-lllq 851B Mrs. Alice Morrison..\_ 95 93. 0

4 ------ ------

28LL•• ---------- --------· Lincoln Memorial 85 370

Park Cemetery.

28Pl••• ---------- --------· Gardena Syndicate 102 401. O

10 305 92

10 284

29AL•• B-1111 841 Formerly E. C. 67 154

Haskins.

9½ 100

See footnotes at end of table,

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | '°  G)  a"'.a  I; El  0 | =  O'"'  'd .e  .<..e"-'  A | p.  P-t | Use of well | Analyses and measurements | Remarks' |

**T. 3 S., R. 13 W.-Continued**

A L\_' W-138, well 54

Gravel and sand

--------------------

1,000 \_

C,E

T,E

A L \_

A Wmd \_

A Wmd \_

Obs Wm \_

Dom, Irr C, Cp, L, Wsd

Irr Wsd \_

A Wmd \_

A Wmd \_

(Downey).

Sand and graveL-

Obs L, Wmd W-138, well 167

(Downey).

Gravel and sand Coarsegra,eL

-Gravel and-sand

A- Wmd \_ A L \_ PS C, L, Wmd \_

--- - --- 11:::========== £ :=============

W-138, well 214

C,E

T,E

P,W

Dom Cp \_

Irr L -------------

11:s=========== Wm

(Downey).

LACFCD, well 882D;

test hole,

P,W

Dom, Stock Cp, Wmd, Ws

T,E

P,W

IAr\_r\_----------- Wsd. \_

Irr, Stock Cp \_ A. W sd \_

C IIrrrr \_

w------------ ---

P,W

P,W

A C. Test hole. A L \_

PS \_

C,L, Wmd,

Ws.

*?*------*-*-----*-*----*-*-*=*--*=*-- ---*675*- ======= -----------------

tA============

CiJ'.· s=======\_

-------------------- P, E Stock Cp \_

-------------------- C, E Irr Cp \_

-------------------- T, E Dom, Stock Cp \_

--------------------

--------------------

P, I Dom, Irr Cp \_

T, E Dom, Irr Cp \_

-------------------- T, E Dom, Irr C, Cp, Wmd \_

Gravel and sand.\_ T, E Dom, Irr Cp, L \_

W-138, well 252

PW Dom Cp, Wsd \_

(Downey).

Gravel and sand \_

T,E

Dom, Irr Cp, L \_

do Obs L, Wrd, Ww \_

do

A L W-139, well 580

(Redondo).

460508-59--21

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones t | |
| USGS | Serial No. 2 | Loca- tion No. 2 | LADWP  *No.a* | Owner or user | a;,  ":O:s::\_  :::1::  < | ..,  .::;-  ga;,  .Cl  -s.  a;,  A | ...  a;,  ....'oo'  a;,a;,  s-§  !§  A | i:i.  .£  ..o..,.- ,  .Cl  a;,  A | ""''  a;,  i::.::;-  ,!,40;>  **g**  .Cl  E-1 |

29B2 A.H. Marsh \_

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **T. 3 S.** | **, R. 13 W.-Continued** |  | | | | |
| **3/13-29A2** ---------- |  | ---------- | C.R. Haskin | 66 | 234 |  | 155 | 17 |
|  |  |  |  |  |  |  | 176 | 5 |
|  |  |  |  |  |  |  | 182 | 3 |
|  |  |  |  |  |  |  | 196 | 4 |
| 29A3 A. Kilgore \_ 65 172.0 204 1  29BL ---------- Mrs. Bessie Pivey \_ 64 --------- -------- ------ ------ | | | | | | | | |

|  |  |  |
| --- | --- | --- |
| 62 | 183 | 10 |
| 70 | 168 |  |
| 75 | 208 | 6 |
| 67 | 220 | 6 |
| 56 | 300 | 12 |
| 55 | 196 |  |
| 43 | 70 |  |
| 44 | 54. 5 | 6 |
| 44 | 140 |  |
| 45 | 198 |  |
| 44 | 85 |  |
| 45 | 65 | 5 |

29B3 John T. Pilkington \_

29B4\_ \_ B-llln 831C 7-A-28 Advance Dahlia

29B5

29CL

Fadrom \_

B-lllw 831D 7-A-29 Mrs. P. J. Weaver\_ \_

29C2 T. B. Goossen \_

29EL Mrs. E. Newton

29E2 RiHdearmmond. \_

29E3 Manuel Thomas \_ 29E4 H. S. Stone \_ 29E5 Jesse McIntyre \_ 29E6 H. "\V. Bach \_

29E7 M. P. Silva \_

29E8 J. J. Hoover\_ \_

29FL E. J. Bell \_

47

45 70

55 215

8

8

10-6-5

29F2 Charles H. Shepard \_ 47 75

29F3 A. Pratt\_ \_

46 --------- -------- ------ ------

29F4 W. E. Smith \_ 48 72 8

29F5 Nora **L.** Bacon \_ 47 57 6

29F6 \_

29GL \_ B-111 831B 7-A-34

2902 B-lllb 831A

K. C. Holland \_

W. S. Condren \_ Mrs. Albert E. Rose

47 55 4

55 198 8

50 111 8

2903\_ \_ B-llla 831 \_

29N4l --\_

29N2

William H. Meyer \_

William H. Meyer \_

H. E. Kuck \_ John Grant\_ \_

60 235

60 70

36 350

38 553

8

4

12 454 37

510 41

29PL\_ B-107f 832

29P2 B-107h 832A

Union Oil Co., "Gar­ dena No. 1."

\_

46 --------- -------- ------ ------

45 --------- -------- ------ ------

29P3 7-A-52 Formerly Peter

Dykzeul.

29P4 East Gardena Vege-

56 514

52 536

29P5

table Union. \_

30AL B-106b 821 Formerly Shuler

51 --------- -------- ------ ------

Dunn.

30A3 7-A-31 Los Angeles County 30A4 \_

41 39.0

45 225

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 30A2•• \_ B-106e 821B | 7-A-32 J.P. SchlaegeL \_ | 45 | 696 | 12 | 359 | 12 |
|  |  |  |  |  | 512 | 73 |

45 247

593

14

111

30BL\_ B-106m 821C Formerly R. D. Dow\_

40 210

7 ------ ------

30B2 7-A-9

30CL\_ B-106w SllE 7-A-8

30C2 B-106x 811F 7-A-10

30Dl \_ \_ B-1061 811

Frank Rehor\_ \_

M. Larsen Dairy \_ Coltrin Ranch \_ Formerly A. A. Cary

48 256

48 250

46 225

42 201

7 ------ ------

8

10

|  |  |
| --- | --- |
| 151 | 11 |
| 166 | 35 |
| 175 | 30 |

6

30D2 \_ \_ B-106p

30D3 B-106e

SUB

snc

W. J. Gcade \_ Formerly C. W. Love\_

41 40

40 116 10

30FL\_ B-106L

811A

Formerly N. E.

32 205 7

30F2 B.C"o\Vw. lBesa.rnes \_ See footnotes at end of table,

35 40 6

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones t-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | ,..  <I>  i::l,C>  s"':.:sS  s  0 | j:::  0,.......  'd  .,j.:.::  e'-'  A | :a  i;:l.  :,  fit | Use of well | Analyses and measurements | Remarks r |

**T. 3** S., **R. 13 W.-Continued**

|  |  |
| --- | --- |
| Gravel T, E Irr, PS L \_  Coarse graveL ------------------  do  GravdoeL \_  ::::::::::::::::::::::::::: ::::::: t ·J - :!:::::::: 8t:::::::::::::  J, E Dom Op \_  T, E Dom, Irr, Op \_  A Stock. Op, L, \Vmd \_  T,E Dom ------------------  'I',E Dom Op, Wmd  P,E Stock Op \_  P,E Stock ------- Op \_  P,W Dom, Irr, Op \_  P,W Stock. Op \_  Stock \_  T,E Dom \_ Op  T,E Dom, Stock \_ Op \_  P,E Dom \_ Op \_  P,W Dom \_ Cp - ------  P,E Dom \_ Cp \_  J, E Dom \_ Cp  P,E Dom Cp  P,E Dom, Stock \_ Cp P,W Dom \_ Op \_  P,E Dom, Irr Cp \_  Stock.  J, E Dom . ------- ----------  P,E Dom Op, Wmd \_  P,E fDoomm, Stock L \_  T,E C, Op, **L \_**  P,W Dom Op \_  Sand \_ T,E Dom, Irr, Cp, **L \_**  T,E  Gravel-and sand ·------ Stock. \_  -------------------- ------- ------- ---------- **A** ·-----------------  AA\_ - -Wmd \_    A C  T, E Irr ------------------  Wsd  Gravel T. E Dom, Stock Op, L, Wmd ••.. Gravelandsand \_  Sand andgraveL \_  T, E L, Wmd \_  T, I Irr ------------------  -------------------- A L \_  T, E Irr Wmd \_  J, E Dom, Stock Op, Wmd. \_  -G1: ; j------------ ------- ------- T, E :E:::::::::::: f1=1\_ :::::::::::  do  A C, Cpr, Wsd \_  Wsd \_  Gravel and sand A L  P,W Irr Op \_ | LACFCD, well 831D.  Oil!test hole.  W-1391 well 545  (Reaondo).  W-139, well 464  (Redondo).  W-139, well 496 (Redondo). |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  G) .. ,.. | | | Water zones 1 | |
| usos | Serial No.a | Loca- tion No. a | LADWP  No.a | Owner or user | ":O:i::..  **:**:**:**1**:e**  -< | !  0.  G)  A | G)  ....'co'  G)G)  s-5  -o-,-,S-  A | .0s.  ;o;..J-..  0.---  G)  A | r.o  r.o  G)  =-§--  .-1:-1--  8 |

**T. 3** s•• **R. 13 w.-Continued**

311

3138080t4= ========== ========= ========== =G==.==H=.==M==a=s=o=n==~~=======~~=\_=

3003

Anna Kemper

\_

41 175

42 300

41

35

10 ------ ------

30HL\_ B-106c 821A Formerly Chas.

Straumer.

30H2 B-206y 821D 7-A-33 Henrietta A. Moline

43 41.1

44 48

41 175

65 --=3--4- ---1--4-

10 ------ ------

30H3 Mrs. Emma Hart \_ 43

59.0 8

30Jl B-107g 822A 7-A-35 M. R. Peck (formerlr 37 743

16 495

-10

30JL\_ B-107 822 J. <j,i\_t - - c- -·- 36

148

520

7

208

30J3\_ George W. Shirley \_ 35 92

132 12

30J4 L. J. Morganthaler \_ 40 75

8 ------ ------

30J5 C. F. Johnson \_ 30KL 7-A-37 H.B. Johnston \_

30K2 Emily Costa \_ 30LL \_

30L2 ------------------------

36 156

39 200

--198

31

198

8 132 10

------=- ------ ----==

30L3 \_

30L4 \_

30L5 \_

Mrs. Mabel C. Voss 36 30

Geo. D. ArnelL 36

Jane Benvenuto \_ 33 55

2½ ------ ------

30L6 \_

30ML \_

30M2 \_

30M3 \_

30NL\_ B-107e 812A

30PL\_. B-107d 812

Davies & Pursche \_ Arthur B. Page \_

W. A. Schofield \_ Tony Dugazau \_

Pete Ciabarri (Jersey Maid Dairy Farms).

Formerly Ben Ayald\_

32 200 12 ------ ------

31 39 6 ------ ------

31 37.1 6 ------ ------

23 28 6 ------ ------

27 195 -------- ------ ------

29 42 8 ------ ------

30QL E. Costa \_ 33 80

6 ------ ------

30Q2 J. T. Bever \_ 31 40

30Q3

Fred Castillo \_

30 100

10 ------ ------

30Q4 H. H. Baker \_ 32

37. 8

12 ------ ------

:8ir\_

-L. C. Maguet \_ 30 60

30R2 S. 0. Barnes& Son \_

31 550

31AL\_

31BL\_ B-107c 813

Ethel McClain \_

Ella Hitchcock \_

34 319

30 200

6 ------ ------

**31B2** State of California \_ 31B3 Ralph Marsh \_ 31B4 **A.** Herzog \_

31B5 B-107c 813 Ella Hitchcock \_

26 25

26 700

26 65

27 300

2 ------ ------

31CL\_

M. Takeshita \_ 26 79

3 ------ ------

3102 ---------· Gunderson \_

27 250

3IFL Nancy Coleman \_

31F2 J.E. Rochon \_

27 650

27 159

12 ------ ------

6 ------ ------

31F3

------··-- \_

27 --------- -------- ------ ------

31F4 J. J. Bruckshaw \_ 30

30.0

31HL\_ B-107a 823 J. H. Bush \_

30 404

31H2 do \_

31H3 Clyde E. Sheets \_ 31H4 Joe Claro \_

31H5 Bernardino ----------

31LL. 7-A-43 Mrs. Woods-. --------

26 30

26 150

26 152

26 50

26 140

8 22

3 ------ ------

3

2

31L2

Charles Anderson \_

31 700 10

31L3 Bert B. Bynum \_ 32CL\_ B-112e 833D 7-A-49 John Larronde \_

3202 do \_ 32DL J. Segovia \_

31 50

31 70

32 275

35

30

6

6

8 ------ ------

5

32FL\_ B-112c 833B L. B. Chase Oil Co.,

John Larronde

\_

33 --------- -------

32F2

B-112a 833A 7-A-48

well 1.

49 750 12 ------ ------

32F3

32F4

32F5

32F6

B-112 833 7-A-47 Hata \_

---------- \_

---------- Hata \_

---------- Ed Cost\_ \_

43 550 10 ------ ------

46 --------- -------- ------ ------

42 1,500 10 ------ ------

43 662 10 530 130

See footnotes at end of table.

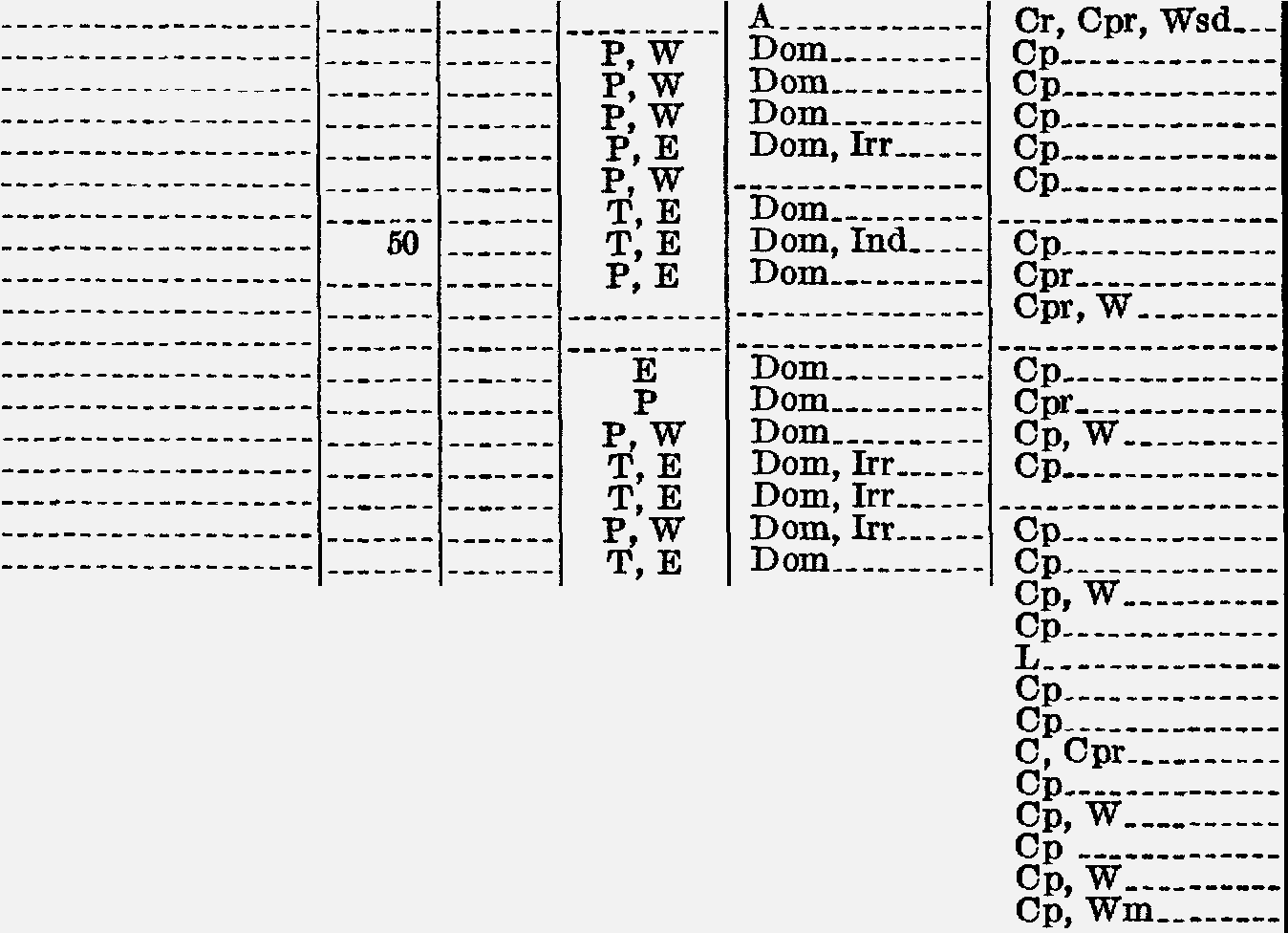
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of  material | **i:;.o**  rll  §.s  =as  C, | o---  '0  o,'-'  1-o  A | si:i.  ::s  Poi | Use of well | Analyses and measurements | Remarks 7 |

**T. 3** S., **R. 13 W.--COntinued**

Quicksand

T,E

P,W



p

P,W

\_

P,M

Irr, Stock Irr

Cp \_ Cp,L \_

--------------------

-g ;:I ci ci==========:::::::

Sand and gravel•••

--------------------

P, E Dom Cp, Wmd, Ws••

¥, i:::::::::: -cp:-r::wiii,c::

T, E Dom, Stock Cp,L \_ P, W Dom, Stock Cp \_

Gravel and sand

----12\_5\_ :\_--\_-\_::: TP,, EE s t 0ck Cp \_

T, E

Dom, Stock Cp \_

Dom, Irr

-------------------- -·----- **P, E Dom, Stock**

Cp, Wmd

**Cp \_**

-------------------- -------

p

T, E

*D :* Stock, Cp \_

P,W

Irr Cp \_

-------------------- 765 -------

P,I

C,E TI

P,W,I P,W

P,W

T,E

Irr Cp \_

Dom Cp \_

Irr Cp \_

-Dggom: , S=t=oc=k== -gCt=p=,=L==========\_

Gravel and sand••

-------------------- -------

=::\?! =?)//\=

T,? f m

P, E Dom \_

n

P, E Dom, Irr \_

=\it

-------------------- ------- P, E Dom, Stock,

T, E

Irr.

Ind Cp \_

-------------------- ------- P, I Dom \_

-------------------- ------- Obs L, Wm \_

-------------------- ------- Obs Wm \_

Oil\_well.

-------------------- ------- T, E Dom C, Wd \_

c \_

Sanci"and graveL

T, E tr:=========== -i;:::::::::::::::

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| USGS | Serial No2 . | Loca- tion No.2 | LADWP  No.a | Owner or user | Cl)  ":O:s;  :j  ;:e  -< | ..  I  .Cl  0.  Cl)  A | ...  Cl)  -;;-  <D<D  s-§  ..o.:.s.a  A | .0s.  o,.....\_  ;;j  o.  Cl)  A | "Cl')  :;::;-  Cl)  .*Q gi*  .Cl  8 |

**T. 3** S., **R.13 W.-Continued**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 3/13-33Al... ---------- --------- 7-B-36 Union Oil Co  33A2 ---------- do  33BL\_ B-117d 853A 7-B-37 I. W. Hellman Estate\_ 33EL.. ---------- --------- 7-A-50 Union Oil Co  34Bl..\_ ---------- Dominguez Estate Co\_ 34DL. B-117b 862B 7-B-45 I. W. Hellman Estate\_ 34D2 B-117a 862A 7-B-35 G.D. Hufford and  Morrell.  35AL.\_ B-122j 893 Carson Estate Co \_  35BL.\_ B-122h 892B H. Y. Sasaki \_  35B2.•• B-122L 892D 7-B-42 do \_  35B3... B-122q 8820 do \_  35B4 B-122e 8830 Dominguez Estate Co\_  35CL.\_ ---------- ---------- Carson Estate Co \_  3502 ---------- ---------- do \_  35El... ---------- Dominguez Estate Co\_  35GL\_ ---------- --------- 7-B-39 Carson Estate Co  35Hl.. ---------- --------- ---------- do \_  35JL.• B-122p 893A 7-B-40 Dominguez Estate Co. 35J2 ---------- --------- ---------- do \_  35Kl. \_ B-122d 883B do \_  35LL. B-122c 883A do \_  35ML B-122b 883 7-B-38 Pacific Electric  Railway Co.  35NL. B-123b 884A Dominguez Estate Co. 36AL.. 0-930c 912 ---------- Carson Estate Co \_  36A2 --------- LB,Artesia Street  bridge, test well (south).  36BL.. B-129 902 6-A-26 Southern California  36B2 --------- Edison Co., Ltd. \_  do.  36B3 ---------- 9020 LosAngeles County,  test well.  36CL\_ B-129d 902B  City of Long Beach: North Long  Beach:  3tiDL. B-122i 8920 7-B-44 Well2 \_  36Gl. --------- \_ J. Well ET-4----  36JL\_ \_ C-929c 913B Imseng \_  City of Long Beach: 36PL\_ ---------- -----,.--- Well ET-3 \_  36P2 ---------- Long Beach  Boulevard bridge test well,  36P3 ---------- second. \_  third  36QL.. C-929j 903 Test well \_  36Q2 ---------- North Long Beach  Extension Water Co., Inc. | 146  146  153  115  115  125  125  53  57  56  *56*  56  57  57  74  52  51  47  47  49  51  49  47  57  57  56  54  *56*  56  56  51  52  46  44  44  50  50 | 250  350  375  700  500  374  100  --------- 174.0  92  140  150  595.9  400  130  175  154  129  --------- 350  18  --------- 260  20  200  29  30  21  15  15  190 | 16  12-10  16  16  --------  **12** | 272 | 30 |
| 410 | 70 |
| ------ | ------ |
| 8  8  6  10  3-1½  10-8  10-8  12-10  12-10  7  -------- 12  6  --------  12  6  10  6  6  6  8 | ------  ------  ------  ------  ------  ------  ------  ------ 86  60  ------  ------  124 | ------  ------  ------  ------  ------  ------  ------  ------ 35  41  ------  -·----  6 |

T. 3 S., R. 14 W.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/14-lAL | B-52d | 1405A | -------- - - | Formerly E. 0. Smith.  Mrs. Drusa Wellett... Southern California  Water Co.:  NormWaenlldie plant:  l\_  wen 2 | 158 | 97 | *6½* | ------ | ------ |
| 1A2••• | B-52e | 1405B | ---------- | 163 | 233 | 10 | 210 | 17 |
| lBl  lB2 | B-52c  B-52g | 1405  14050 | lJ-C-38 | 198  195 | 220  390 | 12  14 | ------  184 | ------  98 |

See footnotes at end of table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones ,\_ Continued | Pumping data | | | Miscel!aneous | | |
| Character **of**  material | tp,...  CV  g*rn*,a  El  0 | !0::,-,,.  "O  !c::s'-'  A | A  El  :::l  i:i.. | Use of well | Analyses and measurements | Remarks7 |

**T. 3 S., R. 13 W.-Continued**

|  |  |
| --- | --- |
| =8==!=;:=-=s=a=n=c=C======-=-=-=-=-=-=-= =--=-=-=-=-=-= ---l--E----- -i-t-=-=--=-=-=--=-=-=-=--=- \_c£, L, -W=d ====  =-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=- =-=-=-=-=-=-=- =-=-=-=-=--=-= ----; ------ POrbis -I ====== [C;w, -Cmp-, =W==m=====  T,E Irr W \_  T,E Irr ------------------  ::::::::::::::::::::::::::: ::::::---:;-:----O;b,s;::::::::::: Wfm \_  r:::::::::::I  :-:-:-:-:-:-:-:-:-:-:-:-:-:-:-:--:-:-:-::-:-:-:--:-:- :::::: nP, E { :::t::::::::::::\_  T, E Irr Wm \_  Grave]\_ L \_  Gravel and sand A L, Wd \_  1--- ----- - -----------1--- ----• - ------ P,E p;m, Ind , gpr  T,I A Cpr,W \_  1----- --- ------- -----(----- --1---- --- '----------  1-- -- ----------------1---- --- '----- -- T,E Irr ! Wm \_  Sand -- --------,-------,------- T,E Irr I L \_  1-- - ---- ---- ------ ---1- -- - ---1--- -- --1------- ---1-- - -------- -----1----- -------------1  \ - !- ! ! 1 1 W  T,E PS Cr, Ww \_  1- - - - - - - - - - - - - - - - - - - - 1- - - - - - , - - - - - - - - i - - -T-if- - A Cpr, W \_  Irr 1  A Cp, W \_  \ -- - - - " - - - -- - " - - -- - - -1- -- - --- I - - - -- - -1- - - - - - - -- - A Cp, W \_  .4 Cp,W \_  GraveL-----------1-------1-------1 T, E Dom I CCpr --\_ | ml::::ll l  , LB, well E-15. |

1

=

:

**T.** 3 **S., R.14 W.**

I !

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1- ------- --- ---------1  GraveL --------  Sand and graveL\_ | -------1  -------1  250  508 | -------1  --- ----1  6  16 | ----------  ----------  T,E  T,E | 1A - | \_------------- |  |
| A J C, Wmd \_  PS C, Cp, L, Wm | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  (I) .. 1-, | | | Water zones 1 | |
| usos | Serial No.2 | Loca- tion No. 2 | LADWP  No.a | **Owner** or user | ':O:s;.\_  ::1  ;:e | ig  .cl  i  A | (I) 1  Eosloa  -A--- | .s  0 .....  ;;j  -s.---  (I)  A | ""''  (I)  .*=*bl*z-*  .-cl ---  (I)  0  8 |

**T.** 3 **S., R.14 W.-Continned**

3/14-lFl..•.

B-47j

1395A

10-D-13

Los Angeles County Water Works District No. 1.

228

350

16 165

174

IGL ---------- --------- ----------

Southern California Water Co., Nor- mandie plant,

200

598

14 220 36

265 25

lJL B-53j 1406A

well 3. Mrs. Bates

180

104

6 ------ ------

ILL.•. B-48c

IPL.•• B-48b

1396A

1396

George Washington High School.

Pan American Oil Co.

233

218

283

445

12 191

12 **127**

185

92

318

22

IQL

B-53a

1406

----------

Emil Firth.. ----------

195

12

120

IRL .• ---------- ---------

Formerly J.B. Brockley.

189

7 ------ ------

2AL\_. B-471

B-47e

2Fl •••• B-47a

2LL.•• B-48

**1385A**

1395

1385

1386

10-D-ll

Formerly Wesco- Chippewa Pump Co.

0. TW. Jeollh6nson Ranch:

Well 4. \_

220

204

160

495

368

602

12 161

14 230

12 246

98

64

136

3AL.\_ B-43b

3D1••• B-39

1375

1355A

10-D-12

Formerly J.M. Yahira.

Thompson (formerly

Harvey).

146

89

434

125

14 223

336

10 \_,..,..

7

------

56

3FL •• ----------

1366

10-D-8

Catherine Fernald (formerly C. A. Van

Nest).

83 139.0

8 ------ ------

3Jl •••• **B-44d**

1376B•• ----------

T. M. Dines 90

Southern California Water Co.:

94.8

6 ------ ------

**3KL..**

B-44g

**1366B**

Yukon plant: Weill•.•••.••

74 652

16 366 46

536 14

560 62

**3K2,..•** \_..,.

Weil 2. 76

756

367 38

3RL ••

B-44i

13760

----------

**81** 105

-------- ------ ------

4NL •• B-40e 1346B

Truro plant:

Weil I ••.•.•.•

76 636

12 318

479

80

157

4N2••• ---------- --------- ----------

Weil2

73 695

14 477

197

4N34.••

---------- --------- 10-C-12

Formerly NeLc;on 76

695

6 ------ ------

4N5 •••

B-40

B-40f

1346

13460

10-C-13

Formerly Blaksely 75 F%i:.Z\t C. M. 74

284

----ii:i"" -\_.-.,---- ------

4N6 •••

------

B-40d

1346A

----------

Loretta V. Slinack 76

184

12 ------ --- ---

5BL .•

- ----

--- - -- --

90 500 6

5EL •• 10-C-10

Formerly Freeman

88 77

18 ------- ------

Development Co.

------ 1,200

10 **130** 70

5.Tl••.. B-36h

1336

Formerly Frank

Dicksens.

77 200

5QL

6JL •..

---------- --------- ----------

---------- 10-C-9

---------

Robert Mechura Formerly Mines air·

field).

80 151.0

90 208

8 ------------ ------------

6ML. B-36

6

1306

Formerly Andrew Bennett.

104

12 ------ ------

7CL .•

702 •••

**7El...**

B-36c B-36j

**B-361**

1316

1316A

**1307B**

10-C-7

10-C-17

Formerly J. H. Dins• more.

Formerly Sante Fe Land & Improve- ment Co.

Formerly Dinsmore Ranch.

103

245

-------- ------ ·-----

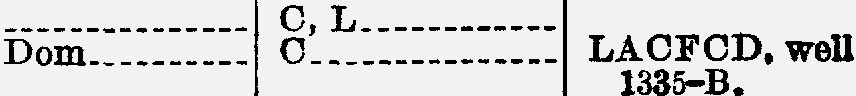
See footnotes at end of table.

|  |  |  |  |
| --- | --- | --- | --- |
| 105 | 245 | 14 | ------ ------ |
| 134 | **301** | 14 | ------ ------ |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of  material. | tp. ...  "'::l  =8;.as  0 | 0 ......  'd1i3  o:!,.\_, | aA | Use of well | Analyses and measurements | Remarks 7 |
|  | 1-r  A | ::, |  |  |  |

**T. 3 S., R.14 W.-Continued**

Gravel and sand 1,240 12



T,E

PS C, L, Wmd \_

Sand and graveL\_

do

512

21 T, E

----------

PS C, L, Wm \_

------------------

A Wsd W-468, well 5A.

Sand and graveL A L \_

Gravel and sand \_ A L, W \_ Gravel. A L \_

A Wmd W-139, well **700 (Re-**

dondo) W-468, well 5.

Sand and graveL ---------- A Cp, L, Wmd \_

Coarse sand and Cp, L, Ww \_ Safnindeagnrdavgerla.vel. L, W \_

Gravel. T, E Irr Cp, L, Wsd,

Ww.

Gravel and sand ------------------

-------------------- A Wmd \_

Obs C, Cp, Wmd,

Ws.

P,W Irr Cp, W \_

Sand and graveL. 1,045 T, E PS C, Cp, L, Wm

do ---·--------------

do ------------------

do. PS C \_

- ------- - w

Sand and graveL 500 4 T, E Cr, L, Ws \_

Gravel and sand \_

Sand and gravel..\_ 1,100 T, E PS C, L, Wm \_

-------------------- A W \_

A W \_

A Wmd, Ws \_

p P,W

A L, W \_

Gravel and sand A L \_

A L, Wsd \_

A. W \_ A L, \Vsd•• \_ A Wmd \_

A Wmd \_

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. | | | Water zones 1 | |
| USGS | Serial No. 2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | a;,  'O::,::\_  ::i::  -< | ig  ia::.i,.  A | s-..  a;,  -;;-  a;,a;,  s.g  .ti.El  ,...,-..,  A | .Qs,  .s  .-cs.:-i-§-  a;,  A | 00  00  a;,  A  ,l:,ja;>  .-c-:l --  o.!!:l  E-< |

**T.** 3 **S., R.14 W.-Continued**

3/14-7KL-- B-36d

1317

Standard Oil Co. (for-

7ML\_ ----------

10-C-5

merly Dooley).

Dr. A. E. Gough \_

701 \_ -

7RL \_ \_

B-37a B-37c

1318

1318B

Geo. J. Johnson \_ Richfield Oil Co - - -

**SDI.** B-36e

8D2 B-36n

**8EL.** B-36f

8E2.- - B-36n

1327

1327D

1327A

279

10-C-19

Formerly Frank Ben- nett.

Airways Water Co., well 1.

Formerly Frank Ben­

nett.

Airways Water Co., well 2.

8E3\_

**8Gl**

8G2

8Hl ••• B-36k

---------

1337

10-C-18

10-C-15

Formerly Mrs. J. H. Bohan.

Airways Water Co.:

Well 3. - ----------

Well4 \_

Mrs. J. Crosier \_

87 304

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 100 | 140.0 | 10 | ------ ------ | |
| 139 | 350 | 14 | ------ ------ | |
| 95 | 125 | 7 | ------ ------ | |
| 95 | 197 | 12 | 158 17 | |
| 93 | 191 | 10 | 115 19 | |
| 89 | 200 | 10 | 171 20  ------ ------ | |
| 97 | 169 |  | 113 | 56 |
| 96 | 279 |  | 102 | 33 |
|  |  |  | 165 | 6 |
| 96 | 1,000 | 12 | 246 | 29 |
| 87 | 296 | 14 | 100 | 36 |

82 300

259 33

12 114 31

282 8

10 ------ ------

8Kl

--------- 10-C-33 \_

85 335

12 ------ ------

8K2 .• - ---------- --------- ----------

Airways Water Co

88 333

12 119 33

8Ll....

8Nl •••

B-36g B-37f

1327B

1328A

10-C-4

A. Leuzinger \_

do \_

93 300 12

106 425 14

8N2.•• ---------- --------- ---------- do \_

|  |  |
| --- | --- |
| 267 | 66 |
| 125 | 5 |
| 134 | 22 |
| 290 | 130 |

104

308

12 ------ ------

8N3 ---------- ---------

Formerly Richfield 93

Oil Co., Leuzinger

8QL.. B-36p 1338A

well 1.

Airways Water Co \_

88 300

9El ••. ---------- --------- 10-C-14 S. H. Phillips 78

|  |  |  |  |
| --- | --- | --- | --- |
| 350 |  | 293 | 57 |
| 430 |  | 385 | 38 |

9E2 do 77

9JL --- B-40c 1357 Formerly Otis Lock- 65

hart.

9NL

B-41 1348

City of Hawthorne: Well l\_ \_

90 559

12 240 200

9N2 B-41a 1348A Well 2 \_

96 679 14

321 148

9N3. \_ \_ B-41e

1348E

Well3 \_

78 760 16

622 12

295 23

9N4

Well4 \_

80 670

322 66

16 300 70

396 6

9QL •• B-41h

1358C

Formerly Lockhart..\_

65 --------- --------

92 82

194 77

9Q2••• B-4lj Formerly City of

Hawthorne.

lOAL. B-44a 1376 10-D-6 Phillips and Co

lOCL - Southern California

Water Co., Korn- blum plant, well 1.

10c2 B-44e 1366A 10-D-7 C. J. Mertens

69 477

77 600

64 437

67 450

329 50

12

230 10

371 14

490 6

516 84

12 350 18

370 4

378 18

12 ------ ------

10c3 ---------- V. Stableman (for-

merly Fred No- mura).

66 429

12 ------ - -----

See footnotes at end of table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones t-  Continued | Pumping data | | | ·-  Miscellaneous | | |
| Character of  material | ...  01*Q;)*  a  0 | o  "O  m.2:l  **s..**'**.** -'  A | **c:s**  **P-t** | Use of wen | Analyses and measurements | . ·-  Remarks r |

**T.** 3 **S., R. 14 W.-Continued**

Wrd, Wwd \_

-------------------- T, E Wmd \_

-Sa-n-d a-nd g-r-a-v-e-L

p -A -L \_

do A L, Wmd

do

-------------------- ------- T, E PS Cp, L, Wsd \_

Sand and graveL. A **L,** W \_

Gravel and sand A C, L, Wsd \_ Gravel.

Sand and graveL.. \_

-------------------- ------- A Wmd \_

Sand and graveL. 250 T, E PS Cp, L, Ws \_

Gravel and sand \_

do Gravel.

500 12 T, E pg Cp, L, Ws \_

Wmd, Ws

-Sa-n-d a-nd g-r-a-v-e-L\_-

do

T-,-E

Apg

--**L**-**,** -W \_

-------------------- ------- A L \_

Gravel 400 30 T, E Irr Cp, L, Wmd,

Sand and graveL --------·-------

Fine sand and

Ws. \_

gravel.

Dom

Cp \_

A Gas test well.

Gravel and fine sand.

T,E

A W

Cp, L, Wsd \_

Gravel\_ AA LC, Cp\_

LACFCD, well 1347;

Sand and graveL. 500 T, E pg C, Cp, L, Ws \_

do Gravel.

: t ::: :

700 70 T, E pg Cpr, Cr, **L,** Ws

1, :: : ::: : :: :: :: : :: -:::::::::::::-: : :: ::::::::

do -·

Gravel.

--------------- ---- ------- ------- A L \_

Gravel

T, E Irr C, Cp, L, Wmd,

Sand and gravel. Ws. \_

do

do

-----i ===---------- 5\_00 -------

do

T, E pg C, Cp, L, Wm

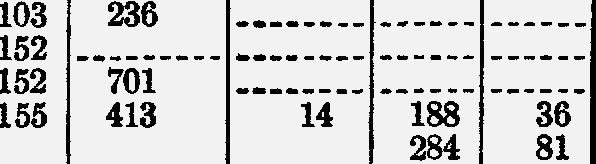
P, E

A

**L,** Wmd

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  ) .. | | | Water zones 1 | |
| USGS | Serial No.2 | Loca- tion No.2 | LADWP No. 3 | Owner or user | Q  ':O:i::.\_  ...**.**.**m**....  *----*  -< | I  .o.c::.  Q)  A | $.,  ..Q.).-;,-  Q)Q)  a-§  -m--.E--!  A | \_i:gi.  ;o;-J--  i----  A | <1l  <1l  Q)  oS i  .-.c-::---  E-t |

**T.** 3 **S., R.14 W.-Continued**



12

199 251

115 407

8 200 51

233 15

320 24

59 200

7 •••••• -·-·-·

195 302

172 104

194

194

202

199

205

140

183.2

270

344

322

582

332

6

4

-···-· ··--··

132 30

164 142

115 183

16 ---·-- ---·-·

12 ---··- ---·--

151 800

16

130 564

250 10

269 126

720 3

16 273 4

285 61

447 96

93 101

51 224

67 274

88 500

5

10

8

16

------ ------

------ ------

210

64

390 110

85 1,000

82 582

12-10

16

------ ------

85 620

236 4

370 10

408 16

444 6

500 18

536 20

16 359 9

400 52

498 52

586 16

49 100

10

:g - 48

48 80

6

6

·-···· --·---

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/14-1001-. ·-·-····-· |  |  | City of In2g5lewood: | 62 | 798 | 18 | 492 | 35 |
|  |  |  |  |  |  |  | 546 | 32 |
|  |  |  |  |  |  |  | 638 | 16 |
| 1002••  lOKl. \_ B-44f | 1367 | -----·---- | Well 30 \_  City of Hawthorne, | 62  62 | --·-···--  480 | 18-14 | 676 | 35 |
|  |  |  | well 5. |  |  |  |  |  |
| lOLL.\_ ---··-··-- |  | 10-D-17\_ | Formerly Security | 60 | 400 |  |  |  |
|  |  |  | Trust and Savings  Bank. |  |  |  |  |  |

Well

**UAL.\_**

B-48f

1397A

10 D-5

E. J. Mertens \_

UCL.. B-48a 1386A 10-D-10 0. T. Johnson Ranch,

well 3.

1ll1D01l.\_ ••B•-•-4•8•g•••• ·1·3·-8·7···- --·· o0..JT.. PJoilhlonswo·n-·R--a-n-c--h-\_-

1102

llJL

B-48h 1387A ·--·-- •••-\_do. \_

B-48e 1397 0. T. Johnson Ranch,

well 7.

llML\_ B-44c 1377 Formerly Johnson Ranch.

12BL.. B-53i 1407D Jerome Dorsey) for- merly Shell Oil Co.).

12B2••• ·····----- ·------·- J.M. Burton \_

12B3 ---··-··-- do \_

12HL \_ B-53 1407 Los Angeles County

12H2\_. B-53b 1407A -·-------- do--·------·-··---

12H3\_. ----·--·-- ------·-- 11-0-26 . do\_-·----··-··--·-

12QL•• ---······- 11-0-9 Sarah R. Tuttle .

12Q2

---·------ ·-------· -----· Southern California

Water Co.: AdeWlaiedlelLplant: \_

**13BL.** B-54

1408

Ballona plant: Well L.

1301••• -------·-- --------- ·-------·-

H. A. Beckman . \_

13E1- B-49a 1399 10-D-1

13Fl B-49b 1398A

13Hl.\_ B-54b 1409 11-0-8

1. M. Phillips\_. \_ John Paulic\_---· ­

General Petroleum

Co.

13JL.\_ B-54n

13J2... B-54c

13J3•• \_ B-54q

1409B

1409A 11-0-31

14090

Southern California Water Co.:

Southern plant: Well **L** . .

Well **2.·-·--··**

Well 3..

13ML\_ --······-· -·····-·· ·-·-·-·--· W.Bushmuller. ·-·

13PL-. ---·····-· ·-··--··· ----·-··-· V.E. Rasic•.. •···-···

13QL

.•...•.••. ··-·-··-· ·········- David Dubois\_ ... ---·

13Q2-•• ··--···--- ·····-··- -·····-··· Mrs. Nellie Seymour.. See footnotes at end of table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones ,\_ Continued | Pumping data | | | Miscellaneous | | |
| Character of  material | *B,...*  "g',s  ::;a  0 | '10:1'""'a"3'  o,'-"  1-,  A | ai:i.  =ll'4 | Use of well | Analyses and measurements | Remarks t |

**T.** 3 **S., R. 14 W.-Continued**

Sand and graveL\_ PS C, Cp,

600 17 T, E L \_

GravE>l and sand

Gravel. Sand and graveL

--------------------

--------------------

T, E PS L \_ T, E Irr Wsd \_

**A\_------------**

= Sanirdgrave} ------- ---T:-:if-- **=A\_-----=·----**-**-** : rmd

: i 1=:f ::: =i =:::::5i::\_§; ::::=: i= \_ *[r.• =iiiii*

-------------------- **A** Wsd, Wmd \_

W-139 well 255 (Re­ dondo); W--468, well

Gravel and sand--

P, E Ind Cp, L \_

10.

**A ------------------**

: tf : yef\_ :======= ======= --- - --- - ========== -L;w-- ==:::::::

- - - :::::::= :=::::: ::::::::== i=::==:::::=:= t::md::::::::

-------------------- T, E Stock L, Wmd \_

Sand and graveL\_ T, E PS C, Cp, L, Wm

do Gravel.

Gravel and sand

675 30 T, E PS

C, Cp, L, Wm

do Sand and graveL-- ------------------

Sand ------- ------- P,pl p =========== p1 - •- 5

Sand and gravel..

T, E Ind

\_·:: :

Wmd, Ws \_

-------------------- **A** C, L \_

Sand and gravel..\_ 725 18 T, E PS C, Cp, L, Wm.\_ Sand and shells ------- ---------------- ------------------

Sand and graveL

do

do \_

Sandy clay and 700 20 T, E PS C, L, Wm \_

Sagnrdavaenld. gravel, \_

sandy clay. Sand and graveL.-

: ::::=: : = *= i* t! *:tti= i* §L ==i

do

TABLE *26.-Description of water wells in {he coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | |  | Well data  .. | | Water zones 1 | |
| USGS | Serial  No.2 | Loca-  tion  No. **2** | LADWP  No.a | Owner or user | ( )  ':1j:i::.  **:i**  +>5  -< | g  .cl | (I)  +>ci,'  CD<D  \_m.EI,  s'fil  i::::: | .0s,  .0...'"..'  .Cl  C1l  i::::: | CIJ CIJ (I)  A '  <1)  ,C,..J-.$., |
|  |  |  |  |  | C1l  i::::: | .cl  8 |

**T.** 3 **S .• R.14 W.-Continued**

Well!\_ \_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ,3/14-14AL.\_ | B-49 | 1398 | 10-D-18 0. T. Johnson Ranch: | | 85 | 395 | 12 |
| 14BL.. | B-49c | 1388 |  | Well2 \_ | 65 | 277 |  |
| 14ML | B-45d | 1379 | 10-D-14 | Well 5 \_ | 49 | 440 | 12 |

|  |  |
| --- | --- |
| 340 | 40 |
| 239 | 4 |
| 244 | 17 |
| 265 | 1 |
| 270 | 3 |
| 276 | 1 |
| 332 | 48 |

15BL

|  |  |  |  |
| --- | --- | --- | --- |
| \_l5DL \_ | B-41e | 1358 | 10- D-9 |
| 15FL-  15GL | B-45 | 1368 |  |

15G2 10-D-15

Formerly Cochran &

Williams. Formerly G. J. Heis­

ler.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Southern California | 52 | 410 | 10 | 360 | 19 |
| Water Co., Cerise |  |  |  | 381 | 29 |
| plant, well **1.** | 53 | 290 |  |  |  |
| Formerly C. M. Fi- | 50 | 74 | 8 |  |  |

Formerly Atwater \_

52 410

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 59 | 368 | 12 | 308 | 60 |
| 52 |  | 6 |  |  |

15KL\_ B-45a 1369

field.

15ML\_ B-41i 1359 Formerly J. H. Smith. 15.N"L. 10-D-3 Carl Johnson \_

15QL\_ ---------- --------- 10-D-2 Formerly A. B. Rob-

bins.

57 87 5

56 80 5

52 35.0 6

16AL. B-41f 1358A

16A2-.\_ B-41k 1358D

16A3 B-41m 1358E

17Dl \_ B-41b 1348B -------\_---

E. L. Roberts \_ Giuseppe d'Errico \_ Warren Willison \_

J. F. Bell \_

0. T. Johnson Ranch, well 8.

60 150

60 87.0

60 95.0

81 185

100 421

7

7

6

12

14 116

296

37

115

17Hl.. B-37j

1338

10-C-2 Los Angeles County

Water Works Dis­ trict 22.

87 460

107 13

270 32

312 102

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **81** | 1,294 | 11-9 | 1,089 | 205 |
| 108 | 506 | 14 | 188 | 21 |

17Jl Loren L. Hillman,

Inc., West Haw-

thorne 1.

17LL. B-37h 1329A 10-C-31 0. T. Johnson Ranch,

well 9.

17ML Wiseburn School.

18AL. B-37d 1318C Luigi MirettL

18OL. ---------- --------- . Republic Petroleum

Co.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Richfield Oil Co. | 89 | 197 | 158 | 17 |
| General Chemical Co. Well!\_  Well2 | 150 | 450 |  |  |
| Well3 | 150  150 | 80  428 16 | 194 | 16 |
|  |  |  | 219 | 19 |
|  |  |  | 255 | 53 |
|  |  |  | 324 | 22 |
| Well4 | 110 | 350 16 | 353  186 | 24  15 |
| 226 | | | | 36 |

92 300

96. 125

102 275

424 33

320 163

4 128 70

5 ------ ------

183 38

18GL\_ ---------- --------- ----------

18NL. B-37n 1309B 10-0-16

18N2 ---------- --------- ----------

18N3

B-37k 1309A

18N4.. B-37u 1309G

19PL. \_

140

159.1

8

I

======I

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 19D\_L ---------- --------- ---------- | H. A. Sweet \_ | 125 | 75 | 7 | ------ |
| 19D2\_. B-37 1309 10-0-1 | General Chemical Co\_ | 145 | 168 | 7 |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 19AL. B-37g 1329  19A2 B-370 1329B \_ | R. E. Bollinger\_ \_ Formerly G. Dagay \_ | 81  82 | 240  175 | 8  7 | 302 6  ------ ------  ------ ------ |
| 1901-.\_ ---------- --------- ---------- | Standard Oil Co., | 94 | 400 | 16 | 221 17 |
|  | well 18. |  |  |  | 257 11 |

I

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 730 | do \_ | 65 | 600 | 12 |
| 731A | 8-A-15 Formerly Maggie | 75 | 320 | 12 |

20JL

B-89f 730A A.J. Durand \_

70 229.3

10 352 --i2a-I

20J2 B-89c

20PL.. B-89e

184

---87-\

**20P2** B-89d 731

See footnotes at end **of** table.

Weaver.

-----do \_

76 158

6 l

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | lo  i;:l...,  <P  "§'.a  ::;a  0 | 0 ......  'd  .<..>'I'-' | i;:l.  **:**E**s**l | .. lJseofwell | Analyses and measurements | Remarks **t** • |
|  | **A** |  |  |  |  |

**T.** 3 **S., R. 14 W.-Continued**

Gravel\_ ....... T,E Ir...-·--····- Cp, L, Ws .'

Sand and gravel\_ ---·-·-·-----·-·-····-·- A.-........... L.••...-----····

\_ .... o....•........ ··----· ........•........ --····---··-····--·-·····---······

-··-do.......-··-·-----·---··--··-·--·-··--·-·······-···-------···-··········

Coarse sand....... --··-··---··---····--···-·-·--··--·-·-·----·----·--·-··-··

Sand and graveL.. -----·· -·-··-- ···-····-- ·-··-·------···· ----·····--·-·----

Sand and graveL.. ·-··--· --·---- T, E Irr....:....... Cp, ,Wm..d\_.

-aravei-aiiifsanL ======= ======= ··- - --- t============ 8;i:;w·:=======

A. ..•.. W •.. \_

W-139, well 170 (Redondo).

GraveL.----·--··· 510 ----·-- ··-·------ A--·--·------· C,L----··-·-·-· LACFCD, well 1368A.

Gravel and sand.• ··---·-··------·----····-········-···--··-··-·······-·····

A----···-·-··-·-··-·············

A.-·····-····- -·-·-·-- --·

A-----·----··- '\Vsd ·-··-·---

A .. \_. . Wmd .• - ·--

A•• • W •-.

------··------···-·· --····· ................. --····-·-····-·· Wsd•. •

········-·············---·- ···-··· ·····--··· ··-··--·····--·· w----···-·-····

,·······-·-····-···- ---··-· ....... -·-······- Obs\_·-··-·-··· Ws..............

Gravel and sand......... ·-···-· T, E Irr••.......... C,L,W........

.\_. do\_........ .. ··----· -··-··- -·--·-···· ---··-·-·-····- \_.\_ -----···----···

Sand and gravel.......... -·---·· .....•.... PS............ L,Wm.d.......

.....do............. ·---···---·-··----···--·-·-·····-····--·-······---···-·-··

... \_.do.........\_.. ............... --······-···--····-··---·--···----·-·····-··

... \_.do..\_..\_.. ....\_'·-··-- ...•... --····-···-·······-·--···--···-·---··-······

Sand and silt...... --····· --·--·- -·-·-·--·· -·····-·-······· C, L,\_W Oil well converted for

water test.

Gravel and sand.. -·-·-·····--·· T,E ···-··-····----- C, L, Wsd......

.....do..·-···----···--··---···-····-··-····---·--······-···-----·-···-···-·-·

.. \_do....-•-······-···-·....... T,E Dom, Irr..

···---·--·····--·-·····---·- -·-··-· P, I Dom, Irr.\_..

GraveL.----··-··· --··-·- --··--- T, E Ind........

.\_ Cp, L•. •-·-·-···

.. ---····-··-···-···

. L.·-····---·····

Sand and gravel...-·-···- -·-··-- AI, E -·-····-···-···· L...............

-·-····--··--· ··-·· .............. -···-····· A-·--·--·--·-· L, W---··-·-···

-·------·--·-·----·· -·-··-- ·····-· --------·- A-·--------·-·----······· --·

Sand and gravel..\_ 195 ···-·-- T, E Ind.•..-•. Cpr, Cr, L, Wsd.

-·--·do--.------------·---·--·-·---·-----··--·--------·-·----------------···-·

do .....----------·---- -------·---·-----···-·--·- --------------··--

Gravel and sand.. -··---- --·---- ·---------·--·-- ·--·-----------·-- Cemented gravel..-·----- ---------· ---·------- \_

Cemented sand 273 -·--·-· T, E Ind... ----··-· Cpr, Cr, L, W and gravel. ·

Sand and graveL --···-- ----·-- -------·-- --------·--···-- -·----------·-··-·

-···-do. .. . --·----------· -------······· ····--······-·

---·----·····---···· 20 -·---·· P, I Dom.....\_.. .. Cp. ·-

-·-··---··---·-···-· -·--··· ··-···- --··-····· A..•.---··---· L... -------·····

Sand and gravel.... 800 5Q T, E Ind\_···-······ Cr, Cp,L·-·--·-

--·-·do ·--······- --··\_·· -··--·- -···---·-- -·-··--·-······· -·-·-···----------

--···--------------- W A·------··------------------·-··

---·---------------- -------·-- Obs L, Wmd, Ws ..

---·---------------- P, W .-------···--·----

Gravel and sand L, Wrd \_

---·-----···---·-·-· 900 -----·- T, E Dom, Irr. Cp, W .. -••···-·

Sand and gravel... ·--·--· --·---- T, E Dom, Irr----·- Cp, L, Wmd\_ ••.

---···-----·--·-···- ·-----· ····--- ------··-- A-------·----- W-··---·-- ·-

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. | | | Water  zones 1 | |
| **USGS** | Serial  No.i | Loca- tion No.3 | LADWP  No.• | Owner or user | G)  'O  =.::..  ::1:e | I  ..C..,l  i  A | ...  G)  :i  *.*a*..'.*-*J*5  o,.E!  A | \_i:gi.  .sz-  .*i*C*'J*lj  A | flJ flJ G)  AZ-  *...'.*J*J*  .Cl |

T. 3 **S.• R. 14 W.-Continued**

3/14-21Bl

21B2

B-4Id

B-4ln

1349

1349A

Southern California Water Co.:

Rosecrans plant: Well!\_ \_ Well2 \_

63 468

62 527

12 ------ ------

14 310 158

21EL\_ 8-A-10

E. Steiner \_ 63 194 10

21Fl ---------- ---------

A. F. Eaton \_ 57 60 12

Southern California Water Co.:

**21Ml--** B-91 740 8-A-16

21Rl

Chicago plant: Well L \_

61 438

52

12 378 21

21R2 52

**22AL-** B-45e 1379A

Chadron plant:

Well i \_

49 710

16 317 67

514 132

660 8

22BL. B-45c 1369B Formerly North

52 236

146 68

22B2 B-45b 1369A

Mdooneta Water Co. \_

52 392

220 16

12 316 21

341 47

1--:= :::::::::: ::::::::: :::::::::: i gL :t::\_ =====

22RL. B-96 770 8-B-14 do \_

22R2 ---------- --------- H. H. Wheeler \_

23JJ B-l0lp 7900 8-B-41 R. W. Harris \_

23J2 8-B-5 do \_

23LL. B-96g 770D Southern California Water Co., Comp­ ton plant, well 1.

53 557

52 500

52 485

51 350

50 203

48 280

52 397

10 ------ ------

14 328 108

16 ------ ------

----16 334 19

23ML. B-96b 770B Formerly ComettL \_

52 654

12 312 96

476 85

**23Nl**

B-96c 771

Formerly M. G.

51 751

12 ------ ------

23N2•• 8-B-37

23Pl... B-lOlf 780

Rogers.

Formerly Alondra "Park View High­ lands."

Formerly W. F. Summers.

51 350

49 171 7

23QL ---------- --------- **A.** M. Avakian \_ 45

50.0

23RL\_ B-lOln 781E A. George \_ 47

4 ------ ------

23R2\_ \_ B-lOlb 781B 8-B-7

Mrs. Ethel Harris .\_

46 214

7 160 50

23R3

23R4

B-lOle 7810 Bell \_

---------- 8-B-40 do \_

46 250

46 215

6 ------ ------

9

23R5\_. \_ 24AL Jim Scander \_

45 200

55 215

12 ------ ------

24A2 ---------- Mrs. J. A. Schenk \_ 52 40

24A3 Theodore Ganotes \_ 24BL\_ ---------- W. P. Griffith \_ 24EL- B-lOlj 790 Formerly 0. I. Gor-

51 33.0

52 418

52 355

24FL Whilalmiam.

Falconer \_ 51

45. 9

6 ------ ------

24F2 \_ 51 8

24F3

---------- E.W. Field \_

51 41. 7 8

51 130 24

*W*i*I*t*.*:======B=-=1=0=6=h===8=0=0=B============

24J2 ---·------ 7-A-4

§-- ----=·---- ---------

F-ohrfmrecr'l:ySJh. L.j --===

Griffin.

Mrs. Eleanor M.

Martin.

52 48.5

52 268

52 56. 5

51 40

6

6 ------ ------

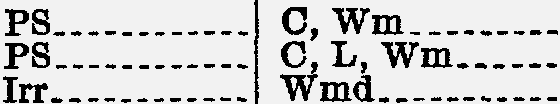
6 ------ ------

Mrs. L. M. Kingsley

51

**See footnotes** at end of table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | ..  al  :a@a  El  C, | iii:  -og-- J  **(lS.\_,.**  A | a0.  Cl  P-t | Use of well | Analyses and measurements | Remarks' |

T. 3 **s., R.14 W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sand and graveL\_  GraveL | 433  550 | 3  \_ | T,E  T,E  P,I  w  T,E  T,E  T,E | PS Irr  Irr | Cr, L, Wmd \_ Cp \_  ------------------ | **W-139** well 284 (Re­ dondo); W-468, well 9.  W-139 well 285 (Re• dona1o) W-468, well  9a.  wd ! o) ell 461 (Re- |
| Gravel and sand 1,160 T, E PS Cr, L, Wm \_  i clnd graveL ---------------- ------------------ | | | | | |
| Sand and gravel. L \_ SGarnadveaLnd gravel\_ -A -L \_  do  -------------------- T, E Irr Cp \_  -------------------- ---------- A Wmd \_  Sand and graveL ------- T,E Irr == Cp, L, Wsd \_  T,E Wsd \_  T A Wmd \_  Sand and graveL. 600 51 T,E PS C, L, Wm \_  Sand and gravel\_ A L \_  Fine gravel and ---------------- ------------------  sand. A L \_  A Wmd \_  A Wsd  ------------  IO \_ P,W St0ck, Jrr Cp \_  P,E Irr Wsd \_  Gravel and sand \_ P,E Dom. Cp, L, Wmd,  Ws.  P, I Irr. -. --  T,E Irr -- -- -- -------- ---    T,E Irr Cp \_  P,W Irr\_ Cp \_  P,W IDrr o-m- ,--S-t-o-c-k-- -C- -p - \_  T,E  A. - -- - - -- -  -------------------- ------- ------- P, W \_  -------------------- ------- ------- P, W \_  \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ T, I Irr ---- -- -- --- -- ---- - - ---    P, W Irr Cp \_  A L  Wmd \_  P,W Irr Cp \_  P,E Dom \_ | | | | | |

460508-59--22

**'326** GEOLOGY, HYDROLOGY, TORRANCE-SANTA MONICA AREA

TABLE *26.-Description of water wells in.the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  ) .. ,\_, | | | Water zones 1 | |
| USGS | Serial No. 2 | Loca- tion No. 2 | LADWP  No.s | Owner or user | Q;  'O  .:.:.:,i:.:.:.\_.  ....:::::,  <: | *Z'*  gQ;)  .cl  -s.  Q;)  A | ..Q.;.),;;;-  Q;)Q;)  s.g  .!5  A | 0.  \_£  o,:...;\_  1:i;"-'  Q;)  A | r/l r/l  Q;)  *Z'*  ,l,jQ;>  .::!@  .cl  8 |

**T.** 3 **S., R. 14 W.-Continued**

3/14-24K3 \_

24K4 \_

24K5 ---------- --------- \_

24K6 \_

Ward A. York \_ 51 47

Collins \_ 51 40

Clay Osborne \_ 51 62

B. E. Sarver \_ 51 60

*5½* ------ ------

6 ------ ------

8 ------ ------

6 ------ ------

24K8

---------- --------- ----------\_

John Rentsehler \_ 51 51

6 ------ ------

24K9 --------- \_

J. F. Kahr \_ 51 40

7 ------ ------

24Kl0. \_

H. E. Stovall. \_

51 --------- -------- ------ ------

24Kll \_

24Kl2\_ B-106g 800A

24K13 \_ B-106q 8000

24K14- B-106 800 7-A-1

H. H. Coil\_ \_

A. J. Anklam \_ Formerly Strawberry

Park Water Co. Formerly Mrs. E.

Jantzen. Southern California

Water Co., Amestoy plant, well 1.

52 40

52 47 10

52 250 12

51 53

55 680 16

24LL Several owners \_

24L2 B-l0lm 790B 8-B-2 S. L. Taylor Ranch \_ 24ML .T. Zaharis \_ 24M2 do \_

24M3 \_

24NL\_ B-lOlk 790A FormerlyR.J.Rogers\_

24N2 : Mike Sego \_ 24N3 8-B-6 Marie Pursche \_

51 200 8

53 320 14

52 720 16

53 134.0 7

51 720

49 197

48 57 8

47 53 5

24.c 4-- H. Spaugh \_

24N5 Annabel Freeman \_

48 --------- -------- --.-

47

--'----

24PL \_

24P2 A. S. Wallis \_ 24QL 7-A-2 Katharine O'Leary \_

24Q3 -Ad-a Eme-r-s-o-n \_ 24Q4 B-106u 800E 7-A-3 Formerly Magnolia

Water Co.

24RL. ---------- Mrs. Nellie Baldrick 25AL- B-106j 801 T. L. Hubbell \_

25Dl

25D2 Frank X. Price \_

25EL. --------- ---------- ------------------------

49 180

47 60

50 70

47 80

46 38

51 225

48 37. 3

44 225

46

43 50

42

4

6

10

8

71 60 165

6

8

25E2' B-lOlc 791 8-B-12 Baust\_ \_ 44 38 8

25E3 M. .T. Johnson \_ 39

25E4 ---------- C. E. Grotzinger\_ \_ 41

25E5 ---------- do \_ 41

25FL Mrs. Stewart\_ \_ 38

32. 2 35.0 30 35

8

8 ------ ------

25F2 B-lOlg 791B FormerlyJohnJ. Dean\_

42 249

10 210 39

2.5F3 B-lOld 791A FormerlyM. E. CowL 39 207

25HL\_ B-106k 801A FormerlyC.E. Wallin 39 28

25JL Arthur Davies 31

4 11 17

8

25J2 Phil Propst \_

2513

25KL\_ ---------- Malcolm Waddell \_

25K2 do\_ -"------------

25K3 B-107n 802B A. J. Walter \_ 25K4. \_ B-107i 802 7-A-38 Meadow Park Dairy

31 --------- -------- ------ ------

35 36 12

32 100 6

32 8

32 30 6

34 178 7

25LL M. G. Marcellus \_

2 L2 F. H. Almaraz \_ 25L3 C. Lenarth \_ 25L4 B. Leach \_

2.5ML\_ B-102j 7920 8-B-13 Jamrs M. Shepherd \_ 25;\Tl ---------- Manly \_ 25N2 A. D. Seaback \_

25N3 ---------- L. G. Singletary \_

25N4 \_

*25N5* J. F. O'Haver \_

See footnotes at **end** of table.

34 56.6 8

33 27

33 44 6

36 150

38 192 6

37

36 205 6

36

36

36 160

*zone of ihe Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| WaCtoenr tzinonuesdt- | Pumping data | | | Miscellaneous | | |
| Chmaaratectreiarl of | p. ..  E  "':::s  §.s  El  0 | j:::  o---  'd  j:.:\_:.Si,l  A | P.  El  :::s  A.I | Use of well | mAenaslyusreesmeanntsd | Reiparks? |

T. 3 s .• R. 14 W.-Continued

[::==:::::::=:=:===:::::=::::== --!!!. - =\==::=:=i: ::=:=::===:::::

1::::::: :::::::::::: :::::::::::::::::::::::1:::::::: :: 1 p, Wsd

I

'\-------------------- 850 29 T, E PS Cr,

L, Wm

Wd-1o3n9d,o)w. ell 459 (Re­

=1 = === == ========I=======J=======J Ii,1j J- ============j-wma::==========

I

,( T, E Irr---------- - Cpr \_

=====:----------=::r: ~~\_j~~  1 ---T,---E---- j IArr------------i-i;-------------------\_ I

Wd-1o3n9d,o)w. ell 449 (Re-

P,E

P,W

p

----------------,w \_

C,E Irr\_.------- , --- --- --- -- - -----

L:::::::::::::=: : ::=:=:: =:::::= H lli:=::::::==+ •;',v •:::::::

I- :: ; :: -:I:::::::1:::::::1 -:-.-:- :::::::::::::1-=m :::::::::::

Wd-1o3n9d,o}w. ell 465 (Re­

. 1 1 Al, E 1 -----

----- ------ --- -- --- - P, I Irr ------------------

-------------- ------------------- P, w A -wma::--:-·:::::

1

1- -- -- --- - *---:-------*

!---

**----1** P.M

Irr j Cp \_

P, W I :rom =======1-L=:::::::=======

-Sa:rnad;e::l:-:a::n:=d==sa=n=d=-=-1=-=--=-=--=-1=-=--=-=--=-I-=--==--=-=-=--=-=-=--= A =====------- LL ====1 W(-R13e9d,owndeoll)4.93

P,W

P,W

P,W

P,W

r \_-----------!\_ Cp \_

A\_ ­

DAo\_ m-- ,--I-rr --- - --- --C-p-, --w--s --\_

T,E

Irr, Stock Cp, L, Wmd \_

P,E

Irr ·· \_

P.W

P,W

IAr\_r-

---,--

-Cp. \_

P,I

T P,W

P,W

T,E

P,E

A j L, Wmd \_

Dom, rrr l Cp \_

}g: gL 1 LACFCDrwell 792D.

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ldentffl.cation of wells | | | | | Well data | | | **Water**  zones• | |
| usos | Serial  No.2 | Loca- tion No. **2** | LADWP  No.• | Owner or user | a)  ':C:,::::\_  :i  -< | g*Z'*  £  i:i.  a)  A | .$..,  a)  ,;;-  Qa)  e-*a*5  A---- | j  o,...\_  .icl',S-:J'  A | "'  a)  \_u-..i.....  .cl  8 |

T. 3 **S., R.** 14 **W.-Continued**



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 3/14-25N6 | |  |  | Formerly A. B.  Caldwell. | 36 | 163 |
| 25PL | |  |  | Mrs. C. Giacomazzi \_ | 31 | 192 |
| 25P2  25p3 B-102i | | 792A |  | H. D. Farnham \_ Formerly R. | 36  31 | 40  170 |
| 26Al | |  | \_ | Mikkelson.  Golden Nursery \_ | 46 | 40 |
| 26A2  26A3 | |  | \_ | L. C. Moore \_  Golden Nursery \_ | 46  46 | 40  228 |
|  |  |  |  | |  |  |
| 26AL\_ | B-l0li | 7910 | Western Riding | | 44 | 183 |

Stables.

7 ------ ------

12 ------ ------

4

7

---- 6 -==--- ------

10 ------ ------

4 150 33

26BL\_ B-101 781

\_ Mrs. 0. L. Sams \_ 44

41.3

7 ------ ------

26B2 8-B-10

26B3 \_

26B4 \_

Formerly Balmer \_

E. C. Bartlett \_

Mrs. Anna Sunder-

44 185 4

45 60 6

45 58.4

26B5 Vamn aBn.ellehem \_ 45 60

26B6. ------------------------ 45 80

26B7 8-B-Q Formerly HenseL \_

C.:

26CL\_ B-1010 781H ----------- G. PUrscQe - \_

26C2 John Juhas \_

2603 B-IOla 781A 8-B-11 C. G. Pursche,

(formerly C. C.

Jorgensen).

48

44 41.0

43 220

44 205

-- -12

7

6

12

--=--- ------

------ ------

------ ------

------ ------

2604 L. Gonzales \_

44 --------- -------- ------ ------

26DL\_ B-96f

771D

Ben Long \_

2 ¼ ------ ------

|  |  |
| --- | --- |
| 46 | 175 |
| 48 | 188 |
| 43 | 215 |
| 41 | 260 |
| 42 | 250 |

26D2 B-96d

26D3\_ \_ B-96e

771A 8-B-36

771B

do \_ Formerly Arthur

8 126 10

7 ------ ------

26EL \_

26E2 \_

Lyon.

F. J. Russ \_

H. H. Blake \_

122 60

190 40

234 12

26E3 8-B-16 Henry Valdez \_ 26FL F. C. Wagner \_ 26GL Carl Pursche \_ 2602 Brattrud \_

26Hl

26H2 B-lOlh 781D Formerly J. D. Beard.

26JL B-102f 792 Mrs. E. U. Knape \_

26KL Ed Christiansen \_

42 470

42 65.8

42 200

43 67.6

42

43 134

37 231

32 100

8 ------ ------

8

6 ---- -- ------

7

8 151

26LL

L. F. Kurtz

\_

26L2 - Elma Miess. \_

!i -·ioo---

8 1a1 62

26L3 Wm. T. Richardson \_

40 125

4 ------ ------

26ML. \_

26M2 W. W. Wallace \_ 26Nl L. L. Flores \_

26N2\_ \_ B-97e 772A Formerly C. Raphael\_

26PL\_ B-102k 782E 8-B-18 Mary Hunt \_

40 249

44 300

*55*

55

45 280

-------- ------ ------

-------- ------ ------

6 ------ ------

26P2 John A. Verburg \_

26P3 Josephine Watkinson\_ 26QL \_

26Q3 -B----1-0-2-a--- -7-8--2-A---- ---------- --P-. -T--. --M--a-r-t-i-n --\_

204 ---8 129 82

43 250 ------- -128 104

45

47 -----;;-- ------ ------

26Q54--- -B----1-0-2---- -7-8--2----- ---------- -C--. -L--. --H-u--d-s-o-n --\_

26RL\_ Beatrice M. Hender-

son.

26R2-- ------------------------

**26R3-**, \_

See footnotes at end of table.

41

41 261-

31 132. 5

37 120.0

35 219

8 139 118

7 ------ ------

***8*** ------ ------

*zone of the Torrance-Santa Monica area-Continued*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of  material | i:i,..  G)  "9'".=a  :;a  c:, | o---  "d  A | c:i.  P-t | Use of well | Analyses and measurements | R emarks 7 |

**T.** 3 **S., R.14 W.-Continu.ed**

A Wmd W-139, well 406 (Re-

dondo); W-468,

T,E

P,E

Dom, Irr,

Stock.

Irr\_-----------

Cp \_

Cp \_

well 7.

A L W-139, well 403

(Redondo).

-Gr-a-v-e-L

T

P-,-W

-I-r-r-, S-to-c-k A

-Cp

-L

\_

W-139, well 433

--------------------

--------------------

P, W

Dom

A-------------

Cp, Wsd \_ Wmd \_

(Redondo).

--------------------

--------------------

P, W

P, W

Irr **L.**

Dom, Jrr Op \_

- P, E -A

--W-md \_

--------------------

-------------------- ------- -------

P, W

p

T,E

Irr Cp \_ A Wsd

Dom, Irr Cp \_

W-139, well 295 (Redondo) W-468, wells.

Gravel and sand \_

Sand and graveL. 50 3

P,W

p

Al, E

---------------- w \_

L, Wmd W-468, well Sa.

A. L---------------

Dom, SJrtrock -C--p-, -L \_-

do

T,E

GraveL. ---------------- ------------------

--------------------

-------------------- -------

--------------------

--------------------

--------------------

Gravel and sand

T, E Dom, Irr Op, W \_ P, W Irr Cp \_ T, I Irr Cp \_

P, W Irr 0, CP-----------

P, W !============= -L===============

T, E Dom, Irr C, Cp, L--------

--------------------

Gravel and sand

C, E

PT,, IE

DoSmto,cSkt.ock Cp \_ Dom Op \_

T, E

Dom L -------------

Dom, Stock Cp \_

T, EE

Dom, SIrtorck -Op \_

-------------------- T, E

fom, Jrr £P--------------

Sand and gravel\_ ----------

T,E

Op, Wmd \_

W-139, well 327 (Redondo).

Gravel and sand. \_

T,E

T,E

P,I

Dom, Stock Cp. \_

Irr\_ L

Sand and graveL.

T,E

T,E

\_

Bg : :::::: 8t-r.::::::::=:=

Sand and graveL. \_

Al, I

T,E

P,W

P,E

Dom, Stock Cp, L, Wsd \_

Irr, Stock 0, Opr \_

Cp

T,I

Dom

Cp

TABLE *26.-Description of water wells in the.C<!astal\_*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. ... | | | Water zones 1 | |
| USGS | Serial No.2 | Loca- tion No. 2 | LADWP  No.a | . Owner or user | Cl)  ":C:,:::\_  .-..a...s..  ;::  <I | I  .cl  Cl)  A | Cl)  j  El.g  . S  A | 0.  \_£  +o>"'a3  ig  Cl)  A | "'  Cl)  \_A,:,;\_3,'  )  *Q,S*  .cl  8 |

**T. 3 S., R.14 W.-Continued**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 3/14-27AL\_ B-96f 7710 Los Angeles County 27CL (Pdaork Department).\_    27DJLL\_ B-91a 751 8-B-15 -J-.--M--c-C--a-n-d-l-e-s-s --\_  27J2 Mrs. D. V. Davis \_  27J3 Formerly Houillion \_  27K2L\_ ---------- --------- ---------- HP. .J**W**. W**.**Nititesltsreonm \_ \_  27K3 ----•----- MacDonnelL \_  27K4\_ \_ George Rickert \_  27K5\_ \_ Z. Dreale \_  27K6 ------------------------  27Ll\_ A. A. Blain \_  27L2 ------------------------  27ML\_ ---------- Nellie M. PohL \_  27M2 H. A. Allen \_  27M3 Vincenzo Burchiere \_  27Nl Timora \_  27N2 R.R. Mann \_  27N3 Mrs. Haraldlne  27N4 FrBedonSsutemllm. ers \_  27N5 E. Palmer \_  27PL \_  27P2 P. G. Gibson \_  27P3 C. C. Eliot\_ \_  27PL J. F. Cavanaugh \_  27P5 Gaston Diche \_  27P6 A. R. Black \_  27P7 -- ---------- White Mfg. Co--------  27QL Mrs. Anna Panter \_  27Q2 ---------- Mark Fox \_  27Q43 -·- -J--. -S-e-l-l-e-rs \_ 27RL. B-97b 772 FormerlyJ. Schroeder\_ 27R2.. \_ Union Oil Co. \_  28KL \_ B-92e 752A Formerly American States Water  28QL 8-A-11 FrSeedrvMicaeuCo. \_  29CL\_ B-89b 721B Annie Reeder \_  29D1 \_ \_ B-89a 721A Simon P. Sneary \_  29D2 B-89 721 John G. Lenz \_  29D3\_ \_ City of Manhattan  Beach, well 11. California Water  29GL\_ SeSrvtaictieoCn2o0.: \_ 29ML B-90j 7220 16 \_  29NL \_ B-90h 722B 12 \_  29N2 B-90 722 8-A-19 John Simpson \_  29Rl \_  30AL\_ B-84d 711 Formerly W. H. Schoellerman.  City of Manhattan 30A2 Beach:  30DL. B-84i 701F Well810 --\_  30Hl \_ \_ B-84h 711A Well9 \_  30ML B-85a 702 Star Nursery \_  30PL\_ ---------- Formerly Martin \_  30RL. **B-90a 722A** Frank Allen \_ | 50  45  48  41  41  43  47  44  47  46  47  47  51  50  55  64  55  70  66  65 | 485  448  --------- 150  160  225  237  121. 5 65 140 212  149  220  63  210  200  160  140 | 14  --------  6  7  10  8  8  8  7  8  8  6  8  6  12  12  8  6  7  8  4  8  6  12  10  6  8  6  16  16  16  16  8  8 | 328 | 108 |
| ------ | ------ |
| 130 | 88 |
| ------ | ------ |
| ------ | ------ |
| ------ | ------ |
| ------ | ------ |
| ------ | ------ |
| 64  65  57  56  65  59  58  59  50  57  53  52  52  54  54  72  92  82  !.l3 96  88  87  *115*  113  120  109  90 | 225  285  231  238  200  250  200  175  65  280  ·so  55  230  ,230  99. 5 200 165 97  520  570  474  500  208  150 | ------ | ------ |
| ------ | ------ |
| 160 | 70 |
| ------ | ------ |
| 190 | 75 |
| 394 | 37 |
| 173 | 177 |
| 197 | 63 |
| 346 | 36 |
| 206 | 194 |
| 102  157  97  241  164  100 | 525  350  390  276. 5 311  250 | 16  16  16  --------  6 | 187 110  225 30  142 24  218 82  245 66  ------ ------ | |

See **footnotes** at end **of** table.

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones I-  Continu¢d | Pumping data | | | Miscellaneous | | |
| Character of material | !ii  i:i,c  Q)  oo°d  lo § | 'do-..-.-.  !  a1'-'  1-,  A | si:i.  C1  P-i | Use of well | Analyses and measurements | Remarks, |

**T. 3** S., **R.14 W.-Continued**

Sand and graveL\_

do

-------

T, E

T,E

P,E Al, E Al,E T,E

P,W

Irr ------------------

A Wmd \_

Dom, Stock Cp \_

Dom, Irr Cp \_

Dom, Irr Cp \_

Dom, Irr. Cp, L \_

Dom, Stock. Cp \_

P,W

Dom Cp \_

P,W

P,E

P,W

P,W

P,W

Dom, Irr Cp \_ Dom Cp \_

Dom Cp \_ Dom Cp \_

P, W

T,E

Irr ------------------

Irr. Cp \_

T,E

Dom Cp \_

--------------------

--·----------------- -------

--------------------

--------------------

--------------------

T,E

P,W,E T,E

C,E

T,E

P,W

P,I

P,I

P,W

Al,E

P, E

P, E

Al, E

P, E

P, E

Dom, Irr Cp \_

Dom, Irr, Cp \_

DoSmto,cIkr.r Cp \_ Dom, Irr Cp \_ Dom. - - ------- ---------

Dom Cp \_

Dom, Irr----·- Cp \_

Dom, Irr Cp \_

Stock Cp ----

Dom, Irr, Cp. \_

Stock.

Dom, Irnrd -C--p --\_

Dom \_

Dom, Stock Cp \_

Sand and gravel\_ \_

T,E

A L wcii! o ) 25

Irr ------------------

A\_ \_ Wsd \_

A Wmd \_

P, W

----------------------------------------

"A'

-Ws-rl \_

--------------------

Sand, gravel, with

shells.

600 25 T, E

PS

Cp, L \_

- - idio -!

=== - ·- - --- -- : . ============

-8--g--,1--t-·w--m--=--=-=-=--

===== ----:================= ======= *1:I* ! :=========== *Wsf r: =*

1

A

A

do I, 125 55 T, E PS C, L\_ -----------

do 905 54 T, E PS Cr, Cpr, L, Ws

Gravel and sand 980 26 T, E PS Cr, Cpr, L, w \_

Sand and graveL ------------------

--G--r-a-v--e-f-a-n--c-f-s-a-n-c--L- ======= ======= ? - --- A ::========== W?- :=========\_

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  (I) .. | | | Water zones **1** | |
| UBGB | Serial No. **t** | Loca- tion No. 2 | LADWP  No.a | Owner or user | ':C:s;.\_  ....ei  -< | I  .c:I  0.  (I)  A | s...  (I)  a'.gi  -o-:1-.E-i  A | 0.  E  o,-..  *:*p*i;*.*J*'-'  (I)  A | ""''  =(I) ,-..  .-C-l -!-  8 |

**T.** 3 S., **R.** 14 **W.-Continued**

3/14-3311AA2.L....

31AL.

31AL\_

B-85d 712A

B-85f 712B

B-851 7120

8-A-4

California Water Service Co.:

Station 6, well **7.. -**

\_

5, well B. -----

5, well **A-· ­**

well C.••--•···

95 340

94

93

92 510

12 183

16 150

157

292

31A5... B-85e 713

31A!L. B-85c 712

8-A-5

TedMorton...•-·•··­ California Water

Service Co., Station 5, well 6.

130 125.9

92 502

10 ·--··- --·--·

16 190 282

31EL. B-85

703

HowardJ. Lovely 96

260

6 -···-- ·---··

31ML. B-85h 7030

32AL. B-90c 732

8-A-8

Formerly Israel Fry \_

California Water Sflrvice Co.:

Station S, well 8.

68 151

95 449

7 136 **15**

16 140 309

|  |  |
| --- | --- |
| 137 | 50 |
| 152 | 63 |
| 233 | 180 |

32FL. B-90b 723

Dr. D. A. Clark •..

146 900

12 --··-· ··----

32H\_L

B-OOe 733

--·-·---·-

James L. Fittinger \_ ...

100

197 8

32H2•. ---··---·· ··•-·--·- ---------· Joe C. Shellnut.•..•.. 99

158 7

32JL.. B-90g 733B 8-A-12 Lloyd Corp 110

413 12

32KL. B-90f

32RL. B-901

733A

7330

8-A-13

W.R. Gallinger..•....

lfiO

109

200

8 --·--- -·----

8

33AL\_ .•••...•...••.•....••..•. A.Villagomez

|  |  |  |  |
| --- | --- | --- | --- |
| 33A2.•. ·--------- ------·-- .. d0----------····---  33A3.. \_ B-92f 753 W. S. Fullerton \_ | 74  80 | 250  198.8 | 12 |
| 33A4..•• ·--···--·· --······- ·--··-·-·- Frank Dermody.••.-. | 78 | 200 | 8 |

. \_ 74

6 --·--- ----··

122 98

33BL\_ B-92b 742A ··--·---·· R. F.Matson...•.•.•. 95 207

33B2.• \_ -···-····· ······--- ---··-···\_- .... o.....---··-···--· 95 214

-·-·-· ----··

8 ·--··- -··---

7 ·--··· -··---

33CL\_ B-92a 742.. \_.. 8-A-9 J. S. Yoshinabo.-·--··

3302-.\_ B-92q 7420 -··----··- ····---···--·-····--····

33DL.............................. Redondo Tile Co--··-·

33EL- B-92 743 Pacific Crest

B-92g- 743B Cemetery.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 33E2... B-92h | 7430 | Walter Hammond..•• | 107 | 190 | 7 |
| 33FL\_ B-92j | 743E | Joe GaldarisL........ | 98 | 233 |  |

106

105

92

121

272

101.4

594

228

10 ·--··- ···---

10 ······ -·-·-·

*10½* ...... -··-··

6 169 59

··-··· ····--

154 79

33F2...................... ···-·····- Mrs. Maude Harring-

ton.

3301•• ···-·-··-- -·······- ---·····-· V.G.Mott..·-·-···-··

3302. \_ B-92L 7530 Formerly R. 0.

Hickman.

3303.. B-921 743D Formerly George Harsh.

100 400

100 250

82 230

98 **174**

10 ...... ···--·

10 ··--·· ···-·- 10 110 120

7 100 74

33HL. B-92m 753A --···-·-·· Perry SchooL ..-- 77

33H2.. -··--··-·- -·-·--·-·--········ .. do ··-·-····-··- 77

33H3•• ---·-·-··· -···-··-· -···-····· A. C. Hurt..••·-··- 80

33H4•. -·-·-····· ----·-·-·---··-·-·-·---·do-··-··-···•··-· 80

199

230

187. 8 250

6 112 87

10

8 ··-··· ---···

33H\_5. ---·---·-- ··-·-·- 8-B-34 Crown Water Co. 80

300

12 -·-·-- ·-----

33Jl.•• B-920 753D ·-···---·- ------·---·-··-·----··-·

78 ·····-··· ........ ·····- ......

33J2\_ •. ------··-· ·-··-···· ···--··-·· Royal Mutual Water

Co.

33J3.-. ·-········ ..••..... -··-······ DonF. Willis... ••-···

73 201

78

8 173 28

33J4\_ .• ·-·--·---- ---·----· ---·-----· ··--··--·--···-·--·---·- 33Kl.. B-92c 743A Mary M. Friedman...

33K2•. B-92k 753B Formerly J. Rochleau.

78

100

84

218

230

10 -----· ·-····

12

10

33K3•• B-92n 743F --··--·--· McAlli'!ter . .\_

33LL.. ··-·•··--- -·······- ---···--·- BPlvedere Mutual

Water Co.

33L2 ·------·-- --·---·-- -·-·------ R. J. Boyle ·-

33L3 ---·-·---- ---·--·-- --·-···-·· M. W.Freeman------

94 191

91 250

93 160

90

91 178

8 167 24

8

7 --·-·- ····-·

33PL•• ··-·-----· ---·--·-- -···-----· -··-·--··--

t!=== ========-= ========= ========== :r rdrt Ji 1=======

Seefootnotes at end of table.

93

110

216.0

10 ·-··-· -·--··

8 -····· ··-··-

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | ..  (I)  "S'.a  *=;* s  Cl | 0 ......  'd  «,sS'-l'  A'"' | =s  i:i.. | Use of well | Analyses and measurements | Remarks' |

**T. 3 S., R.14 W.-Continued**

Sand and graveL.

300

T,E

PS-·-·-·--··--1 C, Cpr, L, Wm

158

T,E

Obs ··-----· Cpr, Wm.•.•..-.

Sand, some graveL

352

570

I····....··-....·-···I······-•-·-·-,-- - --··- ··-·

T,E

PS---····-·-·· Cpr, Wm..••----

1 :::::::::::: gg \{;';f = ===

- - - ==1===!====: j:::::: = j-·-P w··j g ===========! 8 &t :::

Sand and graveL\_ --·---- --·--·- ----·-···-

A-----········ L·--·-····---•--1 W-139, well 274

(Redondo) .

... do ..•.••.•.-... 740 --·--·- T, E

PS-·-··----·-· Cr, Cpr, L, Wm.

Obs·--·-·-··-· W....·-·--··-···

Sand and graveL. --·-·-· --····- PPE

Dom, Irr ••..•• Cp, L••••.......

Irr.··-···-··-· CP--·-···-·······

Sand and graveL.\_ --····· --· T, E

Dom,Irr••..-.

Cp,L, Wmd, Ws.

.•... do••••••··-···· --•--- • --· -·· • -·••·· •·- · 1-·- - - • •• • ·--···-1••-•·--··••··-•••-1

I·· ••. -... ·-· ..•....-I·.•.•..I··.··-. T,E

I·-····-····---··-··············-·· ·--····---

Dom, Stock, Cp, Wmd.......

Irr.

**A..........-.. ···-·-···-····-···**

·ornveiaii,1san<c= :::::::::::::: ·-. · ··· . . :::::= 8g;L:::::::::::

-····-······-··--··· ....... -··-··· P,W Dom, Irr

Stock.

·-···-····-·--·····- ·-····· ..•.... P,W Dom, Stock••. Cp, Wsd ••..

·-·-·····-······-·-· ····-·· ······· p --·-·····-····-- ··-·······----··-·

····---···-···-··-·· ·-··--· ····-·· ..•....... Obs•..•. Wmd, Wrd, Ws.

--··--·-·····-·····- --····· -···-·- ··--······ ··-············· W.......•..•..•.

··-·-··············- ··-··-· ······· ···-······ **A............\_···-····----• ·-**

Sand and graveL. ·--···· ..•.... T,E Irr·-·-········ Cp, L, **W..--···-·**

1-·-···-·-- ·--·-1-·-·-••I•·-·..•

Sand and graveL••1 •••••••,--··---

**P,**

T,E

Dom.•.. , Cp, L----·--·---1 W-1391 wen 310

Dom, Irr ••.•.. L•••••....•.•... W-139.t well **313**

(Reoondo).

(Reaondol•

**P,W**

"saiici.an<igravel ==1=======1=======1··· . -··I i> ::::::::::1 r :::::::::::===1 W-139, well 321

.•...do•.••.....•\_.. ·--···· -··-··· -···--··-· **A--··-·····-··** L---·-··-···-··- W ::o: i)312

(Redondo).

••. \_.do..••........• -··-··· ··--··· ······-··· **A·-·--···-·--·** L-----··----·-··

!:::=:::::::=::=:::::::::=::::::::: --;

··-·····-·-·-······ ··-·--· ....•.. T,E Sand and graveL••...•.• - T, E

T,E

ls::::::::::::::::::::::::::::::1

Dom--·--···-· CP-··--·-···--·· PS·-····-···-· Cp,W••••...••• Dom, Irr--··-· Cp......•. •.

Dom••....•.•. Cp,L-·---··----

Dom, Irr .••... ····- •I

l

I·--....-·-· -·-··--··I····.. •I• ••••••

I···-·······-········I····-., . -······

p P,E

Dom, lrr ...... Cp, Wsd·---···-

**A...... ......** L---·-·-··-----·

P, E I PS .........•.. Cp••..••\_•. •..•.

1·S·a-·n-d-·a-n·d··g·-r·a·v·e·L·-•L.-.-.-.-.-.'-.··-··-··-·j--·--··-·· **A** L,Wmd••..•.--

I•••••••"•••• -•-•••••I•·••-••I-•-•--•I•••••••••• **A.**--...·-·-·--1- • -•·-· -·- -•• -• •• ·I

I-· ·-·.·--•••--•••-I·••••-•I•- --··.

•------ ...-- ----------,- -- -**---1-** -- -- --

P,E

P,E

p

T,E

::::: :j. :::::::::::::::

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| USGS | Serial No.2 | Loca- tion No. 2 | LADWP  No. a | Owner or user | CD  ':O::,::\_  :i  ---- | ..,  g  .cl  Po  CD  A | r-.  CD  +>tij'  CDCD  so§  . §  A | -Po  0,.......  ig  CD  A | "'  C=D,......  o.sl  .-cl----  E-t |

**T.** 3 S., R. 14 W.-Continued

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 3/14-33P2 Peter Skipper \_  33Qp3L -8--A---1-8 -Co-l-u-mb--ia Br-o-a-d--  casting Co.  33RL. B-93a 754 8-B-39 H. McAllister Ranch\_ 34AL. Mrs. Goss \_  34BL B-97a 762 Ed Saul.. \_  34B2 Southern California  Edison Co., Ltd.  340D1L..\_ ---------- --------- -8--B---3-2--- -S--o-u-t-h-e-r-n--C--a-l-if-o-r-n-i-a----  34D2 B-92d 752 Edison Co., Ltd.  Circle B Riding  34D3 Academy.  ------------------------  34D4 \_  34FL T. C. Novarro \_  34F2 B-97d 763 8-B-31 Snodgrass \_  34F3 J. J. Williams \_  34GL Luis Vrduzco \_  34HL Charles Jacobs \_  34JL ---------- Earl ,Ving \_  34Kl \_  34K2 8-B-30 Joe L. Costa (former- 34LL\_. EalyrlRH.eBlm. eMrsorrow). \_ 34Ml Rutilo Romero \_  :'l4NL \_ Miss Florence Archer\_ 34N2 J. T. Ellis \_  34PL Walter Nielsen \_  35AL\_ B-102c 7820 Ed Saul.. \_  35A2 F. X. Girard \_  35A3.•.  35A4 B-102d 782D David Haynesworth 35BL. 8-B-19 F. E. Drake \_  35B2 E. S. Collins \_  35B3 B-102b 782B Richard Mansfield \_  35B4. W. IL Clark \_  35B5 B. W. Davidson \_  35CL\_ Higgins Brick& Tile  0.WMoorkesn. \_  35EL.- ---------- --------- ---------- E. R. Brown \_  35GL. B-102h 783A \_  35Hl \_ J. S. Stevens. \_  35H2 Pedro Jiminez.. \_  35JL 8-B-23 Formerly Mrs.  f'Kl Cameron. \_  35LL Moneta Water Co \_  35L2 ---------- ------------------------  35L3 B-102e 783 8-B-28 Moneta Water Co \_  35L4 A. Garcia \_  35ML\_ F. W. Link \_  35M2 8-B-29 Stephenson Bros \_  35M3 B-97 773 Moneta Water Co \_  35M4  35RL \_ B-103b 794 Southern California Edison Co., Ltd. (Torrance substa­  36BL tion). \_  Albert SandovaL  36B2 7-A-39 A.H. Vaughan \_  36DL. John Greenwood \_ | 84  90  100  82  56  57  65  68  74  74  72  70  70  71  71  66  60  62  66  58  70  72  76  76  72  41  40  46  45  48  47  46  54  50  55  63  58  56  47  62  61  64  62  63  63  63  63  63  57  38  38  29 | 200  200  225  99. 5 235 229 485  168  300  210  250  ---------  225  260  215  215  264.0  214  225  IGO 235  300  219  221  150  188  165  400  265  400  480  45  200  139.6  190.0  410  210  410  147.3  ---------  600  148. 7 600 193 550  77. 4 315 127.0 | 10  10  8  7  8  --------  10  8  12  8  10  10  10  7  12  7  8  8  12  16  --------  6  16  8  8  8 | 155  ------  155  125  110  184  254  ------  470 | 70  ------  35  70  68  4  126  ------  78 |

See footnotes at end of table.

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones I-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | ..  <P  "'=  C | ios,::,....\_  "O  ios:s:':-'  ....  A | :s:,  ll-t | Use of well | Analyses and measurements | Remarks 7 |

**T. 3 S., R.14 W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| -·----·-····-···---·  ·oravei" ·---·· | ........  ······· | ......  ........ | T,E | Stock......... | Cp...•---··-·-·· |  |
| T,E | Irr............ | Op•......•...... |  |
| ······-··-  . T,E ... | .............•..  Dom, Irr·---·- | Wmd.----·-··-·  r :============= |  |
| ·--·--··-··-···--··-  Sand and gravel....  Sand and graveL..  ····-············-··  ..........•.••......  .•..................  ·-······-···········  -···--··············  •••.....•••....•.••• | 500 | ....... | T,E  T,E  P,E  P,E  T,E  T,E  T,E  T,E  P,W  T,E  T,E  P,W  T,E  P,E  T,E  T,E  T,E  P,E  T,E  P,I  P,I  P,W  P,W  P,I  T,E  P,E  T,E | Ind...........  Dom, Irr......  Ind.••.....•..  Dom, Stock...  Dom, Irr ...•.. Irr............  Dom..........  Dom. Irr......  Dom..........  Irr••....\_ ..•...  Dom, Stock...  Dom, Irr.. -•..  Dom, Irr......  Dom, Irr......  Dom..........  Dom, Irr, Stock.  Dom..........  -....--··--·.... | Cp....•---·-··-·  Cp....·-·····-··  Op, Wmd•......  Op, Ws....•....  Op•......•......  .................. Cp, L, Wmd... . Cp..............  Cp·······--··---  Op.......•.•....  .....\_ ...........  Cp, L, Wmd.••.  Op..............  Op..............  Op, L•..........  Cp..............  Op, L.·-········  Op......-.....-. |  |
| 600 | ·•••••• |  |
| ....... | .•.... |  |
| ....... | ...... | LACFCD, well 792B. |
|  |  | A............. ·-···- ·-  Dom, Stock... Cp, vVmd.......  Dom.......... Op..............  Dom, Irr ...... Op..•...........  Irr, Stock..... Op..............  A.•........... ·····-············  Dom, Ind, Op..............  Irr. | |  |
| ....... ....... T,E ··-············· ...•..............  .•••... .••.•.. P,M .............•.. L ........••..  ....... ....... P,W Dom.......... Op..............  ....... ....... P,M ................ Op..............  ..•.... ······- .......... A.•........... W...............  ..•.... .••.•.. P,W .....•.•.....••. Op.............. | | | | |  |
| Sand and gravel................. T,E PS............ L••.............  .....do...•......... ··-·-·· ........•........ ··········-·---·--·-····---···--·-  ····-do.•.•...........•.... ·--·-·· --·-···--· ·-·---··-··-·-·· ..................  ..................•. ..•.... ....... P,E Dom, Stock... Op..............  ........................... ....... .......... ................ C,L,Wmd.....  P,I Dom.......... Op..............  P,E Dom.......... Op.. \_...••......  T,I PS............ C,Cp.....·-····  P,W  Sand and graveL...•........... Al, E Dom, Ind C,Cpr, L,  Wsd, Ww.  ·----···-······-·--- -·----- ---·-·· p -····--·-····--· ········-··-·----·  -----------·--·---·- ....... ----·--··· -·······-·····-- L, Wmd.........  ----·--·-·······-·-- ··-···- ··-···- ....•..•.. A•............ -······-···----··- | | | | | |  |

TABLE *26.-Description of water wells i-n the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  (I) .. ,\_, | | | Water  zones 1 | |
| usos | Serial No.2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | ":C:,;.\_  ........  :-$  -< | I  .d  Pi  (I)  A | ..(I.).,;;;-  (1)(1)  \_a,1\_i,  "'.a  A | *s*Pi  ..o..,.-....  .pd!,'-'  (I)  A | =: ..........  (I)  ,\_!:o,l<\_P,  .l!l  .d  E-t |

**T. 3 S., R. 14 W.-Continued**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 3/14-36D2 V. G. Comparette \_ 36D3 ---------- P. D. Jamison \_ 36EL.\_ B-102g 793 Formerly Mrs. Francis  **A.** Corwin.  36FL\_ ---------- --------- Edward A. Pitts \_  36GL\_ ---------- --------- Frank Machado \_ 3602 B-106d 803A J. W. Barnett (for-  merly F. H. Carrel).  36Jl ---------- 7-A-42 C. E. Slye \_  3612••• ---------- --------· ---------- J. C. Huchingson ••••.  361K3•l•• ---------- --\_ W.J. Watson \_  L. R. Figge \_  36K2.. B-107b 803 Roosevelt Memorial Park Association.  36K3•• B-102q 793A 7-A-41 Formerly Barnett  *:t ---* --B---1-0-7-k--- -8--0-3-B---- H. Ranch. . \_  T. Jorgensen.  36ML\_ ---------- --------- ---------- H. Woolway \_  36M2 B-1020 793C 8-B-38 184th Street SchooL    36M3.\_ B-102m 793B 8-B-22 W. H. Seward (for-  merly Luckens­ 36NL \_ JombneyZeurlr.lite \_  36N2 ---------- --------- do \_  36QL. B-108c 804 7-A-44 Morgan (formerly St.  Martin Ranch).  36Q2 ---------- --------- 7-A-45 Joe B. Ramos \_  36Rl ---------· --------- F. J. Easter \_  36R2-- ---------· --------- ---------- Bennett-------------- | 36  36  51  47  40  43  39  36  36  42  43  47  47  47  47  52  51  52  52  47  46  37  36 | 144. 5 185 163  128. 5 300 400  350  55.8  64  322  659  300  270  587  100. 0  315  193. 0 80 63.0 500 218.0 352 254 70 | 7  --- 4  6  5  8  - 10  **10**  4  -- 12  7  **4**  6  6  6  10 | ------  14f  ------  ------  ·-----  526  ----··  ------  ------  ------  ----··  ------ | ------ 21  ------  ------  ------  141  ------  ------  ------  ------  ------  ------ |

**T.3S., R.15 W.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/15-lHL •• | B-36a | 1306A I 10-c-s  ---- ----- ----------  1297E 9-D-15  1297D 9-D-14  1307 ----------  1297 9-D-3  1297A 9-D-2  1297B 9-D-1  1297C ----------  12970 ----------  1297F 9-D-16 | Andrew Bennett City of El Segundo:  Well610.-----------  Well5  Smitb ---------------  City of El Segundo:  Well L.•. ---·-----  Well 2.............  Well3  Well 4. Well8  Well 7. | 110 | 625 | 12 | 84  177 | 48  13  55  15  16  42  24  6  5  ------  20  70  10  14  22  36  33  -··ai-  50  26  24 |
| 12BL.\_  12GL\_ | ----------  B-33g | 115  113 | 400  349 | 16  16 | 185  139  205 |
|  |  |  |  |  | 290 |
| 1202 | B-33h | 108 | 394 | 16 | 129  197 |
|  |  |  |  |  | 318 |
| 12HL. | B-36b | 140 | 189 | 8 | ------ |
| 12LL. | B-33 | 176 | 355 | 16 | 236  285 |
| 12L2-.. | B-33a | 174 | 503 | 16 | 210  230 |
| 12L3 | B-33b | 171 | 370 | 16 | 278  218 |
| 12LL\_  12LL. | B-33j B-33k | 183  167 | 378  380 | --··10-· | 275  --207- |
|  |  |  |  |  | 262 |
| 12L6..•• | B-33i | 174 | 350 | 16 | 222  296 |

See footnotes at end of table.

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones t-  Continued | Pumping data | | | Miscellaneous | | |
| Character of  material | p. ..  S*en*.*=*s  ::;a  0 | 0,.......  'd  as.\_,  So<  A | 0.  =El  P-t | Use of well | Analyses and meamn-ements | Remarks' |

**T.** 3 s .• R.14 **W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| --------------------  --------------------  Gravel. | 25 | 6 | Al, I  P, W | Jrr A  Dom, Jrr Dom, Stock A | Cp \_ Cp \_ L  Cp \_ Cp \_ Wsd | W-139, **well 384** (Re• dondo).  W-139, well 1001 (Re-  dondo); W-468, well 6.  W-139, well 560 **(Re•**  dondo). |
|  |  |
|  |  |  | P,W  P,E |
| -------------------- |  |
| T, E Dom, Stock Wsd \_ P, E Dom, Stock Cp \_  P, M Dom, Stock Cp \_ C, E Dom, Stock Cp \_  Cp, L \_  A. L, Wmd \_ P,W Dom, Irr Cp \_  P,E Cp  P,W Dom, Irr Op. \_ p L, Wmd  Obs Wmd, Ws, Ww\_  P,W  A  P, W Obs Wmd, Ws \_  T,E Dom, Jrr Cp, Wmd \_  T,E Dom Cp \_  P,E Dom Cp \_ | | |
|  |  |
| -------------------- |  |  |
| Sand and graveL |  |  |
| -------------------- |  |  |
|  |  |

**T.** 3 **S., R.** 15 **W.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Gravdoel and sand.. | 540 | T, E | Dom, Irr WC, sCp, L, Wmd,\_ |  |
| Sand and graveL\_ 680 54 T, E PS C, L------------  do 1,050 20 T, E pg Cr, Cpr, L, Wm  do -------------------------- \_  Clay, ;,and, and \_  gravel.  Sand and graveL\_ 950 11 T, E PS Cr, Cpr, L, Wm \_  do ---------- \_  Sand, clay, and \_  gravel.  P,W Obs Ws \_  Gravel. A Cr, Cpr, Wmd Sand and fine \_  gravel.  i: :n-Ja rL. ------- ------- ---------- \_A\_------------ \_C, Cp, L, Wmd  Sand and graveL ---------------- ------------------  Coarse gravel and A Cr, Cpr, L,  Sa\_nsadnda.nd graveL Wmd. \_  -------------------- ---------- A C, Cpr \_  Sand, gravel, and 900 18 T, E PS Cr, Cpr, L, Wm.  cladyo. \_ | | | |
| Sandoand graveL\_ | 970 33 | T, E | A------------- CWr,md Cpr, L,\_ |

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| USGS | Serial  No.2 | Loca- tion  No. 2 | LADWP  No.a | Owner or user | <I)  "O  .:.:.,,:.::.:..,\_  ;::. J, | I  .p!:I. | 1-r  <I)  +>'ri,'  <l)<I)  s-5  !S  A | Pi  .o£,.-...  p.. i,  <I)  A | '1l  '1l  <I)  A,....\_  \_o...S.., |
|  |  |  |  |  | <I) | .cl |
|  |  |  |  |  | A | 8 |

**T.** 3 **S., R.15 W.-Continued**

3/15-12LL Well9

164 380 16 212 23

278 22

12RL

B-37i

1308

Southern California 95

Edison Co., Ltd.

12 ------ ------

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 13AL\_ B-37p 1308A  13A2 ---------- --------- ----------  13AL\_ ---------- --------- ----------  13A4 ---------- --------- ----------  13DL\_ B-32 1288  13D2.. B-32a 1288A  13El B-32c 12880  13FL. B-33e 1298B  13F2 B-33d 1298A  13GL. B-33c 1298  13G2 B-33f 1299  13HL\_ B-37s 1308B  13H2\_. ---------- --------- ---------- | Standard Oil Co.: Well 10  Well 13 Well 15 Well 24 ---------  **Well!\_**  WeJl2  Well 4b Well5  Wells  Well 6.  Well7 Well 12.  Well lL | 106  110  101  122  97  90  100  112  105  129  **145**  95  104 | 345  450  400  450  250  251  404  497  474  530  475  600  456 | 16  16  16  12  12  26-16  20-12  20  16  **16**  16 | 230  292  249  286  268  318  242  302  412  159  150  168  H\9  185  320  355  **192**  242  340  408  195  230  288  370  435  215  162  198  277  3:i2 | 59  50  25  12  15  10  38  38  13  11  14  4  33  99  27  55  38  52  34  16  15  40  32  **25**  7  85  12  29  86  73 |
|  |  |  |  |  |  |  |
| 13JL B-37r 1309D ---------- | Well IL---------- | 107 | 400 | 16 | 181  222  290 | 31  34  51 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 13J2 ---------- --------- ---------- | Well 21-  Well 23 | 100 | 452 | 16 | 366  235  282 | 7  15  13 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 13J3 ---------- ---------- ----------  13RL. B-37q 13090 9-D-12 | Well9 | **143**  164 | 466  400 | 16  16 | 263  380  292  376 | 103  68  50  24 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **13R2--** ---------- --------- ---------- | Well 16  Well 17. | 153  **134** | 480  450 | 16  16 | 339  212 | 121  13 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 13R3.\_ ---------- --------- ----------  13R4-- ---------- --------- ---------- | Woll 19  Well 20----------- | 133  158 | **440**  504 | 16  16 | 270  366  284 | 12  41  26 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 13R5.• ---------- --------- ----------  13R6.\_ ---------- --------- ---------- | Wen 22 | **149** | 495 | **16** | 426  275 | 30  **71** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 14AL\_ --B---3-2--b--- --1-2-8-8-B--- ---------- | Well 4a  Well3 | **79** | 403 | **26-16** | 378  ------  185 | 32  ------  33 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 14AL. | City of Manhattan Beach: | **116** | --------- -------- | | 307 | 11 |
| 24DL. B-32e 1289  See footnotes at end of table. | Well 5. - - | **99** | **390** | **16** |  |  |

**158**

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | *w*.::,...  a,  oo+::>,  l§  0 | 'od-.-3-  ,E:l  «i'-'  r-.  A | a0.  ::s | Use of well | Analyses and measurements | Remarks' |

**T.** 3 **S., R.15 W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sand and graveL\_  do  -------------------- | 800 | 20 | T, E | PS | C, Cpr, L \_  ------------------  W | Electrical ground. LACFCD, well 1307A.  Standby well. |
|  |  |  |  |
| Sand and graveL **A** Cr, Cp, L, w \_  Coarse gravel and \_  sand.  Sand and graveL\_ 1,000 39 T, E Ind Cr, Cpr, L \_  do \_  \_cto 800 35 T, E Ind Cr, Cpr, L \_ Fine sand \_  Sand and graveL\_ 475 85 T, E Ind C, Cp,!, \_  do ---------- \_  Sand, fine gravel, \_  and clay.  Gravel\_ **A-------------** C,Cpr,L \_  do **A** Cpr,L \_  do \_  - a.1- - = = ====== ======= ========== - : ========= 8 'c t\vi:il,-  sand and fine Wsd \_  Fignreavesla. nd and \_  Grcalvaeyl.\_ **A** Cpr, L,W \_  do \_  Sand Sand and graveL \_  do **A-------------** Cr, Cpr, L,  do Wmd \_  do \_  Coarse sand \_  Sand, gravel, and \_  clay.  Gravel and sand **A** Cr, Cpr, L, w  Sand and graveL 1,180 26 **A-------------** Cr,Cpr, L \_  Sand  Sand and graveL \_  do 1,000 20 T, E Ind Cr, Cpr,L \_  Sand and graveL\_ 850 32 T, E Ind Cr, Cpr, L \_  do \_  do \_  do \_  do 1,108 87 T, E Ind C, Cp, L \_  do \_  ----- ------------- 920 14 T, E Ind Cp, L  : de!ndgraveC --- - ======= : - --- - ========== - ·- ==  =====i :==--========= ::\_ --- -- -- :: -- *J t==========* \_g:g : t::::::  do 560 16 T, E Ind Cr, Cpr, L \_  -sani ndsome - - --- -- : - --- - =========== - ·- - ======  gravel. Ind C, Cp,L \_  Sand and graYeL\_ 900 50 T,E  Sand and gravel, clay streaks.  -------------------- **A** C, L \_  Gravel\_ **A** Cpr,L \_  do \_  Gravel and coarse 500 20 Obs C, L, Wm, Wrd  sand. | | | | | |

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. | | | Water zones 1 | |
| USGS | Serial No.1 | Loca- tion No.1 | LADWP  No.a | Owner or user | CD  'C  :::s::..  ::;ie  -< | g  ,.cf  A | 'C"D'  ;i  a.-s5  A---- | *3*  ;o;.J-..  ---  CD  A | ""''  =CD  ,\_!,4CD,  o.l:l  .cl  E-1 |

**T.** 3 S., **R.15 W.-Continued**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/15-25AL- | B-84b | 701A | 8-A-2  ------- ---  -----------  8-A-l  ----------  8-A-3  8-A-17  703A  ---------- | Well 3. | 145 | 547 | 14 | 204 | 76  36  46  8  57  11  ------  **31**  14  26  ------  ------ |
| 25A2.•.  25A3•.. | B-84g B-84! | 701E  701D | . Well *1 -·--·*  Well 6 --· | 156  156 | 350  350 | 16  16 | 224  222  287 |
| 25AL. | B-84a | 701 | Well 2 -··------ | 151 | 339 | 16 | 222 |
| 25CL. | B-84e | 691 | Formerly Manhattan  Beach Co. | 88 | 200 | 10 | 284  ------ |
|  |  |  | City of Manhattan |  |  |  |  |
| 25Hl •.  25H2.. | B-84  B-84c | 701B  7010 | Beach:  Well L ...........  Well 4.. ····-··-·· | 142  152 | 579.1  1,000  395.0 | 16  16 | 209  527  239 |
| 36HL. | B-85b | 703A | Formerly Hermosa  Beach Land and | 85 | --------- | -------- | ------ |
| 36H2•• | B-85g | 703B | Water Co.  Formerly S. C. Smith. | 40 | 116 | 7 | ------ |

**T. 4 S., R.13 W.**

4/13-lCL. - ................... ··-·-- North Long Beach

Extension Water Co.

47 236

12 190 24

lFL.. C-934b

904

City of Long Beach, North Long Beach well 3.

46 467

16 380 59

1F2•\_•• ········-· ......... ········-- Orchard Park Water

Co.

46 85

8 ...••• ···-··

lML

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| lNL•• B-123i 895A ..................................  IPL. C-935k 905F .......... Eugene Tincher.-..... | 42  42 | ····-····  400 | ···--··.  8 | -··-·· -·-···  ....•....... |
| 1P..................•.............. J.C. McPherson......  1P3\_. ..................................................... | 43 | 100 | 4 | -····· ··-··· |

................... ···-······ Mrs. Cope 45

43.0

4 ...... ······

1P4....................... ·····-···· James R. Ellis.-......

lQL.\_ C-935e 905 .......... R.WM. ackie........

1Q2•.• C-935f 905B 6-C-4 T. W. Bishop.........

2AL.- .......... ···-···-- ··-···- Dominguez Estate Co.

44

43 162

44 60

43 400

45 160

4 ·-···· ......

4 ·-···· ······

12 ······ ·····-

2JL ... B-12-3f 894A ...............d..-·-···--······

2J2\_ •.. B-123e 894 7-B-41 Del Amo Estate Co\_..

45.

42

927

155

419

12 49

251

74

2J3 ......................................do\_ ...............

<>J4....................... ·-··-····· .. -.. do....-...........

44 168

44 178. 4

14 ............

14 -··•--

2K.l•\_ ................... -········· .....do................

44 24. 5

I¾ 22 3

2::'IJ"L.\_ .......... ·····-··- .......... George Mindrup......

41 100

*2½* ···•·- ......

2PL-. B-I23d 885B 7-D-50 Del Amo Estate Co.. .

B-118c 875D

2P2 ·-· ..................................d.................

2P3. B-123c 835A .......... C.H. Eilers...........

37 118

37 97

37 145

12 29 88

4 ······ -·-···

12

2P4.\_....

R-123a 884 ··-···-··· George Mindrup......

-U 161 14

2RL\_. B-123g. 895 ·····-···- DelAmo Estate Co.. .

3RL .. B-118h 875K .......... ·-·-·do.................

Dominguez Estate Co.:

5JL •. \_ B-113a **834A** Well **2·-- ·-**

41 85. 3

34 392

13 750

12

126 6

368 8

12 633 44

5LL

B-113 **834** 7-A-46 Well L ...........

12 751

688

12 350

587

26

/j

164

**5QL ..** B-113b 835 Los Angeles County Flood Control Dis- trict, test well 3.

11 105

6 ------ ------

See footnotes at end of table.

*zone of the Torrance-Santa Monica* area-Continued

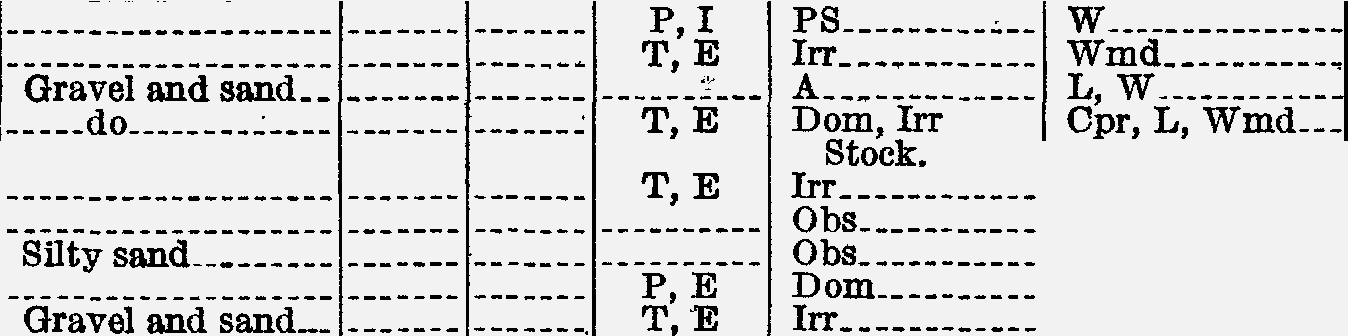
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Oontinued | Pumping data  - | | | Miscellaneous  - . | | |
| Oharacter of material | c,  a)  g"'\_s  a  0 | 0 .......  't.:sI  o:i'-'  Sot  A | s:i.  ll'4 | Use of well | Analyses and measurements | Remarks' |

**T. 3 s.• R. 15 W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sand and gravel  do  do  Fine sand and gra,·el.  Sand and.fine gravel.  -----do.  ----··--··--·-·-----  Gravel and coarse sand.  Coarse loose sand,  Sand, gravel, and clay.  --·----------------- | 400  690  615  ·----··  ··-·---  **300**  215  ·------ | 32  36 | T,E  T,E  ·-·---·--- | PS·-----·-----  PS·-------·---  PS.\_.....\_..  A.-·-·--·-----  ----------------  A------·------  PB----·-------  Obs  A .  A ·- | Cr, Cpr, L, Ws.  Cr, Cpr, L-·---­ Cr, Cpr, L, W  C, Op, L, W.. -.  ---·----···-------  L.----·---------  Cr, Cpr, L, Wmd, Ws.  Cr, Cpr, L,  Wmd, Ws.  ·-------·--··-·-·-  L.------------·· | W-139, well 267  (Redondo).  W-139, well 271 (Re­  dondo). |
| -------  ··-----  ------- |
| ··-·----·-  T,E |
| ------- | ---------- |

**T. 4 S., R.** 13 W.

Gravel and sand



·------

T,E

Dom, PS...

Cp, L----···-·-·

do .... -----·- ·------

T,E

T,E

P,W

jJ' g r--·-· ·--

Dom, PS......

Dom·-·---·-··

Dom, Stock...

Cr,L, Wr, Ww.

Cp.•.•..-.•..••.

Op, W..•.......

------·-·---···---·- ·----·· ----···

C,I

A•••.•.•·-·--· W -·-·-·-··--

Irr·-·-·-·-

--------·--·--·----· ·--·-·- ··--·--

TP,,EE

pg .\_. ··· - ·····-----·-·-····

GraveL-·-·------· · ·- ·-·--·-

P, E

Dom, PS...\_.• Cpr.·-·-·-·--···

W-138, well 843.'

Cpr, Wmd.. .\_

Cp, Wmd ··----

Cpr, L, Wm .

USGS test well.

Wm..... LB, well E-14.

·---·-·-·········-·- ---···· ··--··· P, E Dom

========:::::=:::::= ::::::: :::==== : - ;stoc1c::::: c·::::::::=====

--·······-·-·-····-···-·-·- ·---··- ·····-·--- Obs·-···--···- W......·-··-·---

Sand and gravel.• \_ ·------ ·----·- T, E Dom, Irr .. Op, L, W• ·-

---·-do.·--········ ··-·--- ··-··-· ·····--·-- ·-----·-----··-- ·--···--·---------

Gravel and sand... ----·-- ··-···· ·-·····-·- A----·-------- Cp,L, W-· ·-

·-··-do.--···--···- ··•··-··--··-· ·-·-·---·- ·-·---------·--· ······--···-···-··

Coarse sand .•.....•.•..• ····-·- ·----··--- -,-·-------·-·-·- L, Wd, Wrd •. JBL, well 834.

Gcavel and sand.• -··---- -······ ·--·-··--· ··--·--·----·--···········-·······

---······-·-·-·-·-·· ·--·--- ·-··--- ·-····-··- **A... --··--···-** Opr, L... ·--····

**460508-59-23**

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| -  Identification of wells | | | | | Well data | | | Water zones 1 | |
| USGS | Serial No.2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | a.,  'd  =:::..  ::l  -< | ...  :;:.-  ga.,  ta.,  A | r-.  a.,  i'  s-5  \_m S..,  A | .0s.  0,.....  il  0,'-'  a.,  A | fll fll (I)  .!=a:I:.Q:.t -  \_.....,  .s:=  8 |

* 1. **4 S., R. 13 W.-Continued**

4/13-6JL B-108a 824 Dominguez Estate Co

|  |  |  |  |
| --- | --- | --- | --- |
| 6J2 do \_ | 20 | 173. 3 | 4  8 |
| 6KL B-108b 814 7-A-51 M. B. Beauley \_ | 23 | 82 | 5 |

20 95

------ ------

6K2 George N. Branning

23 70

3 ------ ------

7EL

B-108 805 Frank S. Austin \_

34 99. 9 7

8LL-- B-114 836 Joseph Loria \_

8Pl\_

9BL-- B-113c 855 Shell Oil Co., Inc \_

18 32. 2

18 9. 3

21 1,060

36

2

-------- ------ ------

9EL B-114a 845

Del Amo Estate Co \_

16 --------- -------- ------ ------

9HL Shell Oil Co., Inc \_

9RL Richard Brothers lOAL \_ B-118 875 7-D-46 Jesus Cruz

24 1, 202

24 568

33 175

32-16-

12

10

25 284

128

10A2\_ \_ B-118a

875B

8750

7-D-47 do \_

32 112

--------

.,.

------

B-118d IOBL \_ B-118f

875E John Malcolm \_

29 141

10 93 3

10B2 do \_ lOOL Stauffer Chemical Co\_ lOEL \_ B-119a 866 Shell Oil Co., Inc \_

24 120

26 895

25 1,092

120 10

IO ------ ------

16 717 140

|  |  |
| --- | --- |
| 63 | 3 |
| 907 | 50 |
| 335 | 105 |
| 795 | 70 |
| 975 | 45 |

12

l0E2 \_

l0FL ·--------- \_ lOGL\_ B-llSc 8750 7-D-41

well2

Dominguez Estate Co\_ Martin Brothers \_

Ben Maciel. \_

30 1,230

28 17. 6

29 185

90

18-12

l¼ 12 6

7 ------ ------

1002

---------- --------- ----------

Melandras \_ 30 80

5 jj"

1003 ---------- --------- ----------

1004 ---------- --------- ----------

lOHL\_ B-118g 875J 7-D-40

Joe Uribe \_ Jesus Cruz \_

30

30-

31

115

370

5 63

6 70 32

10 ------ ------

10H2 \_

Grande \_

30 --------- -------- ------ ------

10H3 \_

Manuel Lopez \_ 30

85 4 iis·

lOJL

B-119s 876M 7-D-36

Mrs. Jeanette Jones.•.

29 157 4 42

IOJ2. B-119t 876N do \_

29 160 10 123 20

10J3 7-D-35 do \_

10J4 do \_ lONL L. Machado \_ l0RL Los Angeles County.\_

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 29 | 20. 5 | 1¼ - | 20 - | 2 |
| 38 | 27. 9 | l¼ | 24 | **4** |
| 37 | 26.0 | l¼ | 26 | 1 |
| 37 | 26. 7 | 1¼ | 25 | 2 |
| 38 | 30. 4 | l¼ | 27 | 1 |

29 350 10 ------ ------

- -- -----4 --- - -

UBL Del Amo Estate Co \_

11B2 Los Angeles County 11B3. do \_

1101 do \_

llDL. B-123 885 7-D-48 C.H. Eilers \_

35 149 12 ------ ------

11D2\_ \_ Los Angeles County llEL C.H. Eilers \_ 11E2 do \_ llFL Dominguez Estate Co\_ UHL. Los Angeles County

llJl•• Southern California

Edison Co., Ltd. llKL. B-127b 896A Carson Estate Co \_

34 28. 6 l¼ 30 2

31 145 12 ------ ------

31 110 2 ------ ------

34 30. 8 l¼ 27 5

37 14 6 ------ ------

36 --------- -------- ------ ------

34 127

11K2 ---------- ------------------------

34 140

--14 --- 60- 53

11K3 B-127m 896D Carson Estate Co \_

33 167

11K5 do \_ ULL Dominguez Estate Co. 11L2-.\_ B-124o 886E 7-D-38 do \_

11L3 Los Angeles County llPL. do

12Al \_

36 20. 9

33 140

34 144

33 30. 5

30 23.3

40 330

l¼ 13 7

----- ---50 - 65

*-----i¼* 22 7

l¼ 17 6

6 ------ ------

12A2\_ \_ City of Long Beach \_

See footnotes at end of table.

38 1,946

26-16 ------ ------

*zone of the Torrance-Santa Monica* area-Continued -

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | **i:i.o**  "':i  :§a.ss  0 | 0 ........  "CJ  ,el  «...i'-'  *Q* | 0,  El  ::I  /.l.4 | Use of well | Analyses and measurements | =  Remar 7 - |

**T. 4** S., **R.13 W.-Continued**

P,W Dom, Stock... C, Cpr, W......

f ••• ••••••••·········I·······1• • ••• ·· 1·•·P••,•W···· ··D·o·•m•·.•••.•.·.·.·.•••.·. Cp, W •.........

CWs.L, Wmd,

t • •• •• •• ••• • "" ·••••••I•••••••I·••••••

P,E Dom......••.. Cpr.............

l·••·················I·······1·-- • • • •

P Obs.••.•...•.. P,W Obs...........

Cpr, Wmd......

Cr, Cpr, Wmd, Ws.

I·- •••..-.••••••...•·I···....I•• ·- •• • I• •••••·-·.I•••••••••••-·- •• ww·.·.·.·..·····················

**A .............**

T,EIr.r...........

Sand, in streaks•.. j•..•..•1.......1 T, E Ind 8;t =========

Gravel envelope well, open 26-1,202 feet.

I==================================

p: E Dom, Irr ...... Cpr, m......

::flta:O: JBL, 1

1-····· ············-·I 1 ••••• ••

T,I

Irr••.......•..! Cpr, Wd•···••··I LB, well E-9.

Sand and gravel... ....... ..•...• T, E Irr............ Cpr, L......•••. LB, well E-20. Gravel.•...•........•...•..............•..........••.•.•......•. •.

1 !:I

- Sandf and grav=e=l..=••==.=.=.=.=.=..=.=•==.=.=.=.........•...f.E.:.=.=..=.=..=.=.•=.=...£•..=.=.=.=..=.=.=.=..=.=.=.

•....do............. ..•...• .....•. T,E Ind..•........ L•••. •..

*:.;r*

sand======= ======= ======= ========== ================ ==================I

.....do............. ..•.... ....... .......... Obs. C, Cpr, L, Wm.

I================================== *:,·I* B :========== gg ========

USGS test well. LB, well E-18. LB, well E-7.

Sand and gravel... ..•.... ....... P,W Dom•.•....... C, CEr, L•. LB, well E-7**A.**

tif}1 :} mrni:::rn= JI mm==:: 11;:;:imrn

LB, well E-17. LB, well E-6. LB, well E-6A.

JBLt.well 876K; **LB,**

weu D-36 (old).

Coarse gravel. •••................•........ A.•........... L...............

W..............

!J

W-138, well 840.

Cpr LB, well D-36 (new);

Cp...........•..

Sand..•....'...........•..............••.. Obs..•.....•.. Cpr, L, Wm. USGS test well.

'==================== ======= ======= :==========

.•..•do•.•••..•.••.•.•.••••...•••..••.•••••• Obs........••. Cp, L, Wm. Do.

Fine sand..........•..•..•.............•.. Obs........••. Cp, L, Wmd. Do.

Silt•••.........•.•.......•.•.•.........••..............•.. Wm. Do.

Fine sand......... ..•...• ....... .......... Obs...•....... Cp, L, Wmd.•..

.............•...... 990 ....... T,E Irr.•.......... Cp, L, Wd......

Silty fine sand.... ......• ....... .......•.. Obs....•. Cpr, L, Wm.•.•I USGS test well.

Cp•.............

'==================== ======= ======= *l.'*i B :==========

l

Cp..............

Fine silty sand.....•...••............•.•.. Obs........•.. Cpr, L, Wm.•.. USGS test well.

I···················· .............. ·········· **A.............** Cpr, **W** LB, Dominguez Street

bridge test well.

P,W Stock..•......! Cpr LB, well D-40.

I····················I·······•······· **P,W** pr..········•·· LB, well D-34.

**A ·.**

W-138, well 851.

Gravel and sand.. ......• ....•.• T,E Ir•r•.•..•..... Cpr, L, W•. LB, well D-33.

Silty sand..............................•.. Obs........•.. Cpr, L, Wm.•.. USGS test well.

A..•.......... L....•. W-138, well 853.

Gravel and sand.. ....•.• ....... T,E Ir.r•........... Cpr, L, Wd LB, well D-38.

Sand...................................•.. Obs•.......•.. Cpr, L, Wm.•.. USGS test well.

.•...do..........•.•......•. •

1••·················· C,I

Obs•.....•. Cpr, L, Wm.•..

PS, Irr........ Cp..............

Do.

1 - .\_

Sand and graveL.1·······1···-···1···,l'·E .. ,.Irr, Stock.. ===1====== ========:1 W-138, well 839:LB

- -• -

· - ·- - -

- -' - -

.,. 1 -

- ,

TABLE *26.-Description of water wells in {he coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| USGB | Serial No. 2 | Loca- tion No. **a** | LADWP  No.a | Owner or user | CP  "O  ::1::.\_  :::1  ◄ | ..  I  :S  g.  A | ...  CP  +>',jj'  CPCP  -a--5-  o,,S  A | *s*0.  .8:;3'  .0.c:.1-J-  CP  A | :  CP  A:;3'  -J--  .cl  8 |

T. 4 **S., R.13 W.-Continned**

4/13-12B1•• Pillow 40 130

4 106 14

12B2•• ---------- Los Angeles County \_ 15

130

1201 C-935g 9050 Virginia City 42 138

12EL \_ B-129b 906A 6-0-1 Virginia Country 38

B-127c 896B Club.

336

12 ------ ------

12E2\_ -

38 35 6

12FL- C-935h 906B 6-0-2 Llewellyn Bixby------ 77 177

122F02L•••. -J. .-E-r-i-c-k-s-o-n 37

1202. \_ C-935n 9050 C. S. Johnson 37

12HL- C-935d 915 6-0-3 Jotham Bixby Co 54

27

**22**

674

6

12 -- 424 -- 200

12H2

12Kl C-9351 906D Virginia Country

---------- --------- 6-0-6 do \_

81 ----iir 980- --·sr

12K\_3\_\_. C-935cb 990054AA

91 1,010

---------- --- odo· --\_

44 295 14 188 72

12ML\_ B-129a 906 Carson Estate Co \_ 13DL- C. S. Jones, Los Cer-

ritos Estates.

45 350 14 --280- --·so-

60 358 12 256 101

38 475 12

13JEL\_L

56 450 6 ------------ ------------

C-905g 897L LC.hBe.nHeyod--g-e-s--N--u-r-s-e-r-y-\_-

47 121 -----6-- ------ ------

13ML C-905d 897E Alfred Encinas \_ 13MN2l.-- -C----9-0-5---- -8-9--7-A---- ---------- --P-a-u--l-V--a-le--n-z-u-e-l-a --\_

13N2.- C-905h 897N do \_

14AL \_ B-127d 8960 Dominguez Water Co. 14AB2L\_ -\_ -B----1-2-7-a--- -8-9--6----- ---------- --D-o-m--i-n-g--u-e-z--E-s-t-a-t-e--C-o-\_-

106 295 ------ ------

30 35

-----4--

58 205.0 ------ ------

58 240 5

--200-

30 500 220

30 31 6 ---63- ---37-

31 230 12

176 33

14B2 do \_

1401-- B-124c 886B Dominguez Water ' Corp., well 14.

31 200 12

31 193 12

---88 6r

14Dl•• B-124b 886A Dominguez Water Corp.:

14D2\_. ---------- 876! Well 11 \_

30 189 12 77 44

28 161 16 80 58

14D3\_. B-124a 886

14D4.. B-119n 876J

Well911 \_-

29 150 12 117 31

28 1,013 12 791 222

14FL-- B-124m 887K Dominguez Estate Co\_ 14F2 B-124q 8870 do \_

14F3 Los Angeles County \_

30 130 12 50 59

30 135 12 73 28

24 22.3 1¾ 18 4

32 164

1401. \_ Dominguez Estate Co.

14HL \_ B-127 897! Fitzgerald Engineer- ing and Construc•

32 187 -----8-- ·-143" ----2-

14JL.. C-9050 897F

tion Co., test well 3. Oil Operators, Inc \_

27 600

14J2••.

28 33 6

14JK3l\_ \_ B---1-2-7-e -8-97 --H-. E-. D-i-c-k-s-o-n \_ 25 26 6

29

14K2 B-127j 897J do \_

14K3- \_ B-124h 887B Southern California

29 71

31 130

5 ------ ------

14K4.. B-124g 887A

Edison Co., Ltd. Mrs. Myers \_

29 110 **2** ------ ------

14K5.- 7-D-27 Southern California

Edison Co., Ltd.

14K6.- City of Long Beach \_

14LL-- B-124k 887F 7-D-25 Southern California

Edison Co., Ltd.

30 49. **2** 6 ------ ------

29 **20.** 3 1¾ 16 5

29 114. 3 10 86 28

14L2 B-124L 887J

14Ml.. B-1241 887D \_

14M2•. ---------- --------- ----------

14M43 ---------- --------- -------\_---

See footnotes at end **of table.**

Baxter Ranch \_

M. HeratsukL \_ Mrs. E. Lester \_

J. K. Raven \_

N. Namura \_

27 }: 8 ------ -==---

83 4 ------ ------

28

26

26 87 2 ------ ------

26 8 ------ ------

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Oontlnued | Pumping data | | | --  Miscellaneous | | |
| Character of materlal | ..  .,,  §a.a  Cl | 0  *i*..,*i* ,  ..  A | aQ.  ::s  ll'4 | Use of well | Analyses and measurements | --  }Wmar:tsr |

**T. *4* S., R.13 W.-Continued**

Sand•••·-·---··--- ····--··-··············- **A.\_......-....** L---···---·---··

Coarse gravel.••.• ··-·-·--···-·- -···-····· -·······-·-····· -·-- --···-·-

--------·-------·--· •••••••••••••• ·-··-····- ·--··-·-········ Wm•••-•••••••\_. LAOFOD, well **OOliF**

test well.

A.\_........... Wd.·--·-·······

···········-·-······ - P,W

Obs•••••• ••• Cpr, Wm, Wrd. JBL, well 896-B; LB,

tbs:::::::::::

well E-1.

--·-------·······--··-·····-·-·-·- P,W

W \_. LB, well ET-1.

A............. Cpr, W••••••••• LB, well ET-2.

----·····--····- ······-···-···-·-·

Gravel.--•-·--·--- -··-- ¥,'f

Dom, Irr, Op, L, Wm\_ •••• Stock.

Obs·-·- Wmd·--·-·--·-·

Band and boulders\_ -··········-········-·-· Obs-- L, Wr••-••••••••

Band and gravel•• ·-·---···-·-··

·--·---·--····-···-- 360 ·-·····

T,E

T,E

Irr.--•--······ Cpr, L, W---···

Irr•••••••••••• L·-···-·--------

Gravel and sand•• -··-···--·--·· Band and gravel•• ···········-··

T,E

T,E

Irr •• \_ L••••••.••••.•..

Dom, Irr--···· L·--··- ·-·-

A............. L-·- ·-­

············-·-·---- -----··--·--·· T, E

·····--·-----··--··- --··--···----· P, I

Dom, Irr ••••.• -·--··············

Obs........... WCp.r·,-·W··-·--·-······-····· LBJ well DT-4. Obs••••·-····· Cpr, Wmd•••••• JBLt.well 897A; LB,

weuD-20.

A•• •----·-···· W-·-·-···----···

Gravel and sand•• ··-·-········· .••••••••• A••••••••••\_•• L.·-·-·-··-···-­ LB, well DT-3.

-------------··---·- --······-···-· -·-------- A••••••••••••• Cpr--·-··-······

Gravel and sand•• -··----·-··--· C, E Irr •••-··----·· Cpr, L, W-··---

···-·do.·····--··-- ·--·-···-····- -·------·· -----··---······ ··----············

Gravel and sand•• ·········-····

T, E Dom, Irr-- Cpr•••••••••••••

T, E PS, Irr-······· Cpr, L·-····-·--

LB, well D-31.

Band and graveL•• ··-······--··· -·-······· A.-•-·---·---· L---····--·-····

Gravel, sand, and 1,500 ····-·- T, E PB.-----·-···· Cr, L, W·---····

clay.

Band and gravel.-- ····-····-··-· -··· ­

PB-·- ·-

Fine gravel and ·····-···-·-·- T, E sand.

**A•.•..•.••••..** LO-r-, -L-•-•·•·•·•·•·•·•·•·•-•·

Band and gravel..\_ -··-··-······· ··-····---

-Bango.:::::::::::: :::::::::::::: -·T,E ••

**A**D**.**o·m··,·I-rr··.•·•·•·•-·\_

Obs.-·• ·-­

C, Cpr, L-······

Cpr, L•.••-..... LB, well D-24.

Cpr, L. Wm. USGB test well.

-arciver···-·····-· -··210\_--·-·-· -- T.E •• **A**Irr ··**.** ····-·-**..**---

Cp••.••·-·······

Cp, L, W••••\_••

**A •.••..•..** WCp·r-,--W-·\_··.·.·.·.-.·..-.· LB, well DT-1.

A••• -•• ­

Cpr, W••••••••\_ LB, well DT-3.

A.-·•-··-····· Op, Wd-·-·-·-·· JBL, well 897-D.

A••• ••····-···

Cpr, W•• \_. LB, well D-21.

P,I Dom-.-·--·--- Cpr, W•••••.\_.. LB, well D-35.

•••••••••••..•.•.••••••••••••••••• -·-······· A............. Cpr-···-···-····

···-·---············ ••••.••••••••• •••••••••• Obs•••••••\_••. Cpr, Wm••• -•-·

Sand••.••••••••••.•.••.••••••••• ········-· **A.\_...........** Cpr, Lt.....Wmd\_.. USGS test well.

Gravel

•••••••.•• ······--·----- ---···-··- Obs\_ •••••••••• Or, L, w\_r•• .••• LB, well D-15.

**A.\_...........** W-·--···········

L-----------··-·

**A---······--·-**

··········-·······-··········-·--· p. w

-----··-···········- -·····- p. w

····-····-··--·--·-·····--····--·· T, E

·--·-----·--·--- CP ·--·-··-­

-1·-rr-----·-·-·---·--···-- cC.p•r• -·•·•·-------

LB, well D-10.

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. | | | Water zones 1 | |
| usos | Serial  **No.2** | Loca- tion No. **2** | LADWP  No. a | Owner or user | Cl)  'd  :=1:::..  ....::::,.  -< | I  ..c:  A  Cl)  A | "Cl')  +s>£'rij' -  !§  A | .As  o  A**J**'-'  Cl)  A | *a,*  *a,*  =Cl)  )  .-c-l---  8 |

T. 4 **S., R.13 W.-Continued**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4/13-14ML ---------- ----·---- C. F. Smith \_  14M6 P. Carmona \_ 14M7 C. T. Nakashima \_ 14M8 B-124j 887E S. D. Wilson \_  14M9 B-126h 889G ------------------------  14M10\_ B-124p 887M Charles KuJL \_  14NL\_ B-125e 888E Watson Land Co \_  14N2 B-124n 887L Dominguez Estate Co\_ 14N3 B-124f 887 do \_  14PL CityofLongBeach \_  14QL ---------- D. S. Bell \_  14Q2 B-124 8870 Oil Operators, Inc.,  14Q3 B-125a 888 test well 1. \_  Bell Ranch  14Q4 B-127h 897D do \_  14Q5-.\_ B-127g 8970 do \_  14Q6 B-127L 897M R. Morton \_  14RL \_ B-127i 897H \_ Fitzgerald Engineer-  ing and Construc­  14R2 tion Co., test well 2.\_  Dominguez Water  Corp.: | 26 129  27 112  27 100  27 125  27 98  26 97. 0  22 110  25 140  26 128  26 29. 5  27  28 134  26 54.3  27 900  27  27 119  27 200  21 24 | 10  112  12  4  8  8  *1¾*  8  8  4  12  6 | 89  116  ------  ------  ------  ------  60  25  50  ------  744  ------ 95  65 | 25  4  ------  ------  ------  ------  67  5  69  ------  156  ------ 20  3 |
|  |  |
| 15AL\_ B-119g 8760 Well 7A 27 161 16 68 76  15A2 B-119L 876H Well8 28 998 12 769 229  15A3 B-119k 876G Well lQ 28 158 16 76 57  15A4 B-119j 876F Well 2, old series 28 164 12 65 54  15A5 B-118n 876R Well6 28 1,001 12-lQ-6 777 224  15A6 B-119f 876B WellL 28 1,226 775 451  15A7-\_ B-119h 876D Well4 28 1,027 12 750 277  15A8- \_ B-119i 876E Well5 28 980 12 744 236  15A9 B-119u 877B ---------- 0. E. Elftman 28 159 12 94 36  15Al0\_ ---------- ----- ---- Dominguez Water 29 230 -------- ------ ------  Corp.:  15A1L ---------- --------- ---------- Well 15 27 1,054 16 800 190  15B3 B-119m 876P Well3 27 947 12 760 187  15B4-\_ B-119e 876A ---------- Well2 27 1,047 12 767 380  15B5 ---------- --------- Well 16 27 975 16 755 220  15CL\_ ·watson Land Co 24  15DL\_ B-119b 876A 7-D-34 J.P. Hoeptner 21 461 10 203 102  380 15  15EL\_ B-119c 867B 7-D-33 Cedric Seabranch 21 117. 5 16 193 36  15E2 B-119d 8760 7-D-62 do 21 360 10 325 - 65  15HL\_ - B-119r 877A Dominguez Estate 26 130 5 50 59  Co.  15JL ---------- --------- ---------- M. H. Nance 24 76 4 ------ ------  15KL\_ B-119q 877 K. Kuramoto 24 136 5-3 80 56  15K2 B-119w 8770 7-D-20 J. KawaichL 24 140 12 ------ ------  15K3 ---------- --------- ---------- Gay Land Co 23 110 5 ------ ------  15NL\_ -·-------- --- ------ ---------- Johns-Manville Prod- 20 925 16 483 302  ucts Corp.  15PL\_ B-120a 868 ---------- do 20 571 12 465 106  15P2 B-120d 8680 ---------- do 20 183 8 147 31  15P3-.\_ ---------- --------- ---------- Dominguez Estate 21 650 12 ------ ------  Co.  15QL. ---------- --------- ---------- Y. Muranaka 22 150 10 ------ -----  15RL\_ --------·- --------- ---------- Nakashima 22 6 ------ ------  15R2 ---------- --------- ---------- Dominguez Estate 22 135 12 80 46  Co.  16AL\_ B-119 867 J.B. Hoeptner 21 200 6 ------ ------  16DL\_ ---------- --------- 7-C-14 Luigi DebemardL 14 80 8 60 20  16HL\_ B-119v 867D Cedric Seabranch 21 147.3 4 ------ ------ | | | | |

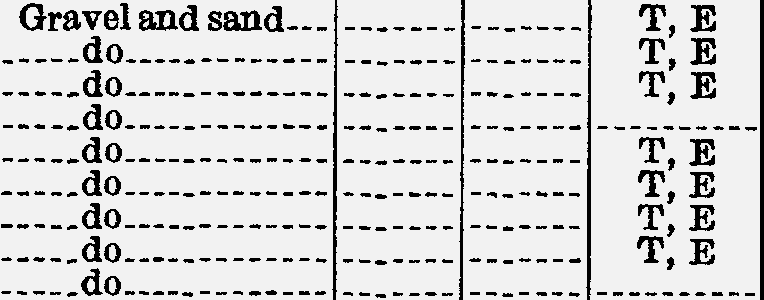
See footnotes at end of table.

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous  ·- | | |
|  | 'a";',  i:i."'  a;,  fll:;j  §.s El Cl | = |  |  |  |  |
| Character of material | 'd  o:i'-'  A'"' | i:i.  El  ::I  i:i.. | Use of well | Analyses and measurements | Remarks7 |

**T. 4 S., R.13 W.-Continued**

GraveLl and sand T, E



P, W

------------------ P, W

Dom Cpr, L --\_

Irr------------------------------

---------------- Cpr \_

LB, well D-13. LB, well D-11.

**A**

**A**

**A\_.**

C, Cpr, **L-------**

W W

- A**A\_------------**

Cp, rL, L, W

\_ LB, well C-10.

g: e iJr :== --=2io- ======= : - --- tis=========== 8;8;;;:i::,-wm:: USGS test well.

LB, well D-2.

Sand and graveL ------- ---------- **A----=** C, Cpr, L, w \_

**A** Cpr, W•• LB,well D-1.

Gravelandsand ------- ------- ---------- A Cr, Cpr, L, **w** LB, well D-3.

-Fin-e and -coarse----------------- --- - c============ E : ======== JBL, well897-C1

gravel.

Coarse graveL ------- **A** Cp, L, w JBL, well 897H.

**A** Cpr,W LB, Wardlow Street

bridge test well.

ps \_ ps \_ ps \_

**A**~~ps~~ **\_**\_

C,L \_ Cr, Cpr, L ­

Cp,,LCpr, L --\_

Cr, L \_

Gravel and sand 2,000 14. 5

T,E

ps ---\_

ps \_

**A \_**

**A.** - - - ---------

PS

C,r, LL, W --\_

C, L, W \_

L ------------

L\_ -

C,L \_

W-138, well 861.

do -------

do -------

do 1,600 4

T,E

T,E

T,E

PS Cr, L \_

PS------------ C, L \_

Cr, L \_

i :1a f! L ===:::: ::=:::: : - --- - =:::::===:: \_?.•\_?. : :- :: JBL, well 867-A.

Sand and gravel\_ ------- ---------- Obs Cp, L. Wmd JBL, well 867-BI

T,E Dom, Irr Opr L \_ SandandgraveL-- ------- P, W Irr Cp, L \_

Gravel and sand -------

P,W

P,W

C, I

Irr \_ Dom \_

Irr \_

Ind

CP----------•---

Opr, L, Wmd, Ws.

Cp,L, Wmd \_

JBL, well 877-C; LB,

well D-4. LB, well D-37.

Sand and graveL-- 1,270

\_ E Ind

OCp,, CWpL, --\_

T,E

Gravel and sand 1,030 ------- T, E Ind C ,Op, L \_ SandandgraveL ------- - -------- A L \_

-------------------- ------- ------- T, E Dom, Irr Op \_

Gravel.

430 \_

T,E

T,E

T,E

Dom, Irr Cp \_

Dom, Irr Cpr LB, well 0-10 (new). Irr Cpr, L \_

P,W

Dom---------- 0 W r, Wmd,

JBL, well 867-B.

Sand and grave} -------

P,W

Dom Op, Wmd \_

Obs Wmd \_

TABLE *26.-Description of water wells in the coastal,*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  <I) .. ,.. | | | Water zones 1 | |
| USOS | Serial  No.2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | 'C  ::::.\_  ::::1  ,::::e..  -< | i  @,  .d  <I)  A | <I)  *+>'<i,*  <l)<I)  so§  -c-e-.S-  A | o..-..  --!-  <I)  A | ="<I')  .!  .-d---  E--4 |

T. 4 S., **R.13 W.-Continued**



4/13-16ML. Watson Estate Co \_ 1701

17Dl.. B-109c 826 7-0-15 Dominguez Water

28

26

26 1,701

5 ------ ------

3

12

17EL. B-109g 827D

Corp.

Crook and Huffln

\_ 35

121

1701 H. Diego \_

18AL. B-109e 827A J.E. Hoepner \_

27 87

33 461

8 ------ ------

18A2-- B-109d 827 do \_

35 200

18Hl- - B-109 827B

J. J. Dunlop

\_ 36 --------- -------- ------ ------

18JL

B-109f 8270 \_

Griggs \_

38 • 67

18J2 ---------- --------- ----------

38

1. F. FieseL \_. -- \_

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 39 | 276 | 12-10 |  | |
| 39 | 251 | 12 | 203 | 48 |

18NPLL \_ B-llOh 818A 7-0-6

18QL\_ B-llOk 818B 7-C-S

\_ Bank of America \_

General Petroleum

CWe

L\_

39 250

}ggt\_ -B-llGa••- 818 =8:

Well2 \_

C. F. FieseL \_

39 250

44 220

212 38

7 200 30

19El••

19HL\_ B-llOf 828 \_

19H2. -- \_

19H3.\_ ---------- \_

19H4 \_

19H5 ·····-----

19Jl... B-llOc 829A

Spencer Coates \_

F. L. Forrester \_

C. Stuffers \_

Carlson\_ ­

A. E. Smith, east well\_

A. E. Smith, west well\_

J. C. Anderson \_

34 180

37 90

37 70

36 70

36 180

35 70

40 262

8

8-6

4

-- -12-

------ '-----

------ ------

------ ------

------ -----=

19J2 B-llOb 829 7-0-9

Theodore E. Klein• meyer.

41 325

12 238

------

19J3 B-llOm 829D Hughes Tool Co

41 --------- -------- ------ ------

19J4. B-llOg 8290 7-0-10 Mrs.AddieV. Steward.

41 100 --·--s·- ------ ------

19Rl•• 3-A-19 F. T. Woodman 20Kl.\_ B-115a 839A Southern California

Edison Co., Ltd.

41

37 550

12 --43:f --iff

20Ll.. B-115 839

20RL. B-115d 849

21HL\_ B-120c 868B

21H2.. B-115h 8580

Mrs. Ana-May Kreyssler.

7-0-13 Harbor View Dairy Co.

Richfield Oil Corp \_

Well 4.\_ \_

37 554 12-10 173 384

40 586 12 460 126

20 156 16 114 18

34 800 24-12 435 116

21H3

21H4

B-115g 858B

B-115f 858A

7-D-56

Well3 \_ Well2 \_

35 800 24-12 430 358

35 800 24-12 430 356

21H5.. B-120L 868H\_ \_ \_

21H6.

21Jl... B-115e 858

21Q1 B-115k 859A

Well7 \_

WellL8 --\_

Shell Oil Co., Inc.,

Wilmington:

27 721 430 291

25 800 435 365

35 643 18 428 215

21Rl\_ \_

Well L 36

750 20-12 ------ ------

Well 2 34

22DL\_ Richfield Oil Corp.:

846 16 440 330

22EL

B-120b 868A

Well 6

20 1,128 -------- --4io- --236-

22E2

Well 5 18

650 18

2201.. 7-D-17

Well9 ------

900 -------- ------ ------

2202

B-120g 878A

Watson Estate Co 25

do 21

50 4 ---93- ---30-

22HL\_ Los Angeles Harbor 23

22H2 DaCvoidmmDi.ssBiorynm. er 20

149 2½

120 12 ------ ------

82 4 -·133- ------

22JL B-120f 878 City of San Pedro \_ 19 165 8 28

------

22LKll.\_ B-1201 879B 7-D-59 Domdionguez Estate Co\_\_ 20 22L2••• Tide Water Associ- 20

14

22QL\_ AlapthedonOseilWCaot.son 31

22RL\_ B-120 879A 7-D-6 Watson Estate Co 17 B-120h 879

22R2•• Los Angeles County 20

590 14 ------

18.5 2 ------ ------

728 2G-12 411 317

250 10 --1--0-7- -··as-

170 6

19.5 2 ------ ------

23AL\_. ------------·-···-····-· 21

See footnotes at end of table.

30 6 ------ ------

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | !,..  "@' .s  :a a  0 | -i--  14  A | '2,  :E,l | Use of well | Analyses and measurements | Remarks' |

T. 4 S., R.13 W.-Continued

P,W

P,W

Dom.......... Cp••.••••••••••• LACFCD, **well 8360.**

Obs. cwrr.md,

A............. W •.••.

Irr•••••••••••• ···---···-· ·-

················--·· ....... ....... .......... A............. W. - ·-

Wd•••••••••••••

JBL, well 826.

•••••••••••••••••••• ••••••• ••••••• •••••••••• A••••••••••••• W••••••••••••••

----·······-·--·-·-- .••••••..•.••••..•••.... A.---·-------· W••..•...•••.•••

•••••••••••••••••••• .•••••• .•••••• P, W Cpr, W•••••••••

•••••••••••••••••••• .•••••• .•••••• P, W Dom. Cpr, Wmd••••••

••••••••.•••••••••.• ••••••• ••••••• T, I ••.•••••••.•••.• --·-·····----··---

Sand and graveL••••••••.•••••• T

•••••do•.•••••••••••••••••.•••••• T

Ind ••••••••••• Ind•••••••.•••

L, Wmd•••••••• L, Wd••••••••••

P,W Dom•••••••••• Cpr, Wmd•••••• JBL, well 818.

A,L

P,E

P,E

P,W

P,W

P,W

Gravel............ ••••••. ••••••• T, E

Dom, Ind••••• Dom•••••••••• Dom•••••••••• Dom••••••••••

A•••••.••••••• Dom••••••••••

Op.••••••••••••• C, Cpr, W•••••• Op••.••••••••••• Op•••••••••••••• Op•••••••••••••• Cp•••••••••••••• Cp, L•••••••••••

C, Cpr, Wmd••• JBL, well 829;

LACFCD,weU 829B.

•••••••••••••••••••• ••••••• ••••••• P, E

P,E

Gravel and sand.. ••••••• .•••••• Al, E

Sand and graveL. ••••••• ••••••• T, E

•••••do............ .•••.•• ••.•••• T, E

Fine sand•••••••••••••..••••••••.•••..•••• Sand and graveL. 1, 200 T, E

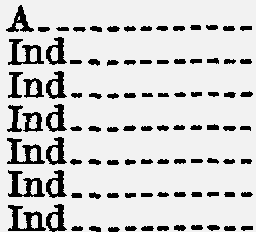
A•••••••.•••••••.•••••••••••••••

Cr, Cpr, W••••• Dom, Stock... Cp, Wmd•••••••

Dom, Ind ••••• Cpr, L, Wd••••• JBL, **well839A.**

PS. C,Cpr, L, W•••

Dom, Ind. Op, L, Wd••••••

LC.r-,-L-.·•-•-.-•-•-•-•-•-•--•

Gravel and sand•• 1,000 T, E Sand and gravel... 750 ••••.•• T, E

•••••do............. 1,450 5 T, E

•••••do............ 1, 980 6 T, E

••••.do............ 1,500 •••••••••••••••••

C, Op, L, Wm•• C, Op, L, Wm•• C, L••••••••••••

LC•,•O-·p·,·L··•·•·•·••·•·•·•·

JBL, well 858B.

C, L••••••••••••

··--···-··------·--· •••••.•••••••• -----··-·· Ind. C,L••••••••••••

---············-·-·· ••••••• ••••••• •••••••••• A••••••••••••• Gravel and sand•• 1,200 18 T, E Ind •••••••••••

LG.,-C--p-r·,-L--,-W··m···.

L.••••.•••••••••

P, W Dom, Irr .•.•.. Cpr, Wmd••••••

h

. :::::::::::::::::::::::::: *¥,;* Dom, Irr ..••.. Cpr, W••••••

Cpr, wm•••••••

LB, well 0-13. LB, well C-15. LB, well C-16.

Band and graveL•••••••••••.••• Band and gravel... 125 •••••••

P,W

T,E

Til

T,E

P,E

Cpr, Wm••••••• Irr. Cpr, L, W••••••

Obs. Cpr, L, Wmd•••

Ind •••••••••••••••.••••••••••••• Ind. C,L••••••••••••

Dom. Op.•••••••••••••

LB, well C-19. LB, well C-5. LB, well C-14.

Gravel and sand••••••••••••••••

T,E

Dom, Irr...... C,Cpr, L, Wd.. LB, well, B-12; **JBL,­**

well 879.

Obs........... Wm. LACFCD, well 8790 l

test well.

A............. Cpr, W••••••••• LB, well CT-23.

**350** GEOLOGY, HYDROLOGY,. TORRANCE-SANTA MONICA AREA

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  Q;) .. | | | Water zones 1 | |
| USGS | Serial No.2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | 'C  ::1;'.\_  !:::i e  -< | *Z'*  gQ;)  ..d...  g.  A | s-..  0)  +>ri,'  Q;)Q;)  s-5  \_o.,...S.,  .A | .0s.  ..o., ..\_  .od .t  Q;)  A | ""''  Q;)  \_AZ' ....  Q.;.  *Q*  .d  E-c |

**T. 4 S.• R.13 W.-Continued**

4/13-23BL. B-125! 898 -----···-- Chambers---·-·-··-·-·

25 142

·----··· 57 85

23CL --····-····-··-·-·- -·---··-·· C. H. Barnes•. ···-···

24 77

2 73.5 3

23C2\_•. ·-··-···-··-···-··· ··-······· R. E. Rose·-···--·····

24 80

2 75 5

2303.•- ---···-···-·····-·· --·----·--

23DL\_ B-125j 888J 7-D-18

23D2.- B-125h 8880 7-D-13

23EL. B-125 888A

Mrs. MoselY--··--·-·­

S. D. Wilson •.

Meecham Ranch••.•

Imai..·-\_ .•.....\_··--·

24 84

24 125

21 63. 2

22

10 ·--·-- ------

12 -·---- ------

23E2 • ··-·-····--·-·-········-····· Mrs. Hill..··-----··-­

20 160

10 ------ ·---·-

23FL.\_ B-125b 888B -···-·-··-

23F2••• ········--····-···- ·---·-----

2301.• ··-·--······--····· ·····-····

2302•. B-125g 888F

B-125i 888H

23Hl.• -···-··-····--·-··- ·-·-

W.F. Moulton.•••.\_. City of Long Beach •..

R. J. WhetnalL \_.. \_..

City of Long Beach, Silverado well 1.

Bonnie Brackett\_• \_.

23 149

22 24.3

23 54.3

25 1,074

23 100

12 46 59

1¼ 21 4

4-3 --··-- --·-·-

26-16 596 470

4 90

23Jl••. ··---··-·-··----··- ··- City of Long Beach.-.

21 10

23LL.. B-125d 888D 7-D-9 Manuel Pimentel!. \_

21 135

23L2-.. B-126d 889D

23L3... B-126 889B

7-D-8

H. & J. Maybury Co\_ Irwin Stewart\_·----···

21 145

20 115

12 71 61

18 ·11 -- 50

23ML B-126e 889E

··-···--·· ·--·-do•. -·-·····•-····

21 912

130 30

260 24

410 502

23M2.• B-126b 889A

23NL. B-126g 889F

7-D-7

.....do•.- ·--·---·

Irwin Stewart...•. •

21 115.2

18 **106**

14 77 41

23PL. B-126a 889

Carlson Ranch\_·--···- 19 --------- ----·--- ·---·- ··----

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f g;\_ -e· ::: 20

15

19

26.5

56.9

33

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1½ ------ --···-

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24El ··--·-···-·---·---· .•. ..... -··-.·\_-. -··--·.•••..-·· 24

24E2.\_. ·········-·-····-······--··-- ·--···········-···-·-··· 24

24FL.•...•••••.•.•••.•... ·-···-·--· ·-··---·-···--··-·----·- 23

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38.1

25

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24F2

2401.

2402

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28.3

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24KL.- -············-··-········-·-· -··--···-··-·---·-·····- 19 25

24K2 -- ···-··-········-··· -·--··--·- ·-·---·--··--·····--·-·· 21 25

24K3 -- ··---·····-····---- ····-·--·· ··-····-·--·-··-··-··-·· 20 27

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24ML. ·····--··-··-··-··· -----····· -···········---- 21

24M2.• ···-···········-··- ······-··· -···-··-···-·--·-- 21

24NL.• ·--···········-·····-··-·-··· J.B. Mosher 21

24N2..• ·-·-----·-·-····-·· --·-·----- -··--·----·---··-----· 21

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29.4

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24N3

24Pl.

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24Ql\_ ---·-·-··-·····---- ··•···---· ---------·-·---·-·-----· 16

24Q2•.• -----·-·---·--·-·-- ---------· ·--------····--···--·-·- 16

24Q3••. ·----···-·-·-··-·-- ·--··---·· ·•·······•··••·•·•·•••·· 20

24Q4•.. -················-- --····---- ··-·-····-·-·-······-··- 19

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24Q5\_•.

24Q6

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24Q7·-- ····-·······-··-·-- ··-···--·· ·--·------·-----····-···

25NL.. C-917 390

26AL\_. B-126f 899 Oil Operators, Inc., test well 4.

26Bl.-. --·-···-····----··- -·--· Dora E. Kabler•••.\_••

16 16

··iai -·· -···-s- 105-· -- 26

18 60

26B2 ·-··-·------·-·-·-- ----·-·-·- R. C. Vaughan----··-- 19 69

"40 29

26O1.•• B-126c 889C Peterson ···----·--- 18

84. 1

7 -·-·-- -·-···

26DL

·-·--·--·-··----··- ·--·· Long Beach Archers

15 85

1 -63. -

.• 39

26EL•• B-136L 3SOC M. M. Thomas-·--·-- 15 147

110 36

26E2••• ·--····-······--·····--·-·--- R. S. HuberL\_.

15 99

3 ·-·-·- --·---

26F1 B-136m 380D 3-B-l Lever•••••••.••• • 16 12

See footnotes at end of table.

*zone .of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | -  Miscellaneous | | |
| Character of material | s:i,..  G)  9"'.'=a  El  0 | 0 ......  ti.\_,  **1-t**  A | s:i.  =El  P-t | Use **of** well | Analyses and measurements | -  Remarks r |

**T. 4 S., R. 13 W.-Continued**

Sand and graveL\_ -·---·- ··-···· ··-··-··-· A....·-······· L-----···--·····

GraveL\_···-······ 7 ··---·-

··--·do•.•••·-·····-······.......

-····-··-··-···-···· ---···· --·····

P, W

P,W

P,W

t-----···---- gpfpr,L---····

Irr--···-·-···- -···-·······--·- LB, well **0-11.**

·······-··-··--·---- --·-··· -·····-

T,E

Obs\_··-··--··· Cpr, Wmd

••••

LB, well 0-8.

l

Obs••• ·-···-·· Cpr, Wmd\_ •.\_••

A·--·········· Cpr, Wd.••••••• JB h LB,

888-A;

····-----···---·-·········- ···-··· T Obs........... Cpr, Wmd.••••. LB, well C-9 (new). Sand and gravel.\_. -·-·--- ••••••• ••••••.••• A--··········· L, W·-··········

USGS test well.

Sand and silt••••••.•••••• ······- ······-··· Obs••••·- Cpr, L, Wm••••

Obs. Cprt.Wmd••.•••

Gravel and sand••••••••• ·····-· T, E Obs••••••••••• Cr, L, Wr, Ww.

Gravel............ ••••••• ••••••• P, W W.•••••••.••••••

···············-···· .•••••. ••••••• .••••••••• A.···-·····-·· Cpr•.•••••••••••

···-·-·············- .........•••..·········- A............. Op, Wd·-·······

Sand and gravel... ••••••• ••.•••. •••••••••• A............. Op, L••••••..•••

···········-··--··-······-- ·····-- -····----- A••••·- Cr,Cpr, Wd-•••

LB, well CT-13.

JBL, well 889-B.

Gravel and sand Sand and gravel.

··--··· -·····- ·---······ A••••••••.\_... Cpr, L, Wmd•••

--·---- ···---- ·-----------·--- \_

LB, well 0-4.

do ....•.... .•. ··-···- ····-·· ·-··-·-··· ··--·----···-- -·-·-·-··--·

Gravel and sand\_.. ·····-· ---·--· ······--·· ·--···-·--··-·-· --·-··········--·· LB, well 0-3.

Sand and gravel... ·------ --···-- ·------··- Obs--··--·--·- Cpr, L, Wrd ••

-··--------·-------- ---·--- ·------ ·-·--····- A\_-·-----·--·- CP-·-----·-··-·· Probably LB, well

····--·····-·---·--· -····-· ·-··-·- ··-······· A.···-·-·--··· Cpr, W.·-·-····

Silt and sand.·-·-· -·---·· -····-- ··-------- Obs.-·-······- Cpr, L, Wmd\_••

0-1.

USGS test well.

···------·-·-·---··· ··--··· ····-·· P,W Irr••..·-·-··-· W••·-··-- LB, well CT-1.

··-···--········-··· ----·-- .••.... ·---·-·--· A·----·--- Cpr, W-·---··-­

LB, well CT-20.

·--····-··--·······- ..•.... ··----- -·--····-· Obs.·······--· Cpr, W·····-·-· LB, well CT-21.

··-··---····-··-···· ·····-· ···-··· ········-· Obs........... Cpr, W-··-·····

········-··-········ .•••.•...••••. ···-······ A\_............ Cpr, W.·--···-­

LB, well CT-18.

LB, well CT-19.

··-·········--··-·········- ·-····· .•••.•..•. A.\_·····-··-·· Cpr, W···-··-·· LB, well CT-16.

····-···········---- ·-·-·-· ----··· ·--··--··- Obs·-·-···---· Cpr, W---···--·

------··-·----·-·--- -···-·- ----·-· ·--·--··-- Obs.. ---·-···- Cpr, W----··--­

·--·--·--·-··--··--- --·---- ·--···- ·------·-· Obs.. ------·-- Cpr, W-·-----·­

-------······-···--· ·-·--·· ....•.. ·-··--···- Obs.•..•-···-· Cpr, W- --··

··--·--··-···-···-·· ••.•..• ······- ····-··-·- A·--····--·--· Cpr, W- ·-

·····-·····--······· ··-···· ....... ···-·····- **A--····--··-··** Cpr, W-··-···--

-------·-···--·-···· .....-.···-··· ···-····-- **A--··-·-·-·-··** Cpr, W--·-··--­

·-···-··-···-······· ·-··--· -··--·· ···-······ A--··-·-·-···· Cpr, W- -·--·

--······--·········- ·-···-· ··---·· ···-·····- Obs... ·-·--··- Cpr, W•

**A·-····-·-·-·-** Cpr, W -·--·

Sand\_. ---·--··----·· P, W Irr\_··---·-··--·······----·-·--··

-·--··-·-----·------ ·-·-·---·- Obs-·------·-- Cpr, W .\_

··----·----·-------- ----·-- ··---·- ·--------- Obs\_·---·-·-·- Op, W--· ·-

··--·------- ------- ---···- --··--· -----·---- A·----··------ Cpr, W .\_

·------·-·---··----- ··--·-· -··------- A.·-·---·-·--· Op, W·---·--·--

LB, well CT-17, LB, well CT-15. LB, well CT-22. LB, well CT-7. LB, well CT-14. LB, well CT-9. LB, well CT-10. LB, well CT-12. LB, well CT-11.

LB, well CT-25. LB, well CT-26. LB, well CT-8. LB, well CT-24.

--··---·------·----- ------- ----···--- Obs . Cpr, W\_. \_

LB, well CT-2.

-----·-------·------ ----··- -·-------· Obs-·-··---··· Cpr, W-- ·-

----·-·---·---·-·-·· ---·-·- ·------ ·-·--··-·- **A-·-·-·---··-·** Cpr, W-····----

A ···--·--·- Cpr, W---··----

LB, well CT-3. LB, well CT-6. LB, well CT-5.

Sand. . ---·--· ------· ··--·----- A---··-------· Cpr, W·----·--· LB, well CT-4.

-----·------·--··--- --·---- ------· ·---·--·-- A.•..---·-··-- Cpr, **W\_. .**

-··-··------------·· ......• ··-···· ········-· A.---········· Cpr, W-- --·

LB, test well.

LB, test well.

-araveL .....\_..··---···------ · ---·--··-·--- 8;bp, L, wd \_ JBL, well 899.

GraveL\_·---··---- ·---·-- ·------

P,W

P,W

P,W

Irr--···-·-···· C,Cpr·--··--··· Stock---·-··-- Cpr, L·-··-···-·

Obs-·---·- Cpr, Wmd.\_.

JBL, well 889-0; LB,

well B-6.

-Sand and graveL ·-----· -----·· ·x:============ ·L::::===========

·-- -v:....

Gravel and sand..• --·---- ------· -·----·--- -·----·--------- --·--·· ·---··

------·---···--···-- -·----- ·------ C, E Irr--··-··--··- Op, **W .**

·--··---·-··---··--- ···---- ·-·-··· -·----·-·- A·-·-·-·--···· Wd·---·· --·

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  .. | | | Water zones 1 | |
| usos | Serial No.a | Loca- tion No.t | LADWP  No.s | Owner or user | IP  'd  =:::..  =!:i  < | I  .a  i  A | 'I"P'  -:;;i  \_a..-.5..,  c,,E!  A | j  :o;-J--  Po.\_,  A | Ol  "IP'  \_AZ,  ..!....  .a  E--4 |

T. 4 **s.• R,** 13 **W.-Continued**

|  |  |  |
| --- | --- | --- |
| 4/13-26F2 B-1261 889H -------···  2601••• ---·------ --------- ---------·  2602\_. ---------- ·-------- ·---------  26Jl ---------· --------· -·-··-  26Kl- ----·-··-· ·-----··- --· --·  26LP1-L••. -B----1-3-6-b--- ·3-8--0-A·--- -··--·-··-  26P2-.. B-136a 380  26P3 B-136j 3810 | C. Smith•••••-••••••••  L. D. Rosser·-----····  FWor.mI.eErlnygKvanlsaobnle•••••\_  0. SchreckengasL••  City of Long Beach.  C. D. Fischer·-·······  Mary Lou Evans.-·-· John Ena.··---·-··-·· | **16** 200 **12** ------ ------  **17** 80 2 ------ ------  **16 107 26-16** ------ ------  **15** *n***16.0** 4 ---43 28-  **13** 2  15 **19.3** 1¾ **17 3**  12 98 12 ------ ------  **12 83.7** 2 ------ ------  12 633 12 ------ ------  **13** 85 4 ------ ------  **13** 4 ---is **3-**  12 **18.4** 1¼  **12** 85 ----·2-· ------ ------  13 64 -·---- ------  **13** 83 2 ------ ------  13 75 2 ------ ------  **13** 70 2 ------ -----,-..-\_  12 ---87 --- 2 ------ ,..\_  11 2 ------------ ------  13 96 --·-i2·-  14 140 --·s1· --ios-  **12 493** 12  383 110  27 230 20-12 200 30  **13 820 14** 196 9  371 317  740 20  **33** 900 **24-12** 412 398  35 842 14 600 306  34 946 20-16 266 **534**  36 **825 16** 435 390  **32** 850 **498** 44  562 **288**  10 **336** -------- ------ ------  11 115 6 ------ ------  45 800 8 200 **100**  45 200 8 --iss· 9-  41 **366**  200 166  42 415 **14** 285 74  50 600 12 207 239  **485** 115  42 ---so·-·- 2 ------ ------  43 6 ------ ------  41 403 15 ------ ------  37 68. 5 5 ------ ------  37 ------ ------  40 84.1 8 ------ ------  43 375 6 ------ ------  36 400 4 ------ ------  37 ··soo·--- 4 --i94- -·ior  15 8  46 **314 12 212 102**  **46 189.8** 12 ----·- ------  14 285 -------- ------ ------ |
| 26P4\_•• ·····-·-·· --····-·· ·········- 8. Wheeler·-··--····--  26P5\_•• -······-·· -·-···--· •••••••••• C. J. Link\_··-··-···-·  26P6-•• ····-·--·· ··-·-···· ··-·-···-- City of Long Beach•••  26QL\_. ·-·-----·· ·----·--- --··-··-·· Fred Emer••·-·····-·  26Q2 ---·--·--- ··------- ------··-- A.S. Curtis-------··--  26Q3 ---------- ·-------- -----· Mrs. Eulia Harmon-  son.  **26Q4** --------·· --····--- ·-··--···- --·-·do••••••-··-······  26Q5\_. ----·····- --······· ····-··-·· R. B.Harding·-· ·-  26Q6 ···-····-· ·-······· ······-··- Hauge·---··--··-------  26Q7 ----··--·- --··----- ··-·-··-·- J. F. Browne --·  26RL\_ C-917c 390A ----·--·-- W. L. Jones--·---··--·  27JL\_. ··-··----- -·------· 3-B-3 U.S. Naval Reserve•• 27KL.\_ B-135d 370 3-B-4 Wat.son Estate Co \_  27LL\_ B-135h 360 Tidewater Asso- ciated Oil Co.  The Texas Co.:  27L2-.. B-135k 3600 Well 2---- ·-  27ML. B-1351 360A Well 3----··· ­  27M2-. B-135j 360B Well L----·----··  27M3.. B-135m 360D Well 5-------------  27ML B-135n 360E -····-···· Well 6--·----· ·-  27Nl\_ •••••••••• --··----- ··-··----· Well 7.-----··-·---  27Rl ··•··----- --·-····- -·--·---·· ····--··--·········-·---  27R\_2. ---·-··--· -·--·-··· -·-·--·--- --W··i-lm··i-n·g·t·o·n-·C··e-m··e------  28NL\_ B-134k 340 3-A-10 tery: i \_  Well  28N2- ---------- 340A 3-A-11 Well 2-------------  29Al••- ------·--· -·····--· ----·-- Traub Land Co.••••  29BL.. B-115n 839B 7-C-12 E. W. Sanderson \_  2901... B-115c 8390 John Holbauch----·---  29El B-134m 320A 3-A-20 B. F. Christiansen\_. 29EF2L\_ -B---·1-3-4·j--· -3-3-0·-·--· ·3·--·A--·8---- Smutzler---·-------···  Rowan·----·-·····--·-  29ML. B-134 320 --·------- Robert Tracy·····----  !I,2:9t½M2-·.\_····-·---·-·-·---·-·- ·--·--·-·-·--··-··· 3-A-21 Wood\_.• ••• \_.-·-······  3-A-'n·- Mrs. E. Schneider.- ••  City of Los Angeles Banning Park well.  FletcWhelrl OLi\_l.C\_.o.: •  f :±t::::::::::::::::::::::::::::::: Well 2--·-·- ·-  l30Cl\_ -·---·-·-- ··-··-·· Los Angeles Co. San­  itation District 2. Poggie Ranch:  [30Dl.. B-llOd 809 **3-A-3** Well1-------------  1 B-133t 310B Well**2 \_**  30D2•• B-133s 310A **3-A-2** Oliver McCoy. \_  30El... B-133j 310 | |

See footnotes **at end of table.**

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  OontJnued | Pumping data | | | Miscellaneous | | |  | - |
| Oharacterof material | *i.*  Ul  8a la El 0 | .:..  ·ouz;-  ca---  s...  A | Q, | Use of well | Analyses and measurements | Remarks7 | j | - |

**T. *4* S., R.13 W.-Contlnued**

|  |  |
| --- | --- |
| Sand.·---·--·----- -·--·-- -·--··· P,E c : ::::: -op::::::::::::::  C  A.·--····-··-- Cpr ··-····  =-----t------··-·----· -·---·- -·-··-· P, W ----·----·-·-·-· Cpr, W•• ·-·-···  ::: ::::::: ::::::: --- :\_v:\_.\_ gk:::::::::: *gg ;* t:wm::::  1  -·-·-------·-·-·-·-- -··---- ·····-- --··------ A-···········- L••· ·---·  ·-····---·--····-·-- --·-·-· ·····-· -------·-- Obs-•. ·-·-···- Cpr, Wm••• -••.  ··-·-··----··----·-- -···--- -····-- --·-··---· --···-··--·····- Cpr, L-·-·--··--  ·--··--·······------ -·--·-- -····-- P, W Dom••---·-·-- Cpr--·····-·-···  --··--··--····---·-· -··-·-- --··-·- P, W Dom Cpr ••  Sand.·-·····---·-- --·--·- ---··-- ---·-----· Obs----- Cpr, L, Wm••••  ···--·------··-·--····----- C, E Irr-·-···-·---· Cpr\_······-·-···  ·----------···----·- ·····-- ------- P, W Irr.• Cpr ·---··  ----·---·----·-·-·-- -·----· -···--- P, W Irr •• ---------- Cpr ·-··---·--  **P,** W Irr •• ---·-·---- Cpr···-·-·---···  --··---------··--·-- 15 --·---- P, W Irr.·--·-··--·- Cpr.-·--- ·-  ·-··-----·--····-·-- --·--·· ---··-- P,W -----·-···· ggr·::::::::::::  ---··--------·-·-·-- -··---- ·----·- P, W ---··--•···--·-- Cpr,W ••·-·-···  --··--·-·---··------ --·-·-· --·-·-· C, E -·-·-·--·······- Cpr, Wm\_·-····  Sand and graveL\_ .••.•..••••.•. ··----·-·- A•• ·-·-·-····· Cpr, L, Wmd•..  ··•-.dO.. -.• ---····· --····- ······- ······-··· -·-·····-·-····· ·---···-· -·--·­  Coarse graveL•\_•• -·--··- -····-· ---------- A.• ·-··--····- L·-·-··--·-·----  GraveL--------·-- -··-·-- --···-- --···----- A.·-·····--·-- Cpr, L, Wd.\_.  :a:ari:;el:::::::::: ::::::::::::::::: ::::::::::::::::::::::::::::::::::  Sand and graveL. 2,400 18.4 T, E Ind •• ·-··· Cpr, L, W\_.  -·---do\_·-··------- ---·-·· ·-····· .•.....•.• A\_•• .•••...•.. Cpr, L, Wd·-···  Gravel, sand, and 3,000 12 T, E Ind ••••••..•.. Cpr, L, Wm••.. clay.  Sand and graveL. 2,000 .•.•... T,I Ind•••••••••.\_ L, Wm••••......  ·--·-do•••·-·-····-· ·-··-·· ·---··· T Ind•••..•••••. L••·- ·-  -····do...••--•---·- --····- ------- --·---·--- -----·----···--· -----·-·-··- ·-  ---·----------·----- ---·-·· ··•·--- ·----·---- A·-·-···-·-··- L-······-·-···--  --··---·-·-···-·---- ..•.••..•.•..•.••.••....··-···--··------ Cpr, Wd·- ·-    400 T,E Ind••••••••••• -··-··············  Gravel and sand 400 Al Ind•••••••••••••••••••••••••••••  600 T Ind........... L••-·-··········  Sand and gravel... ••••••• ••••••• T, E Irr, Dom. Cp,L, Wmd••••  Obs. Wmd•••••••••••  A--···-·····-- L••••••••••••••• | LB,well B-15.  LB, well B-18. LB, well B-20. LB, well B-17. USGS test well.  LB, well B-9.  W-138, well 885; LB,  well B-1. LB, well B-7. LB, well B-4.  USGS test well. LB, well B-8. LR, well B-16. LB, well B-22.  LR, well B-21. LB, well B-23. LB,well B-2. LB, w-ell B-24, LB, well B-19, LB, well B-13. LB, 'Mlll B-14.  W-138, well 984.  LB, well B-10.  **1BL, well 320.**  **w!4 o** 363 (Ree |

TABLE *26.-Description of water wells in {he coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
|  |  |  |  |  | Q) | i"'  ....,  i  Q)  A | ......  Q)  -;;;-  Q)Q)  a-5  -o-1-.-S-  A | .ps.  o..--.  )  -s.---  Q)  A | Ul |
| USGS | Serial No. 2 | Loca- tion No. 2 | LADWP  No.a | Owner or user | 't:I  :::1:::..  .:...::::i:, | Ul  Q)  *Z'*  \_...!.,  ,Cl |
|  |  |  |  |  |  | E-4 |

**T. *4* S., R. 13 W.-Continued**

4/13-3001.. B-133v 3100

: r.\_

B-130n

320B

City of Los Angeles, LoWmeiltla6 plant:

Well5

\_i----------

Well7 \_

31 682

328004113305

16

216

276

31El . \_ B-133e 311

31E2 B-133o 311B

Well L \_ Well32 --\_

33 675

17 716

30

695

20 509

16 350

16-12 224

205

285

31E3 B-1331 311

Well4

\_ 21 671 . '16-12 165 506

31EL\_ B-133p 311A

31LL\_ B-133f 312

Palos Verdes Estates

21 680

30 629.8

20 230 425

26-12 274 164

530 378

31PL-1----------1---------1 1 Union Oil Co \_

40 900

24-16-14 675 147

32DL.I B-1348 I 321

33DL\_ B-134g I 341D

Danie1 Hanson \_ City of Los Angeles,

WWilmeliln1g4ton plant: \_

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  | |
| 38  34 | 73.3  888. 2 | 8  20 | ------  669 | ------  131 |
| 29 | 502 | 12 | 264 | 138 |
| 24 | 856 | 12 | 697 | 94 |
| 26 | 600 | 12 | ------ | ------ |
| 27 | 526 | 12 | 135  270 | 20  180 |

33D2

---------- ---------,----------

Well7

33EL\_ B-134d 341A

33E2 B-134h 341E

33E3-.\_ B-134c 341

33EL- B-134f 3410

Well2 \_ WellL \_

Well5

Well3 \_ Well 12 \_

|  |  |  |
| --- | --- | --- |
| 25 | 563 | 12 |
| 25 I | 577 | 12 |
| 25 | 566 | 20 |
| 26 | 466 | 12 |
| 26  24  21  12  10 | 792  346.8  25  320  1,047 | 12  2  12 |
| 7 | 101 | 2 |
| 10 | 21 | 6 |
| 11 | 250 | 16 |
| 12  11 | -----  98 | 11  2 |

25 887

12 667

|  |  |
| --- | --- |
| 262 | 139 |
| 501 | 60 |
| 129 | 39 |
| 260 | 317 |

114

33E5

33E6

33E7 ,

33E8

B-134e 341B ,----------

---------- ----------

, ,

, , ,----------

Well lQ 26

Well 9· 1

Well 13

529

--ias 38-

------ ------

33E9

33:EFlL0

I\_ ---------1--------·1 ··- --- - - --

---------- --------- -------\_---

Well6 \_ Well ll \_

Well 8-------------

267 107

33HL\_ B-1358 351

33Kl\_ B-135 351A

BobDihase \_ Consolidated Lumber

Co.

1------1·-----

------ ------

------ ------

34CL.1----------1---------1 1 The Texas Co., well 4.

iift:-:::::-- -::: ::::

7

-- -::: ::::- ; :

|  |  |
| --- | --- |
| 33550C2 LI BB--1133661e I | 338811BF |
| 35FL\_ B-136f | 3810 |
| 35LL\_ B-136g | 381D |
| 35Ml\_ B-136d | 381A |

1 1 **G**D.**ilm**D.**o,**M**e O**ur**i**r**l**a**C**y**o**

,------,------

50 73

I

135 115

,------,------

|  |  |
| --- | --- |
| 9 | 153 |
| 10 | 137 |
| 11 | 201 |
| 10 | 201 |
| 5 | 443.0 |
| ·9 | 121 |
| 9 | 125 |

Electrified Water Co.\_

Pan Pacific Oil Co

3-B-20 City of Long Beach

Southern California Edison Co., Ltd.:

|  |  |  |
| --- | --- | --- |
| 35M2 | B-136h | 381H |
| 35M3  35QL\_ | ----------  B-137d | 381E  392D |
| 35Q2 | B-137b | 392A |
| 35Q3 | B-137 | 392B. |

---------- Well 1, east wen

9 -----

4

8 125 12

12

i ,

3-B-21

----------

West well California Sea Food

Codo., Inc.:

;!\_! \_

77 28

35QL\_

35Q5

36EL\_

---------- do -----------

8 , , \_

36ML.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B-137c | 3920 | 3-B-23 | do | 9 | 124 |  | 60 | 34 |
| B-137a | 392 | ---------- | Star Drilling Machine Co. | 9 | 70 |  |  |  |
| C-917b | 401 | **4-A-l** | Home Ice and Cold  Storage Co. | 11 | 310 | 12 | 230 | 10 |

C-917a

391

----------

Soft Water Laundry 15

Co.

See footnotes at end of table.

WELL RECORDS 355'

*zone of the Torrance-Santa Monica* area-Continue\_d

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | t  °o'o";C:'V;  :S;.ss  c:, | ioi::---  '0  .i!,:,:--l!-l  A | ::, | Use of well | Analyses and measurements | RemarksT |

**T. *4* s.;R. 13 W.-Continued**

1

|  |  |
| --- | --- |
| Sand and graveL\_ ---···- T, E PS ··-··- Cr,Cpr, L, Wm.  ··---do • ---------------· --------·---··--·-  ::::: :: :::::::::: - - --- ·- --if:\_E is:::::::::::: 8r,r b - :::  Fint> gravel. . ---·--- -·----··-- A--·---·----·- C, Cpr, L, Wmd.j Sand and gravel. -----·- T, E PS-·--- C, Cpr, L, Wm\_  :::::ii=====::::=::: :::: ::::! : ::: I\_ =:::::=::::: \_8; : f,-;; :I  Fine to coarse 1,650 28· T, E Ind\_···-·--··- L--··-----------  sand.  Obs•••••••..•! Cp, Wmd, Ws••  Sand and graveL.I 2, 500 19 **Al** PS, Obs•.••••• Cr, Cpr, **L,** Wm,  Wrd.  Al PS, Obs.••••. Cr, Cpr, **L,**  ::::::: :::::::::::.1\_......I.-·-·-· Al, S PS,Obs ···-­ Wmd. Wmd  Cr, Cp, L,  I···-···-·•.. -... ···-1--·-•-I- --·--· Al, S PS, Obs ···-- Cr, Cpr, Wmd,  Ws.  ····-a ···-······--· -·····- ---··-- Al,\_s\_·- PS, Obs·-····- Cpr, L, Wmd-..  ·-·--do-.•-·--·---·- -··-·-- ---···· Al,S PS,Obs Cr, Cpr, L, Wmd\_  -···------·----·-··- --·--·- ----·-- -·----·--- PS, Obs\_...... L, Wmd •  · aJ : ·s- l;:::: ::::::: ::::::: --- : --- - ::: ::: *-r:\_* : :.: :  Gravel and sand.. -·----· ---·-·· S PS,Obs .•• L, Wmd•••••••• Coarse sand and ----·----- --------···----- --------··-·-·- 1  gravel.  I--·---·---·--·---··-1-···-.. I. - - - • - - Al, S Obs, Ps ••••••. Cr. Cpr, L,  Wmd.  ·S-a·n·d·-a·-n-d--g·r-a·v·e··L·-·1-·-·-·······--1·-····-······-1--------------·-···-1 PpgS\_······---·-. L, Wd••• ·-···-·  w----··- ·-  ·-··-·····-·-·----·- -··-·-- ·-·-··- Al, S Obs, PS ·-·-- wmd\_ ......•...  -· · · -· · · · · · · · -· -· · · · -····-- -···--· ·--··-···· A\_-·······---­ Cp, ····-·····  ········--···-···-·-···--- -··-··- -········· A·-·-·······-- C,Cpr, **L,**  Wrd. | LACFCD, we.ll 311.  JBL, well 312.  1  JBL, wen 351-A.  LB, well AT-1.  JBL, well 381; LB,  well A-5. LB, well A-6. LB, well A-4. LB, well A-7. JBL, W<'ll 312.  LB, well A-3.  LACFCD, well 381E.  LB,well A-lA.  LB,well A-lB. |
| -·----·······-·-··-· •..••.• ······- M Dorn\_········- Cr,Cpr•. ·--··-­ Sand . ···-····· -······ ······- --··-·-··- A---·-···--··· Cpr, W... ---·-·  Coarse gravel... \_. ·····-- -··-·-- C, E Obs\_···-· Cr, Cpr, **L,**  Fine gravel. ----·----·------------·------------· *Ope,* Wm-.. ---·  ·-·------·---------- -·----· -·---·- ---·----- Obs.---·----·- Cpr, Wm.·--·-·  GraveL ·---·-- ---·--- -----·- P, W Irr·----·-·-·-- Cpr·-·------·--­  -Gravei--··-·-·-·-- -·-···· ···-·-- P, E ·-- rs·-··--··-··- CLp, rW--r-d-·-·-·.-·.-.·.  1·-···--·-·-········- ----·-· --·--·- P, S Obs\_··-···-·-· CrC, pr, Wm.••  - i:\_=-! :.1: :l:::::::l:::::::I : a::::::::::: r,"L;w·.:::::::1  -------- ------------1---- ---1-------1---------- Obs.. ·--·····- Cpr, L, Wm....  ·······--·----····--1-·--·••I••-·-••I•••••••••• A•...·-······· L •• ·------······  1-·--·••••--··-····-·1-·-·-·-I••· . ••,•••••••••• A----·-·····-- C, Cpr, L,  9 Wrd.  Sand and graveL·-•·······•··-···-•······-··· A\_····-····-·· Cr, Cpr, L,  . Wd.  A---·-··-····· W-··- ·-  GraveL •...••..-.•1 •.•...•1•••..•-1.......•.•1 **A.............I L,** W·-···--·····  A-·······--··· |

L\_ .. ·······-····

1

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data  G) .. $-< | | | Water zones 1 | |
| usos | Serial  No.' | Loca- tion No.' | LADWP  No.a | Owner or user | ":O:s::\_  :1  !: | I  .Cl  A | G)  "i  -s--a-  os.S  A | .is:l,  :.Sszg-  g.  A | ""''  G)  .-C-l -  ul  8 |

4/14-lHl••• 1----·----- --------- ----------

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **T.4S.,R.14** W. |  | | | | |
| Aluminum Co. of | 51 | 600 | 14 | 470 | 42 |
| do -------- | 51 | 596 | 14 | 475 | **29** |

1H2•••••••••••••

1H3.--1---·------ --------- ----------- --

3L2L •• --------- ----------

---------- --------- ----------

3L3 ---------- --------- ----------

3LL .. ---------- --------- ----------

America.

do 51

GeCnoerrpa.l Petroleum Well2 Well3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 74 | 800 | 16 |  | |
| 74  75 | 450  450 | 30-16  30-16 | 110  106  360 | 313  234  90 |
| 76 | 454 | 30-16 145 2 | | |

Well4

596

14

197

|  |  |
| --- | --- |
| 522 | 16 |
| 418 | 14 |
| 474 | 45 |
| 536 | 11 |

257

3PL ..

B-98

765

----------

Dominguez Water

94 --------- 12

------ ------

4LL--- ---------- --------- ----------

A.CCoIrUp.fgard

133 344

--------

244 **100**

5BL ••

Dominguez Estate

Co.

95 --------- ------ ------

5DL.- B-86d

724

----------

California Water Ser-

1: 533 --ao-16r··6-i--529-

5NL.- B-86k

725E

vice Co., Station

19, well 1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 124I | 312.8 | I 12 I | 221I | 46 |
| 80 | 281 | 14 | 196 | 73 |
| 98 | 223 | 10 | 142 | **81** |

5N2 1 B-86h 17250 1 ReSdcohnodool. Union HighI

6Fl B-86b 714 Formerly Southern

California Edison Co., Ltd.

601.... B-86i 714A Formerly H. C. Feder\_

6PL

*101*

7Jl\_

7J2

B-86a B-86

B-87b B-87d

705A

705

716B

716D

8-C-9

----------

----------

Formerly Henry Slutman.

California Water Serv- icedoCo.

37

33

97

100

180

41

311

325

8

4 7

16 170

16 205

---sf

141

116

7J3\_ --- B-87

716

---------- do

**100**

306

14 177

129

7J4 B-87c

7160

---------- -- do **100**

311

12 170

141

7J5 B-87a

716A

---------- do.. 97

364

16 183 155

7J6 B-87e.

716E

---------- do 97

Dominguez Water

c .:

232

16 170 62

8C2 B-86g 725B ---------- Well 12 93 476 I I

161 306

SCl.---1----------1---------1----------1 ell 12-L.------, 1151 518

Callfornia Water Serv-

ice Co.:

1661 344

SDL..I B-86j I 725D 1----------t Station 15---------1 146 I 560 I 16 I 1ss

248

384

1:A

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 154 | 440.5 | **18** | 140 | 233 |
| 171 | 519 |  | 130 | 250 |
|  |  |  | 416 | 103 |

50

72

172

SEL,-1 B-86e

8E2 B-Bef

|  |  |  |
| --- | --- | --- |
| 4  12 | 206 | --351- |
| --1126I-  12 | I | 152151  104 |
|  | 428 | 59 |
|  | 537 | 14 |

1----------1 Station 3, well 4---

California Water Serv-

ice Co.

**8ML.I** ! 17'6

8Nl ... B-87g 726A

1····•·····1·····ddoo-..-............

*m*185

.4,.56

----is--

140

310

901 ••• \_ B-93 745 Boonstra Bros

120 225

281

175

9Kl ... B-94a 746 ---------- Chanslor-Canfield 108 557

Midway Oil Co.

11362

Well 2 , 100I 623

lOJl••l•

1----------1 Cit of Torrance:

10605

l0Kl•• B-99 766 ---------- Well L----------- 110 703

B--99a

1776

See footnotes at end of table.

298

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| i Waterzo 1-  , Oontinued | Pumping data | | | -  Miscellaneous | | |
| Character of  :QJaterial | !,..  :da a  0 | = i,:;  o---  'C  i***o***,***s***:***'-***;***'***  s..  A | ::I  P-t | Use of well | .Analyses and measurements | Remarksf |

**T. *4* s.• R. 14 W.-Continued**

Sand and gravel 815 33 Ind L ••• -------··---

Sand, gravel, and 810 29 Ind L\_ --------------

Sacnldaya.nd graveL

do 1,375 33 ---------· Ind L

do do

\_

-----·-------

­

-----------•--·-···· ----··· ------- ---------- **A----------·--** -----------------

••••\_do 1,320 6 --------·- Ind C, L \_

··san30 ·- \_

1,550 10 ----------\_In C, L \_

.\_ do 1,300 20 ---------- L. \_

do ------- ---------- ------------------

-------------------- ---------- **A-------------** W-····---·--·-·-

Sand and gravel.

T, E L \_

p. w

- Coarse sand and.• 525 --=---- -------=-- tbs::::::::::: Kci>r:·L:Wiii:

gravel.

Gravel and sand 270 Ob.'l Or, Cpr, L,

L,

Gravel A

Wsd.

Opr, Wsd \_

Coarse sand and gravel.

A L

-------------

Sand and fine ---------- **AA** --L--W --\_

gravel

**A**

Sand and gravel.. ---------- L \_

do ---------- **A-------------** L\_ --------------

**A**

Graveland sand C, Cpr, L, Wmd,

Sand and graveJ

----- **A**

Wrd.

L \_

do ---------- **A-------------** L\_.-------------

A L----- ---------

do ----------

do 1,500 13 T, E PS, Jrr Cr, Opr, L \_

do **A** L \_

Sand and gravel..\_ 344

do

T, E Obs Opr, L, Wm \_

w:.m,

ddoo

Coardsoe sand and gravel.

--------------------

·

O-bs

- ,-fJ-;

.

Sand and graveL\_ 450 ---------- **A** L \_

**A**

do L

Coarse sand and gravel.

ACl,, EE

IDndom, Stock CW, -C--p-r-,L --\_

Sand and gravel... 1,560 12 T, E ps C, L, Ws \_

do.

Sand

Sand and gravel.••

T, E PS C, L, Ws \_

do ---------------------------------·- ----- ------------------

**460508-59-24**

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | |  | Well data  .. | | Water zones 1 | |
|  |  |  |  |  | Q | *Z'*  gQ)  *i*Q)  A | s..  ..Q.) .,;;-  Q)Q)  s'fil  -o-1-.-S-  A | p. | ....,,  Q)  AZ-  .,!,ja>  c.>$  .-C-l---  E-1 |
| U808 | Serial No.J | Loca- tion No.J | LADWP  No.a | Owner or user | 'C  ::s:::.,  ::::!:!::!i, | .8  ;;j'"'  p.'-' |
|  |  |  |  |  | -< | A |

4/14-llFLI B-103c 1785B

**T. 4 S., R. *U* W.-Continued**

Columbia Steel Co.:

1----------1 Well 3 1

691 620

16 1139043 84

11F2-.. B-103d

llGL. B-103 1102 B-1038

785C

785

**785A**

----------

8-D-13

Well**4** 69

wen 2 65

Well! 68

460 I 16

653 14

295.0 14 613

145

240

288

80

266

286

577

87

63

20

159

123

184

181

36

12QL\_

B-109a

806

7-C-16

Mrs. J. M. Carson **44**

377

7 258

119

13BL\_

B-109b

806A

----------

* 1. S. Government\_

46 --------- -------- --- " - ----

13FL\_

13F2

B-104a

797

----------

David E. Crutcher 49

Morris 49

697.0

20 245

620

260

40

**13NL\_**

B-105b B-105a B-104

63 --------- -------- ------ ------

13PL.

14LL

14NL.

8-D-12

8-D-16

798A

798

787

Mildred K. Reeves Formerly the Texas

Co.

Woolner Oil Co., Ltd.

54

**82**

101

|  |  |  |
| --- | --- | --- |
| 82 | 110 | 12 |
| **82** | 400 | 12 |
| 90 | 265 | 7 |

200

648

5

12 95

**527**

14N2

---------- --------- ----------

Mrs. Anna C. Whit- ney.

------ ------

14PL•• B-lOOd

778

---------- Formerly Geo. F.

Getty.

56

287

219

113

16GL.I B-94e I 757A 1 ' Del Amo Estate

67

228

141

**37**

16LL\_

B-94b

747

8-C-10

ChaWrleesllHL. Quandt:

**83** 240.0 **12**

16L2

---------- --------- ----------

Well2

80 492

14 --i,ii- --aif

16L3

B-94c 747A

Well 2-------------

80 300

14 197 103

16NL

B-94f

747B

8-C-4

E. Henwood Ranch

73 184

8 ------ ------

16QL\_ 8-C-3

A. van Vliet\_ 77

270 6

16Q2

16Q3

B-95a B-95g

748

748A

----------

Joe Abegg Formerly Mrs. Means\_

California Water Serv­

ice Co.:

|  |  |  |  |
| --- | --- | --- | --- |
| 556  418  600 | 18  16 | 2291  193 | 327  195 |
| 400  367 | 18 I | 206I | 188  117 |

86 350

87 189

-----;;--

236

**22**

114

167

17EL., B-87h 727 0

17GL\_ B-94 737 Ell ei: J1ii: f- =t}M\_

17G2

B-94g 737A

1

California Water Serv­

ice Co.:

Station 21---------, 95

Station 11 83

miLI-B-88---- - 7 28 8- C- 5

20JL

B-95i 739A

1 8-C-2

S. Correia (Ellenwood 107

12 250

B-95 739

well 3).

7 , ,

21AL \_ B-95b 1 758

8-D-5

Formerly Standard

Oil Co.

74 111

8 , ,

21PL-I B-95h

749

8-C-1

J. W. Venable , 94

225.0

21QL\_ B-95f

759B

Cambell(?) Standard Oil Co., Pro­

ducing and Pipe

107

22DL-I B-100

768

LiWneeDll!ept.:

, 80

404

12 2061 198

22D2

B-95c

758A

Wen 2 83

---1::::::::: 1- - i - - : ::::I 78

77

;: 1-::::--1-::A 77

390

12 212 '178

! J-:;:a--1-::::---1-::---

**See footnotes at end of table.**

Joshua Hendy Iron WWoreklsl:L\_

Wen2 \_

Formerly Ben Weston

77 353

660 I f! 1-··sa·l--464-

78 501

79 500

206, 147

14 214 240

24:0 200

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Water zones 1-  Continued | Pumping data | | | Miscellaneous | | | |
| Character of matetial | !a  i:i,...  CD  "§''.=s  =;;i El  **Cl** | 0 .......  'd .e  ,a..s.\_, | i:i.  =El | Use | of well | Analyses and measurements | Remarks7 |
|  | A |  |  |  |  |  |

**T. 4 s., R. 14 W.-Continued**

Sand and graveL\_

2,500 T, E

Ind Op, L, W \_

do -1,6-7--5-

do do

1-7 T,E

-I-n-d

-Op-, -L \_

:,\_•do d:::cl ======= ======= ========== - ============= -C·,- L, W=m=d=====\_

do

Gravel and sand Obs L, Wmd, Ws \_

A

Gravel and coarse

sand.

Sand and coarse

gravel.

1,650

Obs L, Wmd, Wrd

P, M A

•- T

\_ LADWP Torrance well 1.

\_

-S°im<fandgraveC ======= ======= --- · :c::==========

T,E

f:w =======

A

Sand and fine ------- A

L, Wsd \_

Sagnrdavaenl.d gravel \_

Fine sand A L W-130, well 345 (Re-

dondo).

Gravel. ------- ------- ' ·-

S-a-n-d a-nd g-r-a-v-eL-\_- -1-,-2-0-0--

T-, -I

-D--o-m,-Jr-r

wC, -Cp-r-,-L \_

Gravel and sand-- ----·-- A C, L \_

-------------------- -------

P, W Obs

Wind, Ws \_

-------------------- ------- ------- T, E Stock Cp, Wmd \_

Sand and graveL\_ -------- T, E Irr L. Wsd \_

Sand and line ------- A C, L \_ gravel.

Sand and gravel\_ A C, L \_

do -------------- A Q \_

W-33, well 342 (Re­

dondo).

-------------------- -------

-------------------- 1, 100 24

T, E Dom, Irr C, Cpr, L, Wsd

PS C, Cpr \_

Sand and graveL. 640 7 T, E

PS C, Cpr, L, Wm \_

Gravel and sand T. E

-------------------- T, E

Irr Cr,Cpr,L, Wmd\_

A Wmd \_

Obs Wmd, Ws \_ Irr----------·- Op,Wsd \_

Sand and graveL. 375 Coarse sand, and 215

fine gravel.

6

2 T,E

Obs Cp, L, Wm, Ww\_ Jnd Cp, L, Wmd \_

A Wmd \_

Sand and graveL\_

T, I

A - ------------ ------------------

In - C,Cp,L

do ------- L, Wmd \_

Gravel and sand T, E Ind Cp, L \_

Sand and fine A L, W \_ gravel.

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones i | |
| USOS | Serial  No.1 | Loca- tion No.1 | LADWP  No.a | Owner or user | Q)  '=C ::.  :i  .;..:,e | ...  *l*  .cl  i  A | ...  Q)  i  -s--.5.;  "'.a  A | §  ;"o";'.J-..  i-..;  A | *UJ UJ* Q)  *\_ez-*  -0-.J.;  .cl |

4/14-22QL-l B-lOOc I 769A

23AL -I B-105d I 788A

T. 4 S., R. 14 **W.-Continned**

Paul Wright (formerly I 79 I 375 Weston Ranch, well

2).

Formerly E. Kettler I 67 I 78

209 I 166

7 30 I 48

23Dl

23A2 1 B-105m 1788B 1 1 Kettler Ranch

67

---------- --------- ---------- MacDonald & Burns•• 89

64. o I

12 ...... ......

23D2 ---------- ----··--- --------·· Henry Wertalls.-••••• 72

230

8 -----· -·-···

23H2L.. B-105c 798B

8--D-7 --F·o-r-m--e-r-l-y--B-o--b--V-e-d--a-•-••- 85 Narbonne Ranch

Water Co. No. 3:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 74 | 446 | -----··-1 | 275 1 | 171 |
| 75 | 460  460 | 16 I | 310  310 | 1 50  150 |

495

12 300 195

k--1\_ B-105e

1\_789

Js-D-1S

Well 1•••••••••••••1

Well 2............. 76 16

23KL. B-105f 789A

23K2.- B-105g 789B

Well 2••••-·-······

Well 2•.•••---··-··

Narbonne Ranch No.2:

1

117

75

600

450

370

3111

230

139

23Nl•. I B-lOOf

23N2.I• B-lOOg

779

779A

8-D-17

Well l ••••••·-·····' 100

640

495

16 486

188

154

24Al... B-110 808 7-0-4

24Bl•.• l B-llOe I 808A 7-0-3

Fo:;f/roeiiimeyer·I

Ranch.

Formerly Bluemle Ranch.

563

r,7 290

12 241 7

7 2235531 277

56

2401••• ·-····-··· ···-····· ••••••••••

2402... B-105k 798F ·--

2403... B-1051 798E 8-D-11

24Dl. \_ B-1051 798D 8-D-10

24EL. B-105h 7980 8--D-9

2244RR2l•..\_ ··B--·l-lO··j--· -8·0·-9·B·--· -7-·--0---2···-

25Bl... B-1101 809A 7-0-1

Howard Brady•••••.•• Mrs. Dorothy Wood•• Howard Brady•••••••• Orcutt.••••••••••••••• Standard Oil Oo•••••• O. Dible••..•••••••••• Superior 011 Oo••••••• Joseph Torino.••••••••

58 100

59 80

57 80.0

59 395

65 429

56 338

58 300

70 140.0

310

7 l••••--1·•••••

5

7

12

10

rn 1·····r····

2501... •••••••••• ••••••••• •••••••••• Mrs. M. Cano••••••••

25Dl•• ·····-···- •.•••••.• - ••••••••••••.•••••••••••

71 I •••••••••l••••••••l••••••I••••••

66

71

25Fl... B-132 290 ···-- A. B. Rozell••••••••••

2501•• B-133r 300B 3-A-1 Formerly 0. B. Haw•

kins.

250\_2. •••••••••• ·-······- ········-· -··-··---··-···········-

250\_3.

·------··· ----····· •••••••••• A. Lermens••••••••.••

71 139282o. I

67 360

67

1*1*2

,·-·······--·,···-·-·-·--·

25Jl••• B-133m 300 ••••••.••• T. Dallape••••••••••••

60 307··-·1·····7···1·········-·-1·········-·-

25Ql••• B-133u 3000 3-A-5

Formerly Weston

50 322

12 •••••• ·-···-

27DL.( B-95d 759

8-D-3

Ranch:

Well 3•••••••••••••

1 108

450

14 303

147

2701•• I B-130d l 260

2-B-4

Well 4•••••••••••••1 95 I 408

### it.::1. ··l· ···l- I... ;: -Qe . : . :1 :

500

: I..'.:.\_\_::\_

27Ml.. B-130e 260A 2-B-6 Weston Ranch, well 7. 27M2•• B-130c 2500 •••••••••• W. E. Oainsley.......

185

140

I M '-- ., !: .

27QL.I B-130f 1260B

28Hl.. B-130b 250B

2-B-7

2-B-2

Ben Weston•••••••••••1162 Well 58. 147

28H2•I• B-130 1250A 12-B-1 I Well 5b••••••••••l • 147

Weston Ranch:

|  |  |  |  |
| --- | --- | --- | --- |
| 257.0 | 7 | 145 | 106 |
| 553 | 14 | 335 | 218 |
| 500 | 14 | 344 | 156 |
|  |  | 278 | 222 |
| 500 ·· | ··15·· |  | .. 238. |

28Jl... B-1308 250 ••••••.••• Well 6. 165

28J2••• --········ ••••••••• •••••••••• Well 9. 185

98............

28J3.•• •••••••••• ••••••••• •••••.•••• Well 185

34Kl •• B-130h 261 •••••••••• ······---·······-··- **300**

See footnotes at end of table.

500

510

240

--------

--------

··212·

100 95

. *zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones t-  Continued | Pumping data | | | Miscellaneous | | |
| Character of material | !a  0, ...  Cl)  ao.=$  a  0 | =  o---  '.C,.,.s.....  A"" | a0.  ::s  ll-t | Use of well | Analyses and measurements | Remarks' |

Sand and gravel

**T. 4 S., R.14 w.-Continued**

T, E Irr **L**



-------------

Qutcksand ------- ------- ---------- A L wi ! o ll 348 (Re

. -------------------- T A Wmd \_

- d : - ==:-:-:-:-:-: :-:-:-:-:-:-:-

*?*P*:.*,I r

t; sd

Gravel and sand

000

T, E

pg L, Wmd, Ws \_

Sand and graveL\_ 900

T, E

pg **L,** W \_

do L, Wmd \_

do--·---------- **A** L, Wmd \_

Sand and fine gravel.

pg C, Cp, **L,** Ws \_

Sandoand graveL\_ 945 1\_3

T,E

Obs

Cpr, L, Wmd,

T,E

do

Ws.

do A L, w wd ! o).ell 351 (Re-

------- P, E Dom, Stock Cpr \_

-------------------- ------- P, E Dom, Stock Cp, W \_

-------------------- A Wmd \_

\_ \_ • Obs L, Wmd, Ws \_

-------------------- ------- ------- Al Ind Cpr, Wmd

-------------------- ---

Irr

---------------------------

T, E Irr------------

T, S Cp, Wmd \_

P, W

Obs Wmd, Ws

SIrtrock. \_ Cp \_

T,E

T,E

Obs Ws \_

Wmd

T,E

IDrr~~om~~  -C--p --\_

P,E

T,I

P,M

- :- === Jiidw

Sand and fine A L, Wsd \_

Sagnrdavaenl.d gravel. A L, W Sand and fine ------------------

gravel.

Sand and graveL\_

P,E

T, E

A

Dom. Irr \_

Dom \_

Dom, Irr,

**L,** Wmd \_ Cp

Cp, , v*t* v sdWmd••••\_

Sand

ObSstock.

L, Wmd, Ws \_

Sand and gravel..\_ ------- ------- Obs L, Wmd, Ws,

do A L,WWwm. d \_

do T, E ---------------- **L---------------**

-S--a-n-d a-nd g-r-a-v-e-l-..-\_-

80-0-

T, -I IArr

Cp-, L \_

, -----do ------- ------- ---------------- **L---------------**

TABLE *26.-Description of water wells in the coastal*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Identification of wells | | | | | Well data | | | Water zones 1 | |
| usos | Serial  No.a | Loca-  tion  No. a | LADWP  No. a | Owner or user | Cl)  'C::s::\_  **:**:**e**:i  < | ...  *'.µ'*  g  .gCl. | ...  Cl)  i  \_a-5  c,,Ei,  A | c:i.  *3*  o.--..  g.'!-'  A | tll tll Cl)  \_C'.µ,)!'  , |
|  |  |  |  |  | A | .Cl  8 |

**T. 4 s., R.14 w.-Continued**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4/14-35Dl.•  35D2.•  35EL.  35E2--.  35FL.  35Jl•••  35KL.  36HL.  36H2.•  36JL••  36J2••• | B-131  --B---1-3-1-a---  B-131b  B-13lc  B-13le B-13ld  B-133  B-133a B-133g B-133q | 271  --2-7-1-A----  271B  281  281B  281A  301  301A  301C  302A | ---------- | Los Angeles County Water Works Dis• trict No. 13.  ..•.do..•••.••.•••.•.••  E. Sidebotham & Son. Los Angeles County  Water Works Dis- trict No. 13.  Southern California Water Co., Oak Plant.  Rancho Mutual Water Co.  Palos Verdes Estates•• Palos Verdes Water  Co.:  Well 1•••••••••••••  Well lA ••••••••••• Well lB ..•••••••••  Formerly Palos Verdes Ranch. | 156  156  178  180  164  181  286  47  41  33  27 | 696  618  585  630  514  500  606  610  793  500  ----·---- | -------- | 60 | 574  --585.  430  ------  461  316  458  653  457  ------ |
| ----------•  2-B-8 | ---·i2··  18 | 0  200 |
| 2-B-9 | 14 | ------ |
| ---------- | 16-12 | 39 |
| ---------- | 14 | 290 |
| ---------- | 26-12 | 152 |
| ----------  3-A-7 | 26-16  16  6 | 140  43  ------ |

**T. 5 S., R.13** W.

|  |  |  |  |
| --- | --- | --- | --- |
| 5/13-lHl •••••.••....•...••••...•.••••••• --··-····-·--·······-··· 40 70  3DL •• B-135o 362 •..••••••. Long Beach Salt Co... 6 116  3D2.•••.••..•......•.••••.•••••••...••••do................. 6 158  3D3... B-135o 362A ••.•.••••.•.•••do................. •.•••• 118 3KL •• B-135f 373 •.•••.•.•• Southern California 6 1,200  Edison Co., Ltd.  **3K2...** B-135g 373A ••••••••••••••.do..••••....•..•••• 7 250  Southern California Edison Co., Ltd.:  3K3•••.••••.•••..•••••••. ····-····- Observation well14. \_ 151  3LL•.••.•....•..•••.••.••...••••••• Well 4----··-·-·--- -- 372  3N•l••..••..•••••••..•..• ···-·····- Well 10----·---··-- -··--· 150  3PL•.• ··--·····- ··-··--·- ·--····-·· Well 13•••••.•..••.•.•••• 150  3P2.•.. ··--·····- ·····--·· ·--·····-- Well 2.•..••••.••....•••. 35  3p3 -······-·· ·--···-·- -·······-· Well 5..•••.••.•.•...••. 155  3p4 -·--·-···· -·-···--- ···-····-- Well 6••.....•.••••. 159  3P5.•.• -·--··--·- --···--·- ----·-·--- Well 3..•••....•••.••••. 35  3P6 -·-·---··· -·····-·- --··-··-·- Well 12•..••..••.•. ·--- 150  3P7.••••..•.••.•. -··-····- •.•..•.... Well 11•••••••••••••••••• 150  3QL.•• ··--·--··- --······· ·-·······- Well 15•••••••••••••••••• 151  3Q2...• -·····-·-- --·--··-- --·---·-·· Well 1....••••••••••••••• 35  4QL.. B-135b 353 City of Los Angeles, 3 470  Terminal Island, well 1.  6DL •. B-133k 312A 3-A-13 Union Oil Co......... 25 1,016  6D2..• B-133w 312B -··--·---- ..•..do................. 24 990  18Jl... B-134i 326 Van Camp Sea Food 3 582  Co. | 16  18-  26-12  24-16  16 | 140 | 14 |
| 65 | 90 |
| 85 | **74** |
| 235 | **86** |
| 600 | 299 |
| **735** | **107** |

**1** Only those aquifers yielding water through perforated sections of the casing are listed.

**2** Assigned by California Division of Water Resources. a Los Angeles Department of Water and Power.

* Altitude of land-surface datum, from topographic map.

5 Depths below land-surface datum indicated in whole feet are reported; those to a tenth foot are measured

**by** Geological Survey.

G Commonly from test at time of well completion; in some cases, however, figure represents estimated current discharge of pump.

7 W-139, Water-Supply Paper 139; name in parentheses indicates quadrangle on which well plotted. LACFCD, Los Angelrs County Flood Control District.

s 4 by 6 feet.

9 3 by 3 feet.

10 5 by 10 feet.

*zone of the Torrance-Santa Monica* area-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Water zones ,\_ Continued | Pumping data | | | Miscellaneous | | |
| Character of material | fa  gi:i,..!  :; El  Cl | =iii:  0  "d Q)  p:$ as'"" A"" | i:i.  El  C1  P-i | Use ofweIJ | Analyses and measurements | Remarks' |

1. ***4* s.• R.14 W.-Con&inued**

T, E PS C, Op, L, W••••

T, E

T, E

Ind•••-••-•\_•• Op, L--···-··--·

PS\_. C,Op, L, Wmd\_

T,E Ind ••••••••••• C, W••••••••••• T, E PS•••••••••••. C, L••••••·--···

.••.••••• A·-·--······-· L, W•.. o•-·-···

T, E PS ..••••.•\_. C \_Cp, L,

wmd, Wrd.

.••.••..•. A............. Op, L, W•••. •

T, E PS•..•.•••••\_. Op, Cr, L, Wm.

---···--·· A ••••••·-····· Wmd\_·····-····

19

••..•••

15

.••...•

.••••••

-··-··-

-····-·

-·-····

1,300

.••••••

1,340

..•.... 1,310

··-·---

1,200

···-·--

850

Sand and GraveL

•••.•do •••••.•••.

•••••do-·- --·

•••••dO----·········

-·--·do•••••••••••••

···-······-----·-·-·

Sand and graveL\_

\_••••do••••\_.\_ •• \_...

Sand and giaveL\_

**T. 5 S., R. 13 W.**

|  |  |
| --- | --- |
| L •.•.•••••••••••  --·········-··-····· .•••... ••••••• P, E Ind••••••••\_•• C, Cpr, Wd••.••  ·····--··----·------ --·---- ----··- ..••...•.. A.·-·····--··- L\_. •••.•••••.•••  Boulders and sand. ··--·-- •••.••• •••.••.•.• A.······-··-·· L .• ··········-··  •••••do.••••••.••••.••••••. ··-·--· -·-······· ••••...•••••.••• Cpr, W•..•..•.•  Obs••..••.• L ---·--·------    Gravel and sand.•..•••..••..••• -·-·----·- Obs ····- L, Wmd••• ·-···  Obs••• ·-···-·· L.·---·-······-·  Obss LWm-d-------··-•--    Sand and gravel. ··-·--- -·----- ·--·---·-- Obs·-··-·----- L, Wmd \_  ·--·-do----·-·---·-- -----·- ------· ·-------·- Obs••·-·-- L, Wmd.-••••••  Obs•••••--···- Wmd·--··-··--· Obs........... L. ·-­  Obs•••••••---· L-··---···--····  Obs·---··----· L -····--------  Obs. Wmd·--·-··----  Very fine gravel. -··---- --··--- --······-- Obs•••••----·· L, Wmd \_  Band---··--------- 454 34 Al Ind ···- Cr, Cpr, Wm.•.  •••••do.••.••..••••• 1,470 32 T, E Ind·---··-·--· C, L•••••••••••.  ••.••••.•••••••..••• ••••••• ······- ······-··· ··--·-····-- Cp,L, W••••••• | W-138, well 998.  W-138, well 882. |

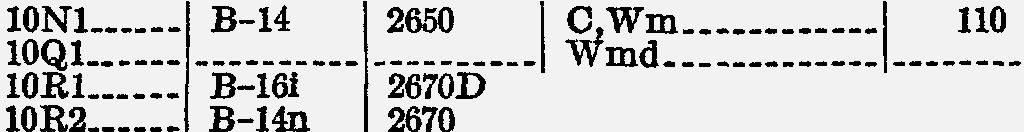


TABLE *27.-Data on wells in the inland zone of the Torrance-Santa Monica area and in the northern 22 square miles (uncanvassed) in the coastal zone* ·

[Analyses and measurements: C, three or fewer "complete" chemical analyses; Cr, four or more "complete" analyses; Cp, three or less "partial" analyses; Cpr, four or more "partial" analyses; L, driller's log or record of cuttings; W miscellaneous water-level measurements; Ws, periodic measurements at about semiannual intervals; Wm, periodic measurements at monthly or less frequent intervals; Ww, periodic measurements at about weekly intervals; Wr, water-level recorder operated currently. Symbol fol• lowed bf "d" indicates measurements discontinued. Serial number and location number: **Assigned by** OalifomIB Division of Water Resources]

|  |  |  |  |
| --- | --- | --- | --- |
| Identifi.cation of wells | Analyses and measurements | Depth (feet) | Owner or occupant and remarks |
| USGS Serial I Location No, No. |

**T. 1 S., R.** 13 W.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1/13-3322JlFL•••• | B-18  B-188 | 2735  2746 | L,W--m--d------------ | 375  499 | Evening Herald.  Los Angeles Examiner Publishing Co., LADWP, well 21-C-8.  Felipe Bollier, W-139, well 998 (Santa Monica). |
|  |
| 32J2 | B-18c | 2746A | L\_ ---------------- | 99 |

T. 1 **S., R.** 14 W.

|  |  |  |  |
| --- | --- | --- | --- |
| 1/14-SPL----- B-llm 2620A  8P2 B-llL 2620  9Nl B-llk 2630  190i-1-.-.---- B-llb 2640  B-14f 2660A  10F2 B-14g 2660B l0HL B-14x 2670B  l0MKIL•••••• B-14d 2660  10M2 B-14a 2650A  B-14v 2650B  I0RL B-16h 26700  l0RL---- B-14o 2670A  I0R5 ---------- ----------  llJl B-14k 2680  11J2 B-14m 26900  12EL---- B-14L 2690B  12E2 B-14J 2690A  12FJ B-141 2690  12Ql B-17d 2700  13EL.--. B-14p. 2691  13Pl B-14q 2692  14DL B-14h 2671  154CMLL •••• B-16L 2671A  B-14e 2661  15D21...•••• B-14c 2651A  15D3•••\_.\_ B-14b 2651  15LL B-14w 2651B  15Pl•• B-14y 2661A  17DL. B-13r 2662A  B-llu 2621A  17EL---- B-13v 26210  18NAlL--.---- B-13t 2622B  1801 B-llf 2611  B-6L 2611F | L\_ •• ­ | 150 | J. B. Schock, W-139, well 625 (Santa Monica).  A. C. Watts, W-139, well 624 (Santa Monica).  J. N. Wilson, W-139, well 617 (Santa Monica).  E. R. Plummer.  Miss Winstanley, W-139, well 298 (Santa Monica).  W. Squire, W-139, well 297 (Santa Monica).  Hollywood Laundry. Reginald H. Jones. Charlie Chaplin.  E. L. Baker, W-139, well 488 (Santa Monica).  Home Ice Co.  Union Ice Co., LADWP well 22-B-3.  N. A. Watson, W-139, well 205 (Santa Monica).  *H.* Kettle, W-139, well 204 (Santa Monica).  A. C. Watts, LADWP, well 22-B-5.  W. C. Fry, W-139, well 273 (Santa Monica).  W. C. Fry, W-139, well 274 (Santa Monica).  H.K. Vickroy, W-139, well 276 (Santa Monica).  H. Devire, W-139, well 278 (Santa Monica).  Mrs. K. T. McFadden, W-139, **well**  279 (Santa Monica).  BM :). W-139, well 424 (Santa Mrs. M. L. Frary, W-139, well 431  (Santa Monica).  w. J. Fay, W-139, well 294 (Santa Monica).  Hollywood Mineral Baths. Hollywood Ice Co.  Sterling Laundry. Rancho La Brea Oil Co.  (Oil well).  City of Beverly Hills.  Sherman plant, well 58, LACFCD, well 2621D.  Garbutt Oil Co. (oil well). City of Beverly Hills.  Mission Water Co. |
| L ••• ­ | 167 |
| L •• - -------------- | 384 |
| Ws ------------  L. -.. ------------- | 120  300 |
| L\_.--------------- | 285 |
| L •• | 401 |
| Wd | 250 |
| L | 259 |
| L | 50 |
| L. | 37 |
| Wmd | \_ |
| L | 275 |
| L •• ­ | 108 |
| L ­ | 291 |
| L\_ ­ | 340 |
| L. ---------------- | 698 |
| L | 540 |
| L\_ ---·- ·-­ | 296 |
| L\_ - --------------- | 65 |
| WWsmd\_d ------------- | ---------------- |
| LC\_r,-L-,-W---s --\_ 2,570  L 270  201 | |

WELL RECORDS 365

TABLE *27.-Data on wells in the inland zone of the Torrance-Santa Monica area and in the northern 22 square miles (uncanvassed) in the coastal zone-Con.*

|  |  |  |  |
| --- | --- | --- | --- |
| Identification of wells | Analyses and measurements | Depth (feet) | Owner or occupant and remarks |
| usos· Serial I Location  No. No. |

* 1. **S., R.14 W.-Continued**

1/14-lSHL B-lln

18H2.. B-6j

18H3 B-13w

18JL B-lld 18Kl B-llr

18K2 B-llq

2611A

2621B

2621D

2621

2611E

2611D

C,L

Cr,L,Ww \_

WCrs,Ld,W-w-- --\_

C,L \_

L. - - --------------

500

**472**

277

565

120

300

L.A.P.R.R. Co., W-139, well 629'

(Santa Monica).

City of Beverly Hills, Sherman plant, well 6A.

Well 7.

City of Beverly Hills.

L. T. Swall, W-139, well 643 (Santa Monica).

*I.* A. Swall, W-139, well 640 **(Santa**

18K3 \_

B-llo

2611B

L 500

Monica).

18KL

18K.L

18NL

\_ B-llp

\_ B-llbb

\_ B-lls

26110

26110

2602D

LCr ,Ws--------------

L

300\_

153

W-139, well 637 (Santa Monica). W-139, well 639 (Santa Monica).

City of Beverly Hills.

Hammel & Denker, W-139, well ***641***

19Dl \_

B-llc

2602B

(Santa Monica).

19D2..

\_ B-llaa

2602E

LC.r,-W--w --\_

616

City of Beverly Hills.

19D3 \_

19Jl \_

19J2 \_

19J3 \_

19ML \_

B-lle

B-68 B-6u B-6h

B-llg

26020

2613E

26130

2613D

C,L,Wmd \_

Ww

Wm Cr,Ww

616

576

367

324

400

Do.

Beverly Hills Ice & Cold Storage Co.,. LADWP, well 22-A-12.

City of Beverly Hills.

Do.

Do.

19RL.. \_ B-llz

2603

L 252

**R.** C. Holly.

19R2 \_ l9R3

B-6g

B-llcc

2613B

26130 (2613F)

Lw,W!'d 330301

City of Beverly Hills.

Do.

Do.

19&4 B-llv 20CL B-13s

20DL B-lli 20ML B-6i

21EL B-13n

21Fl B-13m

21F2 B-13j

26131

2613A

2622A

2622

2623B

2632

2642A

2642

L,Ww \_ L ---------------

Cr,Cp,L,Wm \_

L-- ---------------

L\_ ­

L ­

450

1,930

150

290

**3,229**

2,496

200

Do.

Garbutt Oil Co. (oil well). William Niles.

City of Beverly Hills.

Tidewater Associated Oil Co. (oil well).

Tidewater Associated Oil Co.

Do.

21JL B-13k

21LL B-13L

21L2 B-13i

21PL B-13q

22CL B-13p

22EL B-130

2301 B-148

**23Hl** B-14t

231!2 B-l4u

24BL B-17j

2653

2643A

2643

2643B

2662

2652

2683

2682

2682A

2702A

L ---------------

L. ----------------

L ­

L\_ ­

L ­

L ­

L\_ ----------------

L\_ ­

L. ----------------

**875**

**1,817**

323

1,233

1,220

1,342

45

834

932

Do.

Tidewater Associated Oil Co. (oil well).

Tidewater Associated Oil Co. (Oil well).

(Oil well).

Tidewater Associated Oil Co.

J. L. Plummer, W-139, well 458 (Santa Monica).

Geo. Simmons, W-139, well 459 (Santa Monica).

Geo. Simmons, W-139, well 460 (Santa Monica).

24CL B-14r

24JL B-171

26NL B-15L

2692A

2700

2675

L 625-

L 65

W. P. Moon and Co.; W-139, well **431**

(Santa Monica).

E. Jennison, W-139, well 503 (Santa Monica).

27NL B-15m

28Ct B-13u

29CL B-lly 29Dl B-llx

29D2 B-llw

2655

26430

2623A

2623

2624

L\_ ­

L. ----------------

L, Wsd L, Wsd

L, Wwd

870

2,580

433

421

(809)

382

Rosedale Cemetery Association, W- 139, well 538 (Santa Monica).

Utah-California Oil Products (oil well).

City of Beverly Hills.

Do.

Do.

29Kl ---------- ----------

30AL.... B-6u 26130

Wmd \_

Wmd

K. H. Whitworth, LADWP, well 22-A-9.

City of Beverly Hills, LADWP, well

*Eg:*

30A2 B-6t 2613F Wsd \_

30A3

B-6v 2613H.•• Wsd \_

419

315

2 A-6. =•

30A4 B-llj 2614A L \_

ggat:::: \_! ! W Wsd 30HL B-llh 2614 --------------------

150

318

160

61

J. H. Whitworth, W-139, well 515 (Santa Monica).

City of Beverly Hills. LADWP, well 22-A-11.

J. H. Whitworth.

**366** GEOLOGY, HYDROLOGY, TORRANCE-SiANTA MONICA AREA

TABLE *27.-Data on wells in the inland zone of the Torrance-Santa Monica area and in the northern 22 square miles (uncanvassed) in the coastal zone-Con.*

|  |  |  |  |
| --- | --- | --- | --- |
| Identification of wells | Analyses and measurements | Depth (feet) | Owner or occupant and remarks |
| USGS Serial I Location No. No. |

**T. 1 S., R. 14 W.-Continued**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1/14-35FL  35ML  35p1  36DL  36Ml | B-15g B-15h  B-15r B-15j B-151 | 2685 | | L\_ - --------------- | 235 | F. W. Marshall, W-139, well **146**  (Santa Monica).  Otto Wilhelm, W-139, well 147 (Santa Monica).  Kravchyk. Henry C. 1ensen.  Ferdinand Hohn, W-139, well 160  (Santa Monica). |
| 2676  269856B | | L\_ - ---------------  Ws.  L\_ - ---------------  L. - --------------- | 159  281  66  125 |
| 2696 |  |

**T. 1 S., R.** 15 **W.**

1/15--14DL. B-68

14D2 B-6

22NL B-6o

2570

2571

2553

Wsd\_ Ws

L

150

96

3,003

Carl Laemle, LACFCD, well 2560A. Harold Lloyd.

Amalgamated Oil Co. (oil well).

23FL. B-6b

2573

\_w 300

Los Angeles Country Club.

24Al B-11

24A2 B-lla

24ML B-6c

2602

2602A

2583

wL. -\_ 6-4-7-

Wsd --------

Continental Baking Co.

Beverly Glove Division, Calif. Con­ sumers Co.

Beverly Hills Nurseries.

2501 B-6k

25DL B-6m

25FL B-6n

2501. B-6x

2594B

2583A

25940

2594D

C, Cp,L, Wwd

LL Wmd\_

450

2,745

4,168

500

City of Beverly Hills, Roxbury plant, well 1.

West Coast Oil Co. (oil well). (oil well).

City of Beverly Hills, LADWP, well 23-B-1.

25KL B-6e

2594A

\_w 750

Hillcrest Country Club, well 1, LADWP, well 23-B-3.

25K2 B-6d

27NL B-7b

27N2 B-71

27N3 B-7h

2594

2555B

2555E

2555D

Wmd, Ws

wL ----------------

L\_ - ---------------

720

70

525

well 2, LADWP, well 23-B-2.

H. K. Laird, W-139, well 726 (Santa Monica).

Pacific Land Co., W-139, well 704 (Santa Monica).

28BL B-le

2544A

\_w --------------- --------

28B2. B-la

28B3.\_ B-lf

29CL. B-ld

29GL B-1

2544

2544B

2523

2524

c, Wmd 300

Wsd --------

W\_Ws-d-.------------- --------

United States Government Soldiers Home, well 11, LADWP, well 23-A-1.

Do. Zukin.

Charles Goodwin.

30ML. B-lc

.32AL B-4f 32A2 B-4z

2504

2535B

2535F

L, Ws C,

Ws

w

289

200

250

Los Angeles Athletic Club.

City of Santa Monica, Arcadia plant•

Do.

32A3 B-4g

2535C

Wsd --------

Do.

32BL B-2j

2525

LL 2,510

Union Oil Co. (oil well).

32FL B-2k

2525A

4,587

Birch and Royer (Santa Monica &

Sawtelle Oil Co.) (oil well).

32LL B-2f

32QL B-2e

32Q2 B-2d '32RL B-4v

2526C

2526B

2526A

2536B

L\_ ­

L. - - --------------

Wsd, Wmd

170

99

----igi)"

Philip J. Flynn, W-139, well 896 (Santa Monica).

Dunham, W-139, well 893 (Banta Monica). ·

W-139, well 892 (Santa Monica).

H. T. Maloy, **LADWP,** well 23-C-9.

32R2 B-4x

33BL B-4t

2536C

2545D

WL\_-\_ 1490

Maloy.

Artesian Water Co., W-139, well 887 (Santa Monica).

33B2.. B-4r

2545B

L\_ ­

140

Artesian Water Co., W-139, well 882 (Santa Monica).

33B3

.33B4

B-4s

B-4q..

2545C

2545A

L\_ ­

L ­

300

268

W-139, well 883 (Santa Monica). W-139, well 881 (Santa Monica).

33B5.. B-4p

'33DL B-4e 33D2 B-4h

33D3 B-4

33DL•.•• B-4o

'33GL B-4aa 3311\_ B-4L

.33J2 B-7q

2545

2535A

2535D

2535

2535E

2545E

2546F

2556F

L\_,W --\_

Wsd L

w ­

L. - ------------- --

L\_ ----------------

89

200

300

186

173

83

103

W-139, well 880 (Santa Monica). City of Santa Monica, Arcadia plant.

Do.

Do.

Artesian Water Co., W-139, well 874 (Santa Monica).

Giuliano.

L. P. Heldman, W-139, well 757 (Santa Monica).

J. C. Charles, W-139, well 756, (Santa Monies).

TABLE *27.-Data on wells in the inland zone of the Torrance-Santa Monica area and in the northern 22 square miles (uncanvassed) in the coastal zone-Con.*

|  |  |  |  |
| --- | --- | --- | --- |
| Identification of wells | Analyses and measurements | Depth (feet) | Owner or occupant and remarks |
| USGS Serial I Location No. No. |

**T.1** S., **R.15** W.-Continued

1/15-33.T3 B-4m

33KL.•.•.

33K2••• B-4a

33Ll B-4w

33NL. B-4n

33p1 B-4u

33QL\_ B-4j

33Q2 B--4c

33Q3 B-4b

25460

2546D

2546

2546H

2536

2536A

2546E

2546B

L•• ---------------

Wmdd. --\_

L. --·

**L,W \_**

Wsd

Wsd

200

150

200

300

280

150

150

J. K. Thomas, W-139, well 763, (Santa Monica).

J. L. Edmonds.

Wm. Campbell, LADWP, well 23-C-

10.

Jasper Thomason, W-139, well 767 (Santa Monica).

H. T. Maloy, W-139, well 894 (Santa Monica).

Ogden Estate. Armacost Nurseries.

33RL B-4d

2546A

Wsd --------

Do.

3401.. B-7g

3402 B-7a

25460

25550

**L,W** \_ 231

Sawtelle Laundry.

M. G. Le Page.

3403 B-7

2555A

-W--s-d 5-0--0-

34EL. B-7k

2555

25550 L

94 **A.**

Do.

Wiseman, W-139, well 734 (Santa

34ML

34NL

34N2

34PL.

34P2

B-7n 25560 L

Monica).

86 D. Kennedy, W-139, well 747 (Santa Monica).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| B-7o | 2556D | L\_ ­ | 83 | J. B. Mallory, W-139, well 752 (Santa  Monica). |
| B-7p | 2556E | L ­ | 76 | Geo. W. Lavell, W-139, well 753 (Santa  Monica). |
| B-7L | 2556A | L\_ ­ | 82 | E. H. Thombrue, W-139, well 738  (Santa Monioa). |
| B-7m | 2556B | L\_ - ----------- ---- | 160 | D. L. Allen, W-139, well 739 (Santa |

34p3 B-7e

34p4 B-7t

2556

25560

LW, \_

Ws \_

200

350

Monica).

(Ballona Water Co.) L. E. Ogden, LADWP well 23-D-39.

(Ballona Water Co., well 2), Martin,

34p5..

---------- ----------

Cp, Wmd \_

LADWP, well23-D-40.

Ballona Water Co., LADWP, well

34QL\_ B-7c

34RL B-7r

35EL B-9v

35KL B-9f

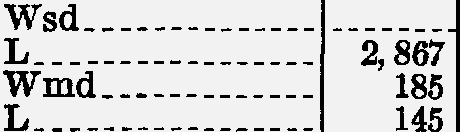
2566

*2566B*

2576D

2576

23-D-43.

E. D. Gill, LADWP, well 23-D-38. Amalgamated Oil Co. (oil well).

J. R. Savichi, LADWP, well23-D-37.

E. R. Taylor, W-139, well 685 (Santa

35K2 B-9o 2576B

Ws, Wrd \_

Monica).

35NL B-9i

2576A

L 319

Mr. Bain, LADWP, well23-D-36.

C. Wicks, W-139, well 784 (Santa Monica).

**T.** 2 S., **R.** 13 W.

|  |  |  |  |
| --- | --- | --- | --- |
| "2/13-5AL B-19n 2747A 5FL B-19g 2737  5HL B-19o 2747B  5NL. B-19b 2728  6RL B-19a 2727  6R2 B-19f 27280  6R3 B-19c 2728A  6RL B-19d 2728B  7BL B-19 2718  7LL B-19k 2719  7Rl B-191 2729  18LALL.• -- B-55d 1430  B-19i 2729A  18CL B-19L 2719A | L \_ | 275 | Service Towel and Linen Supply Co. Angelus Hospital, LADWP, well  21-C-7.  Jefferson Ice Co.  Globe Ice Cream Co.  Globe Ice Cream Co., LADWP, well 21-C-2.  George Zobelein, LADWP, well 21- C-1.  W. T. Austermell.  A.H. Brocamp, W-139, well 110 (Santa Monica).  Los Angeles Railway Co.  Fred Espe, W-139, well 112 (Santa Monica).  J. W. Sommerville, W-139, well 126 (Santa Monica).  Los Angeles Department of Water and Power, Figueroa plant, well 5.  Well 1.  Well 2. |
| L\_ --------------- - | 285 |
| C,L \_ | 408 |
| L\_ -- -------------- | 300 |
| L,Wmd,Ws \_ | 151 |
| L\_ - - -- ------------  L. - - - ----- -------- | 60  171 |
| L -- --- | 428 |
| L. - -- --------- - --- | 64 |
| L. - - -- -- ---- ---- -- | 98 |
|  |  |
| 18PL. B-50 1411 | C,L,Wd \_ | 536 |
| 18QL -------- ------------ | cc',LL,,wWdd -\_-\_--\_-\_-\_-\_-\_ | 610 |
| 18Q2 -------- ------------ |  | 530 |

36$ GEOLOGY, HYDROLOGY, TORRANCE-SANTA MONICA **AREA**

TABLE *27.-Data on wells in the inland zone of the Torrance-Santa Monica area and in the northern 22 square miles* (*uncanvassed') in the coastal zone-Con.*

|  |  |  |  |
| --- | --- | --- | --- |
| Identlflcation of wells | Analyses and measurements | Depth (feet) | Owner or occupant and remark& |
| usos SerialI Location No. No. |

**T. 2** S., R. 13 **W.-Continued**

|  |  |  |  |
| --- | --- | --- | --- |
| 2/13-18Q3 ·-· --··--·-·· --·--····-  18Q4---·-· -·-·-·-··- --·---·---  18RL\_. B-55f 1420  19ML••. \_ B-51 1402  20DL B-55 1421  20D2 • B-55e 1421B    20D3-·-·-- B-55a 1421A  20HL•• B-55b 1431  20H2 B-60 1441  20JL.\_•• \_ B-61 1442  20KL•• B-55c 1431A  20RL•• B-6la 1442A  29AL\_. B-6lb 1442B  29HL•••\_ B-6le 1443B  29H2\_··--· B-6ld 1443A  29PL\_ ••\_ B-56a 1433A  29P2 •• B-56 1433 | C,L,Wd\_ •••••••\_. C,L,Wd.··---··--  L\_ ---------·······  L\_ -·-·---··-- -·-· L•.• -------·------ | 530  560  462  80  300  540 | Los Angeles Department of Water and Power, Figueroa plant, well 3.  Well 4.  Southern Service Co. Mrs. McKenzie Manning. Peerless Laundry.  Do.  Goodyear Tire and Rubber Co., well 3.  LADWP, well 314.  Well 4.  Well 5.  Well 5.  Well 5.  Well 3.  Well 3.  O. A. Nelson, W-139, well 632 (Radon• do).  Los Angeles Department of Water and Power. |
| C,L-----------··-- 260  L •• ----·· 328  L.·--·-··--·-···-· 193  \_L. ··--··--·-·--·- 224  L--····-··--- 195  L.·---··------· 201  L--···---·----·· 165  L ••• ---·-·-·---· 166  L •• ·-····-·--····- 93  560 | |

**T.2S., R.14 W.**

2/14-lML\_ •• B-15k

1M2 B-15p

2AL ••• \_. B-150

201-.••••• B-15a

2ML •.••• B-15b

2697

2697A

2686A

2686

2677

Op, L--···---···--

L\_ - ----···---·-·--

{v;Xs.• ··-- ·-

L\_ •. ---·- ·-

80 O. H. Paine, W-139, wen 193 (Santa Monica).

154 G. W. Johnson Laundry. 868 Daniel Murphy.

347 Artesian Water Co., W-139, well 37

(Santa Monica).

TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica area*

[Based on drillers' records except as indicated. Stratigraphic correlations by Allen Sinnott and J. F. Poland}

**1/14-19D3. Beverly Hills Ice and Cold Storage Co.**

[Abont one-half mile east of Beverly Hills, altitude, 224 ft. Driller's record, with modifications based on sample descriptions by F. B. Kelsey of California Division of Water Resources. Perforations and yield not known]

|  |  |  |
| --- | --- | --- |
| Material  Dep<>sits of Quaternary age, undivided:  Fine sand, buff, argillaceous, contains a few pebbles.·-······-·-- ­  Gravel to 2 inches in diameter, and some clay··--·········-·-·---····--··-·-·· | Thickness (feet)  44  6 | Depth (feet)  44'  ro |
| Sandy clay, brown, and graveL ·-------··-··--··-·····------··-·----··-·-·--·· | 18 | 68 |
| Gravel interbeddea with streaks **of** clay···-······-····---·····--··--····--···· | 4 | 72" |
|  | 12 | 84. |
| : fma11graveL.·--------·---·------·---·--·---······---·-- ·- | 4 | 88 |
| Sandy clay, dark-blue, with a few small granitic pebbles•••...•·---··-···-····· | 6 | 94: |
| S!anydyacl•a;y!,!1!ai **few** pebbles ······-····-···--····-·-·--···--- ·----···-  brown, Wlth granitic pebbles••·--·-·-···-·-······--······----···-· | 24  30  14 | 118  148,  162' |
| Sand, brownish, decomposed granite with small slate pebbles-·····-······--··· | 8 | 170• |
| Silt, mottled brown and gray, with sand••••·-·-·······-··-······-···-···-·-··· | 1 | 171 |
|  | 2 | 173 |
| *:* andgravel::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | 2 | 175 |
| Sand and gravel.. ··- .. -•--·.-· ·---·. -····.\_....-······-···...•••••••••. | 5 | 180 |
| Silt, blue-grayt micaeeous, with a **few** granitic pebbles..• ·--·-·····-···- ­ | 28 | 208 |
| Silty clayj darK brown, micace.ous, with a few granitic pebbles•••·-···-·--····· | 32 | 240, |
| Silt, mott ed gray and orown, micaceous, with slate pebbles to one-half inch in |  |  |
| diameter.\_... ·-····-... \_·--·-··.. -···-·--··\_-·----·.. -··-- - ·-·-·-·- | 8 | 248 |
| Clay, brownish, imbedded with slate and granitic pebbles to one-half inch in |  |  |
| diameter. .....•...-·.•.... •. \_-·-·•••-·..••\_.•..•.\_•••••• \_....·-.•• -·.\_ | 6 | 254,, |
| Clay, hard.••••...-··....--· ......·-·-····\_-····-····-·- ··--··- ·- | 8 | *262* |
| Silt, chiefly brownish, imbedded with slate pebbles and granitic sand\_··-·-···· | 52 | 314' |

TABLE 28.-M*aterials penetrated by typicaz' wale wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**1/14-19D3. Beverly Hills Ice and Cold Storage Co.-Continued**

|  |  |  |  |
| --- | --- | --- | --- |
| Material | Thickness (feet) | Depth (feet) | |
| Deposits of Pliocene(?) age, undivided:  i !;- I tF J. ? :ae; : ;w1iliiomesiii-and1mtedde<fw1tii-arew-  pebb1es ---- --- --- ---- \_ -- --------------------------  Coarse sand and fine gravel, containing pelecypod shells \_  Fine sandkdark blue gray, containing pelecypod shells \_  !: !y /d and10080---------------------- ---------------------------------  Silt, light and dark gray, with a few pebbles \_  CoaayrsaensdangdraavnedL ~~gravel to2~~  ~~inches in~~ d-i-a-m-  ~~et~~e-r --\_  Medium sand, gray, with a few pebbles and gastropod fragments \_  Silt, gray, micaceous, with fine sand ana pelecypod shells \_  Clay, blue-gray, arenaceous and mlcaceous, with a few pebbles of granite \_  Sand and gravel to 4 inches in diameter, containing a few gastropod shells \_  Silt, bluish-gray, arenaceous and micaceous \_  Sandy clay \_  Sand and gravel to 1½) inches in diameter; lower portion contains boulders 8  Clianyc,hebsluien, dwiaitmheptelecypo.d fragments --\_ | 20  32  18  2  6  2  1  41  10  2  14  6  32  20  10  2  30  14 |  | **334**  366"  384  386  392  394  395  436  446  448  462  468  500  520  530  532  562  576 |

2/14-3M2. **Formerly Artesian Water** Co.

(In Ballona Gap north of the Baldwin Hills. Altitude 103 ft. Perforations not known.

gpmin 1903]

**Reported fl.ow 450**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Alluvial deposits: | | | **22**  **50**  **1**  5  **14**  **18**  **50**  10  56  2  **15**  **29**  **96**  16  **4**  **67**  **16**  7  5  35  **4**  **18**  28  **12**  **4**  86  **1.5**  **2.5**  **6**  5  5  **6**  **6**  **42**  **16**  10  **31** | **22**  **72**  **73**  **78**  **92**  **110**  **160**  **170**  226  228  **243**  **272**  **368**  384  **388**  455  **471**  **478**  **483**  **518**  **522**  540  **568**  **580**  584  **670**  **671.6**  **674**  680  **685**  **690**  696  **702**  **744**  **760**  **770**  **801** |
| "50-fSoooitl agnradvcel"y: .--------------------------------------------------------------- | | |
| Gravel and coarse sand \_ | | |
| Unclassified: | | |
| 8 e1 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | | |
| . | | :gtreaks **of** clay ----------------------------- |
| Coarse sand. • ----••- \_ •  ;:s ;•b e:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::  Clay, yellow -- --- \_--- ------- --  San Pedro formation:  *m*C*g*l*:*a*z*y*r-*,*:*b*:*lgue :!?e"!:1J. .\_.:::::::-:::-:-:\_:-: :::::::::::::::•:• :::•:•:•:•:•:\_:.:•:-::::-:-::  bt\_,....  iEi: t:arse sand------------------:·------------- ---------------------- | | |
| GFirnaeveslanad~~nd sand~~ **~~with~~**~~a few st~~r.~~eaks~~ **~~of~~** c-l-a-y --\_  Fine sand • --------------------------------------------  Sandy clay --- -----------------------------------------  "Cement" • -- \_ -- -- \_--- - - \_- --- - - -- - -- - - --- - - - - . -- - - -- - -  .**C**G**l**r**a**a**y**v**,**elhard • --- ---- \_-- \_. - \_-- -- \_ --\_  Sand, some gravel ------------- ---------------------.------------  . hard ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | | |
|  | SGarnadv.e.L . • • -. ----- •-- -------- • ---- - - - - - - ------ ---- --- -------- --- | |
| S8a?nvd.-. er:i sand\_::::::::::::::::::::::::::::::::::::::::::.:. ::::::::::::::::::\_: | |
|  | |

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TABLE 28-.

*Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

2/14-5D6. Southern California Water Co., Venice-Culver City **system,** Sentney plant well 6 (In Ballona Gap, north of the Baldwin Hills, altitude 88 ft. Casing perforated at 326-342 ft, and

492-515 ft]

|  |  |  |
| --- | --- | --- |
| Material  Alluvial deposits:  Soil••.•...-··••.••.••.·-•. \_.\_ ....•.......•\_ •.••..•.•••....•••.•.....•.\_...•..•• | Thickness (feet)  9 | Depth (feet)  9 |
| Sandy clay•............•....•....•........•..•.......-···-·····..•..•••. \_.. | 14 | 23 |
| Sandy gravel to one•half inch in diameter.••.......•...•.••.••............•...• | 12 | 35 |
| SanPedro formation: |  |  |
| Clay, green•••••••••••••••••••••••••••••••••••••••••••••••.•••.••••••••.••••••• | 33 | 68 |
| Clay, blue••••.•••...... .....•......••..\_....•..•.....•.......\_.•••...••... | 16 | 84 |
| Sand and gravel to 1 inch in diameter••.•..•..•.......•......•......•....•.... | 7 | 91 |
| Clay, blue.......······-···-....................•.•.......•.•••.•..••. •. | 70 | 161 |
| Sand and gravel to H2 inches in diameter...................................... | 17 | 178 |
| Clay, blue........•.....•..............\_.. \_....\_. .......••........•......•... | 4 | 182 |
| Fine sand, muddy, with some one-quarter•inch gravel......................... | 8 | 100 |
| Fine sand, muddy•••••••.•....•....•.....•..••...•.....•.•.•••......••........ | 11 | 201 |
| Clay, blue.•............•.........\_.. \_.\_ .......••..•.•...•••...............•... | 21 | 222 |
| Sand and gravel to 2 inches in diameter; some shells........................... | 10 | 232 |
| Sand and gravel to one•half inch in diameter; some shells...................... | 14 | 246 |
| Sand: some gravel to one-quarter inch in diameter............................. | 7 | 253 |
| Sand and gravel to l½ inches in diameter...................................... | 4 | 257 |
| Clay, blue.............••.......··--·-···......•......................•. ••• | 56 | 313 |
| Sand and gravel to 1 inch in diameter ••••.....•..•.•..•.............•......... | 2 | 315 |
| Clay, blue.•.....................·······----..............•..•................. | 11 | 326 |
| Sand and gravel to l½ inches in diameter••.•..............•................... | 16 | 342 |
| Clay, very sandy.......•.......•••...•.......•.••••.......•................... | 14 | 356 |
| Silt, fossiliferous, blue•••.....•••••.•......•....•.•.••••...............•....... | 9 | 365 |
| Clay, blue.............. ....•.•.•..•••...•...............••.•.•. •• | 79 | 444 |
| Fine gravel, muddy, to one•quarter inch in diameter.......................... | 4 | 448 |
| Fine sand, muddy......•...•...•.•.•••..•......•..•....•...........•. •..\_ | 20 | 468 |
| Sandy clay•...........••.................•.....•.•.•.....•....•...........•... | 24 | **492** |
| Clay and gravel to 2 inches in diameter••...........•.....•..•••............... | 8 | 500 |
| Sand and gravel to 2 inches in diameter...•..•..............•....•............. | 10 | 510 |
| Sand, muddy. ••.•..··----··...............•.•.............................. | 35 | 545 |
| Unclassified: |  |  |
| Sandy clay•.•. .•....••.•\_....•....•...•.•.........•.•.•.•....•...\_ ••• | 57 | 602 |
| Clay, blue.•..........•..•...........•..•...••......•.•.••••••. •.• | **208** | 810 |

2/14-23H2. City or Los Angeles, Manhattan plant well 3A

(About 3 miles northeast of Inglewood, altitude 137 ft. Casing perforated at 455-480, 495-520, and 725-775ft.

Yield on test 3,050 gpm with drawdown of 40 ft]

.Alluvial deposits:

Soil.•••......•\_ .•.••....\_.•........\_ ..•••....\_.•........•.............•........

Clay, gray, soft.....•.••.............••••.•..•....•.....•. •

Unclassified:

Sf:aan1dr y:\Tculat yt,· b=lu=e=,=h=a=r=d=•=••==··=·=·=·=·=-·=·=·=·=·=··=·=·=-=·=··=·=·=·=··=·=·=·=·=··=·=·=·=·=-·=·=·=·=·=··=·=·=·=··=·=·=·=·· Fine sand, blue..••..•...•...............•.•.........••............••..........

Clay, blue, hard••........................••.•.......•.•.•.•••......•...•...•..

Silt, blue......................•...............•......•.••••.•. ••.

Sandy clay, blue.•••..............••..••....•. ..··-·.

lft! lt l\_::::::::::=:::=:=::==:::::=::::::::::::=::::::==::=::::=::=:

**Ban**

Pedro formation:

Coarse sand.••.............•....................••................•........•..

Fine gravel.................•.............···-····.. ···········-··-·-.•........

r:1 1l :ieL..**·**·-**·**·-**····**·**·**··**··**···**·**·**·**·**·**···- -**·**-**·**

Coarse sand.•...............•...••..•.••••.••...........•..•.•. •.

r:lr:w0 ================= === ======================================

Clay, blue, hard..................•.............•..•..............•. !

°i: ernow.-..•...-........................•..............-...........

Fine gravel.......•....•.....•....................•................•...•··••··•

Sandy silt, wet..••.•......\_ ......•........•......•...••..............•........

Coarse gravel..............\_ •....................•.•...........................

4 4

22 26

36 62

11 73

7 80

6 86

**8** 94

55 **149**

19 168

33 **201**

33 **234**

|  |  |
| --- | --- |
| 6 | 240 |
| **28** | **268** |
| 10 | **278** |

9 287

5 292

19 311

5 316

15 331

15 346

22 368

27 395

4 399

36 435

14 449

11 460

19 479

9 488

**13** 501

TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**2/14-23H2. City of Los Angeles, Manhattan plant, well 3A-Continued**

Material

Thickness Depth (feet) (feet)

San Pedro formation-Continued

g rsl c:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

te*§ :* = === === ==== ===== === === ==== === === ==== === ==== ======= === ===

Sandy clay, yellow•.••.•-·-·-···-··-·--·····--······-···-·-···-·-··- -·-··-

Sand, cemented ••• ··-·-···-·....-····-\_ ..\_.. ............\_.. .....\_-···....-···\_

Fine sand•••.\_. .. \_.. \_. .....•. .\_.. .. \_.. \_.. \_. .\_.. \_.. .. -· .. \_.\_ ....

Clay, blue, hard••...••.····-·...\_.. ......·-\_.-···-··· .·-·-···-·.-····-··--· Peat.....•...·-···.•.••.•-.•...----- ... -... --. -.. -. ·--.--- -.. --... -. -.. - •..-

Clay, blue, hard-•.. -·-····............\_····-·.-··\_.\_.-·-.\_-·.-··-...•...-··•..

Sandy clay, blue.•• ···-··.-··---.....-··.\_ .........-···... ... -·. ·.•. ·-

!!! .s : .1::jshells•••....-···-.....•....-·-·... ·-··-... ·-·······-·- ·-·-

Clay, blue, and gravel••...•...........·-·························- ·-

Clay, blue, hard... ... -·-·.......--···.• --.....·-·········-·-.·-···-·---· --

Coarse graveL.•. --···---··\_-· --·-·-- -·---·-·--·---·- -·-··-·· \_

2

15

6

7

16

7

9

7

5

14

2

18

12

39

14

2

44

51

25

503

518

524

531

547

554

563

570

575

589

591

609

621

660

674

676

720

771

796

Unclassified:

Sand and shells..• \_-·-·-·-------·-- ·--·-·-·... ·--\_.·····-... -··-.-·-\_··-

|  |  |  |
| --- | --- | --- |
| Silty sand. -··-·-·\_·--··-··-···--·-····-.\_.. ...........••.···- ....\_-· \_ | 22 | 818 |
| Clay, blue..• -···- .. \_.--·. .\_.. ......\_-···-··-··....-·········...•. .-· | 9 | 827 |

2/14-27D1. **City of Inglewood well** 7

[About 1 mile northeast of Inglewood in Centinela Park, altitude 145 ft. Casing perforated at 100--115,

135-159, 177-191, and 245-265]

Deposits of upper Pleistocene age, undivided:

Clay..........\_.. \_.. \_ ... \_...........\_ .. .. \_........\_ .. \_. -·\_ •. \_•..••..\_.• .

Sand, cemented .• -·····..........-·--······-...........······--····-···-···--·

GraveL •. ---··-······- -················--.·-·.-··-·····-···-· ••..••••.-·

**Clay --· .. -···-··... \_ .......--·\_ ..........\_ ....·-·......\_ ....................**

GraveL ....•........\_..•.\_ ...•................•.........•.......\_.....··-··.. .

SanGravel, cemented .. ···-·····-·····-·····-······--········-·····-····-·····-·

Pedro formation:

Clay.\_ ..........·-..•.•...•.\_..•....\_... \_.. \_.. \_ .••...•..•.•..••··-·.•. \_.••...•

8r:;el,.cemented •. :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Sand, cemented\_ ... -·······-·····...................\_····-·····--··-··········

Silverado water•bearing zone:

Clay, blue.·-···-···········-·····-····......•-·····-·········-·············...

Coarse gravel.\_....•\_.......... .•.........··-..•....•.....-·.....•...•...•...

Sand, cemented••..•..• ......\_.. ....--•\_•.•..••.\_......·-·-.··-.· ·.

Unclassified:

Silty sand.\_ .•. ·-· ....-·... -·\_.• ... -·\_··-.••.....•...·-·....\_.. ....·- •.•

24

36

10

8

2

35

20

24

18

14

54

20

1

34

24

60

70

78

80

115

**135**

159

177

191

**245**

265

266

300

**2/14-27Jl. City oflnglewood well 16**

[About 1 mile west of Inglewood, altitude 234 ft. Casing perforated at 236-283 ft. Yield about 450 gpm; drawdown not known. Driller's record with modifications based on sample descriptions by F. B. Kelsey of California Division of Water Resources]

|  |  |  |
| --- | --- | --- |
| De ll:g fE; eistocene age, undivided:·-······--·--····-··- -··-··--·· | 4 | 4 |
| Fine sand and clay, yellow.\_ ....•.........\_.. \_..•....•.\_•. •.\_. | 13 | 17 |
| Medium sand and clay, yellow.........•··-··-·······-···-···-······-····-···· | 1 | 18 |
| Sand, yellowish-gray, and gravel to 2 inches in diameter..............•.•..... | 4 | 22 |
| Sand and gravel to 2 inches in diameter .. ·······--···-········-··············· | 31 | 53 |
| Silt, light-gray, streaked with fine micaceous sand. . ······-·-·-·---···· | 1 | 54 |
| Clay, greenish-gray, with coarse sand and gravel to 3 inches in diameter···---· | 7 | 61 |
| San Pedro formation: |  |  |
| Sandy clay.·-·.·-··....··-···.. ·--·-·........······---··--· ................ | 33 | 94 |
| Coarse gravel mixed with clay·····-····-··-············--···-·-·--···-·---···· | 6 | 100 |
| Silt, light•gray, laminated .•..•...............·-··..•.···-····- -··--·-··..  r g:; bl f :rus::::::::::::::::::::::::::::::::::::::::::::::::::: | 5  26  8 | 105  131  139 |
|  |  |  |
| !;11;:U: v iue.::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | 7 | 150 |
| Sand, light-gray, gravel to 4 inches in diameter.......•..........•...•..\_..•..\_ | 7 | 157 |
| Medium sand, gray, with calcareous clay and sand concretions, weathered |  |  |
| schist pebbles and lignite fragments.··················-···--·-·······-······ | 27 | 184 |

4 143

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TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**2/14-2711. City or Inglewood well JG-Continued**

|  |  |  |  |
| --- | --- | --- | --- |
| Material | Thickness (feet) | | Depth (feet) |
| **San** SPieltd, rgorafoy,r mictaioceno-uCso, nantidnufiende sand \_ Fine to coarse sand, and gravel to 6 Inches In diameter, with silt and lignite  fragments\_------------------------------------------------------------------  Unclassified:  SBioltu,ldgerarsy,omf gicracneitoeuas,nwd istahnldisgtnointee firmagbmedednetds  ~~In g~~-ra-y--s-i-l-t --\_  Silt, gray, micaceous; shell fragments at about 575 feet \_  Silt, dbalurke--graayy,, miccaacceeoouuss ------------------------------- \_  Silt, very hard -  Sandy clay - - - -- - -- -•- -- -- -- - -- - - -- - -------------------\_---  Fine graveL. --- ---  Very coarse gravel, and gas \_  Clay, fine sand, and gravel to6 Inches In diameter \_ |  | 52  47  123  6  298  276  20  5  45  2  1  14  24 | **236**  283  406  412  710  986  1,006  1,011  1,056  1,058  1.059  1,073  1,097 |

**2/14-28Ll. City or Inglewood well 27**

{At the north end **of** the business district of the city of Inglewood, altitude 131 **ft.**

283-310, 398-414, and 424-440 ft]

Casing perforated **at**

|  |  |  |
| --- | --- | --- |
| Deposits of upper Pleistocene age, undivided:  **4'20** Sand sand clay.  **0**S**-f**a**o**n**o**d**t** aannddg":ravel **to2** Inches In diameter \_  Sandy clay -----------------------------------  Sand .and gravel to one-half Inch In diameter----------------------------------  SGarnavdeyl ctloa3y Inches In diam-e-te-r--------------·-----------------------------· --\_  Clay and gravel. ------------------------------- \_  SCalnaydyancdlaygravel. --\_  Fine sand, muddy; some gravel to one-fourth Inch In diameter \_  SFine sand, muddy; some grave\_L ----------------------------------------·-----  Calanyd, asnadndc,la~~nd gravel to three-~~e-ig-h-t-h-s--I-n-c-h--I-n--d-i-a-m--e-te--r --\_  **San** Pedro formation:  4'400Blue clay 16 feet:  S-faonodt garnadveglr,a"v2e7l9t-o3 one-half Inch In diameter \_  Clay and gravel. ---------  Sand and gravel to 1 Inch In diameter-----------------------------------------  CGlraayvealn, dftagcrkaevde,Lto1 Inch In diamete-r --\_  Jt;b et, blue, and fine grave! \_ | 134  6  12  7  8  13  4  18  4  14  16  2  5  36  9  2  5  5  7  9  8  70  2  6  10  10  16  7  10  20  6  24  4  36  3  52 | 134  140  152  159  167  180  184  202  206  220  236  ,238  243  279  288  290  295  300  307  316  324  394  396  402  412  422  438  445  455  475  481  505  509  545  548  600 |
| Sandy clay,abnldues~~mall graveL~~  --\_  Silverado water-bearing zone, 396-455 feet:  Fine sand and gravel to one-half inch in diameter \_  Sand and gravel to three-fourths inch in diameter\_. \_  Sand, fine to coarse.. -----------------------------·---------------------  Sand and gravel to three-fourths Inch in diameter ----------·-------------  Silty glay, blue, and gravel to one-fourth inch in diameter \_  Sandy clay, blue, and grave] to**1** Inch in diameter \_  i:: :l ahJ e::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::  Unclassified:  Clay, hard, with a small amount **of grave] \_**  Oravel, cemented. -- ------**-** --  Clay, blue.  Clay with layers of fine sand.-------------------------------------------------  Clay, blue |

TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**2/15-1C5. Southern California Water Co., Venice-Culver City system, Manning plant well 5**

[About 1 mile north of Culver City, altitude 175 ft. Gravel envelope well, casing initially perforated **at**

672-852 ft.; subsequently plugged at 464 ft., and casing perforated at 146-321 ft. and 370-374 ft.]

Material

Deposits of upper Pleistocene age, undivided:

SCooial~~rs~~e--s-a--n-d-.-\_-.-\_-.-•---·-·-.-•·-\_•..•-.•-·.•-\_.-·.-..-.-.·•·.-.-·•·.·.•.-.·..-.•.-•· -\_.-.••-.-•-•..•••.·•·.·\_.•. -•\_·••.•.·.·.-.·.·\_-.· •

Clay\_. ---···-··...•-·-·-···-··--·---·····-.•.•-··--···-- -· .•..-···-·- Pedro formation:

, g:::~~t~~ag f

San

clay streaks•. •-·--···-···-···-------··--·--··--· ·--

Thickness (feet)

8

.19

*4*

38

Depth (feet)

8

27

31

75

Sand•....

-·---·-·---·-·-·--·--·-···-·······-·--··---·-···-··--··--··-·

-·-

ti 37

15 90

Fine sgarnavde,ll,opoascek.\_e·d·,·-and·f·-ine s-a-n·-d-stre-a-k·s·.-.-···--·---·-··---· -··---\_

Sand, hard-packed, and small graveL-.-·-···-·-·--·----------·---------- ­

Unclassified:

Fine sand, hard•packed, blue-••.•••••--··-···-·····-·•----·------ ·-•.•••.

Ii:§

Pico(?) formation:

tt.::::::::::::::::::::::::::::::::::::::::::::=::::::::::::::::

i 1ljt:::::::::::::::::::::::::::::::::::::::::::::::::::::

1,1t1

ffllli moan •cl••••.•.•.•••.•••••••.•..•.••••••.•.•.••..••.•

I ?St:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Sandy clay, gray, and thin streaks of sand.·········-··-···············-·······

t efi::i sand:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Medium sand••••\_.---.• --•..••••••.•.•••••.•••••.••••..-•.••.•••.•.••-••··••·

Sand, loose, and small graveL--···-········-···-·-·-······-··-···-····-·······

Sandy clay and thin streaks of sand············-···-··························

!i:ii : e·:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

45

11

74

101

10

14

25

4

24

111

19

52

31

7

29

30

25

3

2

11

6

2

2

20

5

2

7

3

14

30

5

51

135

146

220

321

331

345

370

374

398

609

528

580

611

618

647

677

702

705

707

718

724

726

728

748

753

755

762

765

779

809

814

865

2/15-11D2. Southern California Water Co., Venice-Culver City system, Charnoek plant well 3

About 1 mile west of Culver City, altitude 98 ft. Casing perforated at 240-276 and at 300-340 ft. Yield 345 gpm with drawdown of 24 ft.]

|  |  |  |
| --- | --- | --- |
| Alluvial deposits:  Soil and clay.····- ••••••••••••••.••••  "50-foot gravel," 24-42 feet:  : .1: :-r: clay :::::::::::::::::::::::::::::::::::::::::::::::::::::::: | | 24 24  10 34  8 42  20 62·  8 70  46 116  18 134  64 198  42 240  4 244  30 274  28 302  38 340  26 366  10 376  62 438  42 480 |
| San | Pedro(?) formation: |
|  | ; and gravel::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: |
| San | Pedro formation:  Et blue:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: |
| ·gSand and gravel to 1 inch In diameter••••••••.•••••••••••••••••••••••••••.•.••.  *1w::...*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::  Pico(?) formation:  i:ti.blue.::::::::::::::::::::::::::::::::::::::::.::::::::::::::::::::::::::: | |

.

**460508--59-25**

**37**4 GEOLOGY, HYDROLOGY, TORRANCE-S:ANTA MONICA AREA

|  |  |  |
| --- | --- | --- |
| **Allu**C**vi**l**a**a**l**ydeposits: •  "50-foot gravel": | 29 | 29 |
| · Coarse graveL ---• • •. - | 36 | 65 |
| San FPienderosa(?n)dfaonrmd asthioelnl;s --- \_ Clay, blue \_ | 15  90 | 80  170 |
| San Pedro formation: |  |  |
| FCionaersseansadn· d ----------------------- --------------------. --.--  Sand and graveL. --- ----- ---**-** --- -----**-** - -- | 30  ,12  "9  ' | 200  -212  ·221 |
| Coarse sand . .-----------------· -. | 9 | 230 |
| Sand and graveL - ------------------ --------------· -- ------·--· \_ | 24 | 254 |
| CFionaersseansad~~nd~~ -------------~~·~~---------~~-~~------------· \_~~·~~.· • . - ----------.--\_-. --\_  Fine sand . \_ | -21  99  21 | 275  374  395' |
| UnclCaslasyified:-······ · • . \_. |  | 402 |

TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa 1 1onica area-Continued*

2/15-14A3. City of Los Angeles, Barnes City well 2

[About 1 mile southwest **of** Culver City, altitude 42 ft. Driller's record, with modifications based on sample descriptions by F. B. Kelsey of California Division of Water Resources. Casing perforated at 210-250, and at 405-425 ft.]

|  |  |  |
| --- | --- | --- |
| Material | 'rbickness (feet) | Depth (feet) |
| Alluvial deposits: |  |  |
| Silty clay, brownish ------------ ---- -------- --------------- ------------ | 24 | 24 |
| "50-fGoorat vgerla,vderly": --- -- \_  Boulders ------------- --- -- \_  San Pedro(?) formation:  Fine sand, blue, and shells \_  "Sea mud" and shells ------------ ---------------- --·--- -------- | 12  6  8  12 | 36  42  50  62 |
| Clay, blue ------------------------ ------ -- \_ | 13 | 75 |
| "Sea mud" and shells --- ----------- --------- ---- ---- | 55 | 130 |
| San Pedro formation:  Sand, cemented, and graveL --- \_ -- \_ | 4 | 134 |
| Fine sand, blue. ------------------------- ---- ------------- -- ----------- -  Fine sand, gray, granitic, containing a few pebbles *to½* inch in diameter \_ | 56  16 | 190  206 |
| GraveL - -- \_ | 26 | 232 |
| Coarse sand and graveL-------------------- -------- ------------ ---- ----------- | 30 | 262 |
| Fine sand  Coarse sand, packed. --------- ----------- --- | 46  52 | 308  360 |
| Coarse sand, gray, and fine gravel; coarser in lower portion \_ | 65 | 425 |
| Pico(?) formation: ,  Silt, gray, micaceou.s, massive ----- -- \_ | 37 | 462 |

**2/15-17G4. Formerly American States Water Service Co. well** 7

[About 2 miles southeast of Santa Monica, altitude 22 ft. Casing perforated at 40-185 ft.]

Alluvial deposits:

"50-foot gravel": SGarnavdeL

Clay

--

-- --

- -- --

--

-----------------

--

-- - -- ----

- - -

-- \_- --

San Pedro formation:

: : :i• d- gravel -------------------------------------------------

Sand and grave!\_ --------------------------------------------------

Sand, blue ------\_ --- ---------------------------- -------------

Clay and sand --- -----\_-- -------------------------------------------

SCalanyd -\_--·

San Sand. - ------- - ----

Pedro(?) formation:

- --- -- -- - - -------- -

Clay and sand. -------- -- --- --- ----- --- ---------------- ---- ------ -

Clay ---- --- -- -------------------- --------- --- ------- --- ----- ---- ---- -- -

6

11

27

12

9

24

39

12

15

15

18

12

6

6

17

44

56

65

89

128

140

155

170

188

200

206

**2/15-24Cl. Mesmer City Corp. Ltd. well 1**

**[In** Ballona Gap, about 2 miles south of Culver City, altitude 20 ft. Casing perforated at **215-221,** 235-254,

and 344-350 ft]

TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa M-onica* area-Continued

2/15-34A2. **Palisades del Rey Water Co. well** 4

(About 1 mile east of Playa del Rey, altitude 137 ft. Casing perfora ed at 172-212 ft]

Material

Thickness Depth (feet) (feet)

Dune and beach sand:

Soil.••........•••------•--·- ---·-··-..•.·····-··----·-··--··-····-- ••-•••·

SanSand, yellow...•·•·--··········---··--·····-····•······-··-·- ·-

Pedro formation:

Gravel and sand..•. .-···.. ··-\_. ·---... -··-.•\_.. .•.•.••.••...•. •--··--

Sand, yellow. ----·-·--·-·------·------·--------·--· ·-

Gravel and sand . ··-·•..••.•\_·--·-·-··-··-·····---··----··----· --··-

Sand, yellow.. -------···--·---···--·--··-··--·----------·-····-····-··--···-··

Sand, muddy, and light graveL.·-·-·······--··--··-···--··-···---··--·--···-·

Sand, blue..... ··-·. ·-··· .•••·-·.. ···---.-·-·-·....··-···--... ··-·-

Gravel to 1>-2 inches in diameter.---··-···----···-·-----·-·-··--·--··-· ·--

Sand and small gravel.............·····-·-···-··---··-··-···-·----·- -·--·

Unclassified:

Sand, blue, and muddy graveL.·----·····-·-··-·······-·-····--··-···---·-----

Sandy clay .. \_•.•..• ··- .. ... \_..••.----·.-·--·-··........·-. ·--·-· \_

Sand and graveL •• ·--·.... . .. \_.•...--·• \_ --· .. -·----··---•.•.\_ -·· ••

Clay .. \_-·--·.....•...·····--···-.------·········--··--·--···-·---·······--··

4

93

8

15

4

23

15

10

8

10

43

107

7

31

4

**97**

105

120

124

147

162

172

180

190

233

340

347

378

**3/13-SGl. Clara Peopping**

[About 2 miles southwest of Watts, altitude 110 ftJ

|  |  |  |
| --- | --- | --- |
| Deposits of upper Pleistocene age, undivided:  Soil...... ..... ... \_.\_.. ••..\_....•...\_•• .\_.•.•.•.•• .• \_.• \_.•• \_. •. \_  ! t•cemented::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | 27  4  3 | 27  31  34 |
| Sandy clay•. -·--.•. -···\_ ..•••............\_·-·.••.············-·····-··-·•••..• | 2 | **36** |
| Olay\_.·-.....•.•····-··•-·-·-·-·····-·\_.•··---·---··-... \_··-·•.•.---·-···-·-··  Gravel.\_ ....\_·-·•• ...•....•--·. .\_.\_•• \_. ..••.•.•••••.••...•\_. •••.. | 3  2 | **39**  **41** |
| Olay\_.--··--·••••.•.••••.•--···\_···········-···•••••••...••••.. -·- -·--... | 46 | 87 |
| Sandy clay••...•.\_--·---·•••...•.\_... ..•·--·--···-··..•.••••••..·----··•-·-·-- | 9 | 96 |
| Gravel ·--·-··-···-.·-·.••.··-..••...•••··-.....--·\_--··-·····---·-·-·---·- | 16 | 112 |
| San Clay and graveL-----·····-·---··-·-·-··--··--... -·--··--·----·- ·-  Pedro formation: | **5** | 117 |
| Clay•• -····-·-·--·•••·--····-·-- .......•--···-····-··- ·-. | 58 | 175 |
| Gravel.••·-\_·-·--·-·....•••-·-···-·•••.•--·•·-···-•-·---·-•·-·-•-·-·····--··-· | 5 | 180 |
| Clay ·-···--·---··-·\_•••·-··-····-----··..••------·------·-·-··---··--·-·-··· | 30 | 210 |
| GraveL . . ·- \_. -- -- . - - - - •.. - - --- •·-----•--------•·--·-----• •-- | 5 | **215** |
| : fi;ilty sand, black. ---------------··--·-· -·-·-··-- ·--··- | 40  6 | 255  261 |
| 1 . i ; )Jrown ... . ·----- \_-------··-----·-· .·--·  Silverado water-bearing zone:  Sand, green·--·----·-·- ·--- -··-·.. \_·------------·----·-----·-··-----------  Sand and graveL . . . --·----.---··--·--------------·-··.••• --·  Clay, green.•• \_. .·- . . .\_•. •••..••\_-- --- \_•...- \_ •.. --  Sandy·. c-l-a-y-,--b-l·a-c-k·.-•·-- -.·---------···-·-·..···-···.-.·.-.·•·.·.·•·.·•··..·-··-·--···-·-···--·--·-·· •-•-•-•·  "Quicksand," black.·---••.....···-·-··••.····-····-······-···-··.••..•••-----  Sand, cemented ....·-·····-····..•...••••••·-·.•.••.\_•. •••····-··-·--····..••• Cl:ayt, hard, black•.••·-····-.·-··.••.•.•.·-··-·-·-•..........••..·-·····---···- a; t ;ry coarse.• ··---.••-···.•. ·-·····-.••.•••.-- •••••••  Sandy clay . .. \_.• \_.•. ·-- . .... .• \_.. \_.••.•• . ·-  :=f.:::s:i:•::b::l:a:c::k:.::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::  Unclassified:  Clay and sand.....••\_-·-·--·----··.·-••---·.. -·-----.. -------.•.•------------- | 7  10  11  16  3  30  56  6  **19**  21  40  54  13  7  35  7  26  10 | 268  278  289  305  308  338  394  400  419  440  480  534  **547**  554  **589**  **596**  622  632 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| Sandy clay, streaked with sticky clay\_----·-·---------·---·-------------·----- | 148 | 780 |
| Fine sand•• . ·-· ---·---·-···-···----·-···---.. -·---· ·--···----· | 6 | 786 |
| "Quicksand" and some graveL\_···---······--·---··------·-------·-·--· ·- | **2** | 788 |
| Clay•••. •. ·--··--------·---·----·--·------···-----·------------· •••• | 2 | 790 |

TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**3/13-28A1. C. H. Hazel**

[About 1 mile southw?5t of Compton. altitude 91 ft. Casing perforated at 457--467 and 506-525 ft]

Material

Deposits of upper Pleistocene age, undivided:

SColaiyL---·-- •·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•··•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•-•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•-•·•·•·•·

8ti d sand.::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::**:r::i**

§l:f "hardpan"•••••••••••••·- •• •••••••••••••••••••••••••· ·-·-

Sand••••••.•.•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••

E!;mc!;hells :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

!**!r:nted:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::**

**Ban** Pedro formation:

Fine sand and decomposed wood••••••••••••••••••••••••••••••••••••••••••••••

:a ens.:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Sandy clay··-··----·····-·---·-••••••••••••••••••••••••••••••••••••• ·-••••

SllveOraladyo, wblta.1tAer-b·-e·a·r·in-g--·z·o-n·e·,·3·4·8·---5-5·5·-f·e-e·t-: ---·----·····---··-··--··-···--··----·-··

*:6*

Coarse sand and shells••••••••••••••••••••••••••••••••••••••••••••••••••••••••• sand and small gravel••••••••••••••••••••••••••••••••••••••••••••••••••

Gravel, cemented\_ ••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• and small gravel:::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Silty sand\_ •••••••••••••••••••••••••••••••••••••••••••••••••••••••.-•••••••••••

ef!':1enS:a clay.::::::::::::::::::::::::::::::::::::::::::::::::::::::::

SCalanyd,ybclulae.y.·.·.·.·.-.·.·.-.·.·.-.·.·.-.·.·.·.-.·.·.·.-.·.·.·.·.-.·.-.-.·.·.·.-.-.·.·.·.·.·.·.·.·.·.·.·.·.··.·.·.·.-.-.·.·.-.·.·.·.·.·.·.-.-.·.·..· gr::,eb:d and gravel::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Thickness (feet)

16

30

9

9

6

30

15

24

9

36

18

24

33

9

6

18

33

3

21

12

15

24

6

16

9

12

3

24

12

16

60

3

Depth (feet)

16

**46**

54

63

69

99

114

138

147

183

201

225

268

267

273

291

324

327

348

360

375

**399**

405

420

429

441

444

468

480

496

555

568

3/13-30.U. **J.P.** Schlaegel

About 1 mile east of Gardena, altitude 46 ft. Casing perforated at 363--373, 628-638, 660-577, 616-628, and

660-690 ft)

Deposits of upper Pleistocene age, undivided: Soil•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• ''Mesa"••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Sand•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Olay•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Sand••••••••••••••••••••••••••••••••••••••••••••••••.•••••••••••••••••••••-•• • Olay••••••••••••••••••••••••••••••••••••••••--·•••••••••••••••••••••••••••••••

"OClaeym••e•.n•t•"•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•-•·•·•·•·•·•·•·•··•·•·•·•·•·•·•·•·•·•·•·•·•·•·•·•-•·•·•·•·•·.·•·•·•·•·•·•·•·•·•·•· Fine sand••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Olay, blue•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••

''200-foot sand":

Fine sand•••••••••·-·····--··········-····································-···

3

6

19

8

11

16

2

31

3

9

17

36

47

64

62

9

1

104

106

96

43

Sand••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••

Coarse sand•••••·-·--·--······-··-········-·····················-········-····

San Pedro formation:

Gravel and clay••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••-

"400-foot gravel," 242-387 feet:

Olay••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••

*i t•* packed.::::::•••••••••••:::::::::::::::::::::::::::::::::::::::::::::::

SBaanndd•a•n•d.-c·l·a·y·••·•·•·•·•·•·••·•·•·•-•-••-•-•-•-•·••·•·•·•·•·••·•·•·•·•·•·••·•·•·•·•·••·•·•·•·•·••·•·•·•·•·••·•·•·•·•·••·•·•·•·•·•·••· Olay••••--···-•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• GraveL••• -··-•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Fine gravel.\_ ••••••••••••••••..••••••••••••••••••••••••••••••••••••·-· ••••••••• Olay •• •• ·-•••••••••••••••••••••••••••.••••••••••••••••••••••••••

Coarse sand\_ ••••••••••.••••• -·-····················----·············

Olay. •••••••••••••••••••••••••••····-···-··················-··········--···-

Sand ••••·•••••••••••••••••••••••••••••••••••••••••••••••••••••••• ,••••••••••••

148

16 164

12 176

6 182

60 242

28

11

18

21

281

302

320

343

270

16

23

359

4

9

7

125

8

367

371

380

387

612

TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Banta Monica* area-Continued

**3/13-30A2. J. S. Schlaegel-Con&lnued**

Material

Thickness Depth (feet) (feet)

Silverado water-bearing zone:

Sand •••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• OraveL ••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Sand.\_ ••••••••..••••••••••••••.••••••••••••••••••••••••••••••••••••••••••••••• Sand, packed\_•••..••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••

SGarnavde.\_l.•\_•..•.•-•-•·•·•••.•••••••.•-•·•·•·•-•·••·•·•·•·•·•·•·•·•·•·•·••·•·•·•·•·•·•·•·•·•·•·••·•·•·•·•·•·•·•·•·•·•·••·•·•·•·•-•·•-•-•-•-•-•-••·•· Sand and mud••.••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Coarse sand•• \_•.••• ••••••••••••••••••••••••••••••.•••••••••••••••••••••••••• Sand•••••.•••••••••.•.••••.\_••••••.•••••\_••••••••••••••••••••••••••••••••••••• Gravel..• •••••••.•••••••••••••••••••••••. •••••••••••••••••••••••••••••••

Coarse sand••.••••••••••••.•••••..••.••••••••••••••.•••••••••••••••••••••••••• Sand••••••••••••••••••••••••. •••••••.•••.•••••••••••••••••••••••••••••••••••

Clay••• ·•••••••••••••••••••...••••••••..•••.••••••••.•••••••••••••••••••••••••• Sand•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Fine gravel.••••••..•••••••••••••••••••••••••.••••••••••••••••••••••••••••••••• OraveL •••••••••••••.•••••••••••••••••••••••••••••..•••••••••••••••••••••••••• Clay••••••••••••••••••••••..•••••••••••••••••••••••••••••••••••••••••••••••••• OraveL ••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• Sand ••••••••••••••••••••••••.•••••••••••••••••••••••••••••••••••••••••••••••••

9

15

10

4

**25**

10

8

9

6

8

10

3

1

14

6

38

1

9

6

521

536

546

550

575

585

593

602

608

616

626

629

630

644

650

688

689

698

704

3/14-4N2. **Southern California Water Co., Lennox system, Truro plant well 2**

[Altitude 73 ft. Casing perforated at 500-512, 519-576, 580-602, and 611-674 ft. Reported yield **1,100** gpm]

Deposits of upper Pleistocene age, undivided:

..400-foot gravel.., 320--399 feet:

|  |  |  |
| --- | --- | --- |
| "Hardpan"·--···•••••••••••••••••••••••••••••••••••••.•••••••••••••••••••••••• | 14 | **14** |
| Sandy clay, gray..••••••••••••••••••••••••••••. •••••••••••••••••••••••••••• | 59 | 73 |
| Sandy clay, blue••••••••••.••••••••••••••••••••••...•••••••••••••••••••••••••• | 32 | 105 |
| "200-foot sand": |  |  |
| Sand, -gravel to 2 inches in diameter••••••••••••••••••.•••••••••••••••••••••••• | 14 | **119** |
| Sandy clay, blue.•. -·························································· | 5 | 124 |
| Sand, gravel to 2 inches in diameter•••••.•••••••••. •••••••••••••••••••••••• | 7 | 131 |
| Sand, gravel to 3 inches in diameter••••••••••••••••••.•••••••••••••••••••••••• | 7 | 13S |
| Sandy clay, yellow•..•.....•...•..••••••••.•.••••••••..•.•..•.•••••••••••••••• | 4 | 142'. |
| Sandy clay, yellow, with streaks of sand and gravel to 2 inches in diameter•••• | 11 | 153 |
| Sand and gravel to **2** inches in diameter.••••..••••.••••••••••••••.••••••••••••• | 14 | 167 |
| Clay, blue...................................................................... | 20 | 187 |
| Sand and gravel to one-half inch in diameter••••••••••••••••••••••••••••••••••• | 10 | 197 |
| San Pedro formation: |  |  |
| Clay, blue••••••••••••••••••••••••••••••••••••••••.•••••••••••••••••••••••••••• | 16 | 213 |
| Sand, muddy••••••••••••••••••••••••••••••••••••••••••••······ ····• • | 23 | 236 |
| Sandy clay, blue••••••••••••••••.••••••••••.••••••- ·---·· | 74 | 310 |
| Sand, IQUddy•.•\_•• ...•.••.••••••.••.•••••••.••••••••••••••••••••••••••••••••• | fO | 320 |
| Sand and gravel to 2 inches in diameter\_ ••••••••••••••••••••••••••••••••••••••• | 12 | 332 |
| Fine sand ·and gravel to one-fourth inch in diameter••••••••••••••••••••••••••• | 10 | 342 |
| Fine sand, muddy·························-·······-······················-···· | 57 | 399 |
| Clay, blue•••••••.•••••••••••••••••••••••••••.••••••••••••••••••••••••••••••••• | '18 | 477 |
| Sllverado water-bearing zone: |  |  |
| Fine sand and gravel. ••••••••••••••••••••••.•.•••••••••••••••••••••••••••• | 8 | 485 |
| Fine sand and some gravel to one-fourth inch in diameter•••••••••••••••••••••• | 8 | 493 |
| Fine sand and gravel to one•half inch in diameter•••••••••••••••••••••••••••••• | 7 | 500 |
| Fine sand and gravel to 2 inches in diameter.••••••.••••••••••••••••••••••••••• | 12 | 512 |
| Sand and gravel to one-half inch in diameter••••.•••••••••••••••••••••••••••••• | 7 | 519 |
| Sand and gravel to 3 inches in diameter·-······································ | 51 | 570 |
| Sand and gravel to 1 inch in diameter••••••.•.•••••••••••••••••••••••••••••••• | 6 | 576 |
| Sand and gravel to one-fourth inch in diameter•••••••••••••••••••••••••••••••• | 4 | 580 |
| Sand and gravel to 2 inches in diameter.•.•. ••••••••••••••••••••••••• | 22 | 602 |
| Fine sand, muddy, and gravel to one-half inch in diameter•••••••••••••••••••• | 9 | 611 |
| Sand and gravel to 2 inches in diameter•••••.•••••••••••••••••••••••••••••••••• | 30 | 641 |
| Sand and gravel to 4 inches in diameter•••••••••••••••••••••••••••••••••••••••• | 33 | 674 |
| **Olay,** blue•••••..•••••••••••••••••••••••••••••..•.•••••••••••.••••••••••••••••• | 11 | **685** |
| Sand, gravel to one.half inch in diameter, and clay.•••••••.•.••••••••••••••••• | 7 | 692 |
| Gravel to one-half inch in diameter, and sand••••.••••••••••••••••••••••••••••• | 3 | 695 |

|  |  |  |
| --- | --- | --- |
| !sand:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::  Clay\_·-----·-·-·-···--- --·--· -·-- -····--\_-·-·--···-\_ | **98**  2  14 | 98  100  114 |
| "200-foot sand":  Fine sand -·· ---··--- ·-- --·- -··--·---···--·--· -·-· | 10 | 124 |
| SCalnady.with st-r-e·a·ks of clay\_·---·-----·--------··---·---·---·-··---···----·---•·---·-\_ | 36  36 | 160  196 |
| Sand, muddy -·-·-- --·-·-·--\_ --\_ | 8 | 204 |
| San Pedro formation:  Sandy clay . -----·-----·--··-----··--------------- | 113 | 317 |
| "400-foot gravel," 317-384 feet: |  |  |
| Gravel to 1 inch in diameter--····--···-·---·-·-····--·------·--···--·-·--··---  g t | 29  38  38  18  58 | 3'6  384  422  440  498 |
|  |  |  |

'I'ABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**WelJ 3/14-lOGl. City oflnglewood well** 28

{About 3 miles south of Inglewood, and 1 mile east of Hawthorne, altitude 62 ft. Casing perforated at 492- 527, 546-568, 638-654, 676-680, and 700-711 ft. Yield 600 gpm with drawdown of 17 ft)

"200-foot sand":

"400-foot gravel," 362-406 feet:

Fine sand. ·-·--·····-··--·-·-····-·--·--··---

--·-·-····-·-······-····

a!!iraveL.\_ ••••-······-----·····--·--··-·-·-------------· ·-

Basal deposits containing Timms Point fauna: 1

|  |  |  |
| --- | --- | --- |
| Material | Thickness (feet) | Depth (feet) |
| DepSoosiLs of upper Pleistocene a-g·-e-, undivided: \_ | 3 | 3 |
| Clay, yellow•••••-··------------------------------------·--··--·-· ·- | 91 | 94 |
| Fine sand\_···-·------·-------------------------·------ -- \_ | 3 | 97 |
| Clay, yellow. ··-·------·-··-···--···-·-··-··-·----··----··-----·-----·-··--- | 75 | 172 |
| Sand and blue clay···--·---·-········-------------·-·-·--·--·-·---------------  Silty sand\_ ••••--····--·.····-····---- -···-\_•.. \_-·-•.• \_-·•• \_. | 84  13 | 256  269 |
| San Pedro formation: |  |  |
|  | 23 | 292 |
| i dy, blue\_. ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | **H** | 306 |
| Clay, blue\_-· .•. \_-·······-··-·•••••·- -·-·.-·\_ ••\_••• -· ••..• •••••• | 56 | 362 |
| Sand, cemented ·--··-··-·-··-----·-··••••••.•••••.··--·-··-·· ·-- | 5 | 367 |
| Gravel to 2 inches in diameter.•••••••·-····-···-·-·-----·--·-·-·-·---··-···-·· | 6 | 373 |
| Clay, blue -······-·\_-···········-····••••\_-·\_••• \_--··-··•••--·••••··\_--\_-- --- | 5 | 378 |
| Sand and gravel to 1 inch in dlameter••• ·-···-·----·····-··---···· ·--·-- | 8 | 386 |
| Et: E!: | 20  68  1  5 | 406  **474**  475  480 |
| Silverado water-bearing zone: |  |  |
| Sand, hard, blue ··-····-·-----··--·---····•••. -·----·---··--·-··-·· | **12** | **492** |
| Gravel to 2 inches in dlameter.·------····---··-----·-··-·-·------· ­ | 4 | 496 |
| Sand and gravel to 1 inch in diameter\_·-······-·····--· --··--·-- | **31** | 527 |
| Clay, blue.••••••••••••-·\_••••.•••-·•••-•• -· -· ••• \_•• \_-- - - -- ------- -·- ••• ---•• | 19 | 546 |
| Gravel to 1 inch in diameter--·---····----····-··---·-----------·--··-·-··-···· | ii | 557 |
| Gravel to 3 inches in diameter••••·-···---·-·-----··---····-··-····--···------- | 17 | 574 |
| SFilntey sandd\_.··-···•·•·•·•·•·•·•·•··-··--•·.·•-•-•-•-•-•··---··-·-~~·-~~--.-·-····-····-··- --•--·--···-··.-·-·•-- | 4  24 | 578  602 |
|  | 36 | 638 |
| g eri %;:i: i ! r::::::::::::::::::::::::::::::::::::::::::::::::: | 4 | 642 |
| Gravel to 2 inches in diameter\_·-····-·-·····----··--·----·---------··--------- | 12 | 654 |
| Sand with fine streaks of clay·-·--·--··-----···--··-·-·············-······-·--- | 22 | 676 |
| Sand and gravel to 1 inch in dlameter••• ·--·--··----·----···-··-····---··---·­ | 4 | 680 |
| Sand, with streaks of clay -·--··----·····---···---------·----·-·----· -·-·  Sand and gravel to 2 inches in dlameter·----·-----·----------·-·-······-------- | 23  8 | 700  711 |
| Cla\_y, blue••••••--·····-··•••••••••••••••••-·······- ·-•••-·-·•••••••••••••• | **87** | 798 |

1 Microfaunal determinations by S. G. Wissler.

**3/H-22Al. Southern California Water Co., Lawndale system, Chadron plant well l**

[About 2 miles southeast of Hawthorne, altitude 49 ft. Casing perforated at 319-382, 540-554, 622-634, 640- 646, and 660-668 ft. Reported yield 1,160 gpm; drawdown not known]

Deposits of upper Pleistocene age, undivided:

::h::::sv::pea graveL.----·-·-····--·-·······--··-····-·-·-· ====

Clay\_.\_ .. ·-.-··---·-··--·\_....\_-··-.. --·-··-··-····-\_-·.-·-······-··-----· --

**3/14-22Al. Southern California Water Co., Lawndale system, Chadron plant well I-Continued**

|  |  |  |
| --- | --- | --- |
| Material | Thickness Depth (feet) (feet) | |
| Silverado water-bearing zone:  Sand, muddy ---------------------------- \_  Sand, with some pea gravel and fine graveL \_ Sand and gravel to one-half inch in diameter \_ Sand  Sand and gravel to three-fourths inch in diameter\_ --\_  Gravel to three-fourths inch in diameter \_  Sand with streaks of clay \_  Gravel to one-half inch in diameter -----------------------  Unclassified:  **Clay \_**  Sand |  | **16 514**  **26 540**  **14** 554  **68 622**  **12** 634  6 640  6 646  **14** 660  **8 668**  30 **698**  **12 710** |

**3/14-29D3. City of Manhattan Beach well 11**

About 2 miles east of Manhattan Beachi altitude 88 ft. Driller's record, with modifications based on lab­ oratory examination of samples by Al en Sinnott of Geological Survey. Fauna} examination by S. G. Wissler. Casing perforated at 221-238 and 418-433 ft. Yield on test 600 gpm with drawdown of 25 ft]

|  |  |  |
| --- | --- | --- |
| DunSeoaiLnd beach sand: \_  Silty sand, buff; sand grains subangular to rounded and largely **of** quartz; **a**  few granitic pebbles to three-fourths inch in diameter \_  Deposits of upper Pleistocene age, undivided:  Clayey silt, gray, micaceous, with a few quartzite, granite, and other pebbles to three-fourths inch in diameter\_-------------------------------------------  Sandy silt, micaceous -------------------------------------  Clay, with limonitic zones and dendrite along fractures \_  Silty sand, gray buff, moderately micaceous; sand grains subangular to rounded, consisting mainly of quartz and feldspar \_  San Pedro formation:  Sandy silt, gray buff, with limonitic concretions; pelecypod fragments; in­ cmluodrpehdicsarnodckgsrains poorly sorted; a few small pebbles **of** quartz and meta-\_  Silverado water-bearing zone:  Sand, gray, fairly clean, coarse, angular to subangular, feldspar and quartz, with some smaller amounts of pyroxenes, magnetite or ilmenite, garnet, cblorite, muscovite, biotite, epidote, and a trace of shell fragments. Com­ position: quartz, 35 percent, feldspar, 50 percent, others, 15 percent. In places streaks of heavy minerals cemented in part with calcite and hematite. A few pebbles up to 1 inch in diameter. Moderately well sorted \_  Gravel and coarse sand, gray, clean, with pebbles up to 1 inch in diameter; pebbles chiefly granitic ---------------------------  Sand, gray, coarse, poorly sorted, angular to subangular. Composition and roundness similar to sand from 190 to 218 feet. Wood fragments from 290 to 300 feet. A few pelecypod and gastropod fragments in sample taken from 306 to 310 feet\_ ------------------------------ \_  Sand 1 gray, very fine to medium; contains a few pelecypod fragments. Ellip­ soiual calcareous concretions up to 4 inches long and up to *1¾* inches in diameter recovered at depth 335 feet\_ \_  Sandy silt, dark gray ---------------------------- \_  Fine to very fine sand, gray \_  Fine to medium sand, gray,.moderately well sorted \_  Coaanrdsegsaasntrdo,pgordasy, angular to subangular, with abundant shells of pelecypods\_  Gravel and sand, gray, clean, with abundant shells of pelecypods and gastro­ pods. Pebbles chiefly granites and metamorphic rocks (quartzite), witlr s4o1m8 feeepte.gmatite and vein quartz; clay layer or layers about 1 inch thick at \_  Pegbabslterogproadveslh,ewllsith a few boulders; pebbles are **of** granitic rocks. Abundant \_ Gravel and sand; abundant gastropod shells \_  Unclassified:  §f} i:'.W! td, ;:::;;.;;.;;ous,uc::::::::::::::::::::::::::::::::::::::::: | 4  96  27  8  12  18  25 | 4  100  127  135  147  165  190 |
| 28 218  2 220  90 310  38 348  6 354  11 365  29 394  16 410  8 418  7 425  6 431  22 453  5 458  12 470  55 525 | |

TABLE *28.-Malerials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica area-Continued*

**3/15-13R2. Standard Oil Co. well 16**

{About 2 miles southeast of El Segundo, altitude 153 ft. Casing perforated at 368--460 ft. Yield on test 860

gpm with drawdown of 13 ft]

|  |  |  |
| --- | --- | --- |
| Material  Dune and beach sand:  Yellow sand, loose -------------····--··-··--·········-··-- ·- | Thickness (feet)  175 | Depth (feet)  175 |
| Unnamed upper Pleistocene deposits: |  |  |
| Clay, soft, blue\_. -------·····..•...•.....•......•.••.••..............•...... | 11 | 186 |
| "200•foot sand": |  |  |
| Sand and gravel to 1 inch in diameter.•....•.........•.......•.........•...... | 17 | 203 |
| **San** Pedro formation: |  |  |
| Sandy clay, yellow.····-·············.............. ·. | 24 | 227 |
| Bllverado water•bearing zone: |  |  |
| Sand and gravel to three.fourths inch in diameter.....•..........·-············ | 20 | 247 |
| Sandy clay, blue.......................·-·.•.........•··-···-····-·.. ·- | 36 | 283 |
| Fine sand, blue.......·····-·····-····......•..•................•.............. | 17 | 300 |
| Sand and gravel to 2 inches in diameter..•..•.........•.•-····················· | 7 | 307 |
| Sandy clay....•....................··-····...........\_ ...............•.•...... | 32 | 339 |
| Fine sand and gravel, blue, to three-fourths inch in diameter....•.•........... | 21 | 360 |
| Sand and gravel to 1 inch in diameter................•......•..•..•.••........ | 35 | 395 |
| Sand and some gravel to three-eighths inch in diameter••.........•...••••..... | 13 | 408 |
| Sand and gravel to 1¼ inches in diameter.............•..•..•...•.•...•. •. | 17 | 425 |
| Sand and gravel to three-fourths inch in diameter...............••....••.••.... | 11 | 436 |
| Sand and gravel to 2 inches in diameter...............•........••.............. | 20 | 456 |
| Sand and gravel to three.fourths inch in diameter.•...............•..••........ | 4 | 460 |
| Unclassified: |  |  |
| Sandy clay, hard••..•••••.••••.....•.....\_-·.--·.....•......•.••••••••••\_ • | 20 | 480 |

**4/13-12A2. City of Long Beach, North Long Beach well** 6

About 5 miles north of Long Beach, altitude 38 ft. Fauna.I examination by M. L. Natland. OflSing per forated 1805-1955 ft. Well flowed 106 gpm in October 1946; temperature, 94°-104° F in October 1946; sufficient methane present in water to burn continuously. Yield estimated at 400 gpm with drawdown of about 60 ft]

Alluvial deposits:

SoiL.•...................•..........•...•••\_•.. \_.. \_... •....\_•.•..............

Sand and gravel, water bearing.••••...•...............•.••••••••.•.......•.•..

San Pedro formation:

8S1an:d:ybcrl;a;y,abrdlu.=e,==wi=t=h==so=m= e==g= ra===v=e=l=.=•=•=•=.•=.==•= •=•=.=.=.=.=.•==.=.=.•==•=•=•=•.=•==..=.•=.=.==..=.==.=.=..=.=.=.=•. Clay, yellow.............•....•....••...•...................•...•.........•....

Clay and gravel, tight•..•••...••.•••••................••.......•.........••...

Clay, yellow, hard.....•••.........•....•.......•...•...........\_..............

Sandy clay, blue, with some gravel, water bearing........•.....•.•.......•....

Sand, packed, and gravel, water bearing.•..•.......•.....•..•..•.........•....

"Sea mud," shells, and wood fragments.••.••••...............•••••......•....

Clay, blue, hard....\_....•...•..........•.......................•...•.....•....

"Sea mud" and shells.\_ ..•.••.....•....•.........•.....•.•.•.•••.........•....

Sandy clay, blue............•.....•.........••.......•...•...•••••.......•....

Coarse sand, some gravel, water bearing..•..•....•.•...•••....••.........•....

"Sea mud" and shells•••...•......•..•.........•...•.•.•.•....••.......•.•....

: i.

c fl;,b

f:e;andshells..........\_.....••..................•. •..••..•.

Silverado water•bearing zone, 237-466 feet:

Sand and gravel, with shells...••...•..••....•....•.....•.•.••...•........••...

Coarse sand, water-bearing...•.......•.•.•.........••.•.•. •••••••.•

Sta1

nd:=

a1n!d,Sg:rra.ve!li,;wi=th==st=r=ea=k=s=o=f=c=la=y=..=•=•=.=..=.=•.=.=•=..=.=..=.=..=.=..=..=•=.=..=•=.=•.=.=•=..=•=.=.•=

.

Sand and gravel, clean.............•.........•...•............•••••....••.•....

Sand and gravel, with streaks of sandy clay········-···-··-·-·-·-·-··- ­

Clay, blue, with streaks of sandy clay•.•.•.•••.•.••.••..•....••••........•....

Clay, blue, hard.•.................•...••.•..•••••••....................•.•.•..

Sandy clay, blue....··········--···-·-·--···-··-·---········-········-··-·-···

Coarse sand, dirty, tighL•..•.....•••.•.•..•••••••••...•••.•••.••••••.•.•••....

Clay, blue, with streaks of sand.•••..••••••••.••••.•.••.•..•..·······-·-····--

58

172

23

31

10

24

466

638

661

692

702

726

|  |  |
| --- | --- |
| 11 | 11 |
| 16 | 27 |
| 8 | 35 |
| 12 | 47 |
| 11 | 58 |
| 8 | 66 |
| 10 | 76 |
| 9 | 85 |
| 7 | 92 |
| 25 | 117 |
| 17 | 134 |
| 2 | 136 |
| 16. | 152 |
| 12 | 164 |
| 22 | 186 |
| 28 | 214 |
| i5 | 229 |
| 8 | 237 |
| 19 | 256 |
| 7 | 263 |
| 8 | 271 |
| 48 | 319 |
| 8 | 327 |
| 30 | 357 |
| 51 | 408 |

**4/13-12A2. City of Long Beach, North Long Beach well 6-Continued**

Material

Thickness

(feet)

Depth

(feet)

Pico formation, upper division:

Sandy clay, blue ------------------------------------

Sandy clay, packed, with streaks of coarse blue sand \_

Clay, blue, sticky ------------------------------------------

Sand, packed, with streaks of blue clay \_

*m: :*

g} :,hard\_:=::=======:===:::::::::::::::::::::::::::::::::=::::::::=====

SEani:dbia; n:idi{\_g-ra::v:=el:,::w::i:t:h:::s::t:r:e:a::k::s::o:f::c::l:a::y=, =w=a=te=r=b=e=ar=in=g==================\_

55 781

25 806

8 814

57 871

13 884

12 896

22 918

20 938

30 968

13 981

i: /J i,si\t Y--- -- - - --

|  |  |  |
| --- | --- | --- |
| CSalanyd, asntidckgyr,avbelLue, with streaks of gravel\_ --\_ | 19 | 1,039  1,058 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
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- - - --

45

. 13

1,026

Clay, blue, sticky. ----

CSalanyd,ybclluaey,,bbalrude,awnditshtisctrkeyaks of graveL --\_

Sandy clay, blue, with streaks of hard sticky clay\_----------------------------

Sand, packed, with streaks of blue sandy clay; water bearing \_

Sandy clay, blue ----------------------------------------

Sandy clay, blue, with streaks of sticky clay \_

8l: : g{ :: tt cisiicty\_::::::::::::::::::::::::::::::::::::: ::::::::::::

Clay, blue, hard, with streaks of blue sand \_

8

11

61

39

35

22

7

122

49

28

1,066

1,077

1,138

1,177

1,212

1,234

1,241

1,363

1,412

1,440

Clay, blue, bard -- --- -- ---- --- \_

5 1,445

Clay, blue, hard, with thin streaks of packed sand \_ Fine sand, blue, with streaks of soft clay; water bearing \_

59 1,504

16 1,520

60 1,580

Clay, blue \_ •

* - \_

4 1,584

Clay, blue, hard \_ Very fine sand, blue, mixed with clay --------·-----------------------------

Clay, blue, with thin streaks of sand ---·-----------------------------------

Saud, dry, very hard ------------------------------------

Sand, dry, very hard, with streaks-of soft blue clay \_

Fine sand, blue, with streaks of clay; water bearing \_

Fine sand, blue, and some fine gravel; water bearing \_

Clay, blue, an. d streak-s--o-f-s--a-n-d-;--w--at-e-r--b-e-a-r-i-n-g---· --\_

= :::::,::::::::::

If!i:

Sand, blue, and fine gravel; wateJ,' bearing

\_

::::::::::::::::::::::::::::::::==:===:==:

22 1,606

4 1,610

30 1,640

8 1,648

2 1,650

14 1,664

26 1,690

16 1,706

2 1,708

16

10

. 24

' 6

6

6

1,724

1,734

1,758

1,764

1,770

1,776

8{! ; !• very hard --------------------------------------------------

/b i,b3!\_·:\_.::::::::::::::::-::: :::::::::::::::::::::::::::::::::::::::

gi: : t} :,

Sandy clay, blue, and fine sand; water-bearing \_

very hard -----------------------------------

Clay, blue, with streaks of fine blue sand; water bearing \_

Fine sand, blue; water bearing \_

Clay, blue - -- ---- - ---- \_

Coarse sand, blue, and fine gravel; water bearing \_

!Ifi.:!if; ::::=:::::::::=::::=:::::::::=::::::=:::::::=

4 1,780

5 1,785

11 1,796

30 1,826

4 1,830

8· **1,838**

9 1,847

18 1,865

21 1,886

2 1,888

30 1,918

8 1,926

12 1,938

10 1,948

7 1,955

TABLE 28.- *Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**4/13-15All. Dominguez Water Corporation well 15**

In Dominguez Gap, altitude 27 ft. Descriptions of material by Allen Sinnott and R. C. Newcomb of the Geological Survey, based on examination of samples which were collected every 10 ft. by Paul Karnes, driller for Roscoe Moss Co. Fauna! examination by S. G. Wissler. Depth interval commonly assigned on basis of interpolation between sampling points. Samples from surface to 220 ft. were taken from well 4/13-15A10 (Dominguez Water Corp. well 14), located about 200 ft. northwest ofwell 4/13-15All. Casing perforated at 800-990 ft. Reported yield 2,000 gpm with drawdown of 14½ ft.]

AlluSvoiaiJl. deposits:

Material

• • \_ \_

Thickness (feet)

**8**

8

Depth (feet)

Sand\_.

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-- • -

- - - - \_

**10** 18

Sandy silt, brownish gray to gray, with fine sand; grains granitic, subangular to rounded, with some mica and very little clay material

Gaspur water-bearing zone:

Gravel and sand, gray; fine to coarse quartzose sand, angular to subangular; cobbles to 6 inches in diameter. Greenish-gray silt and fine sand at 120 feet. Lower portion fossiliferous, with pelecypod fragments. Eighty to

**90** percent of the pebbles are granitic; remainder chlorite schists, argillites and phyllites ---------------------

Unnamed upper Pleistocene deposits:

Sandy silt, greenish gray, sand portion very fine to medium, angular to suban­ gular; pebbles to one-half inch in diameter at 160 feet, chiefly granitic; musco­ vite and biotite abundant. *A* few small chalky concretions, pellets at 170 and 180 feet; limonitic stains present. Pelecypod fragments present at 170

feet. At 190 feet, ferromagnesian minerals largely altered to epidote. Quartz and feldspar, 75 percent; dark minerals, 25 percent \_

Maebduiunmdasnatntdh,aonliivnesghraalylo,wanergusalamr ptoles bangular; largely granitic; garnet more\_

Siltysand, greenish gray, medium-grained, angular to subangular, and granitic; cahmlonigtedaanrkdegragrrnaeitnsw; sitohmbeiogtriatveealnpdreostehnetr ferro-magnesian minerals present\_

Medium sand, gray, angular to subangular, granitic; clean and well sorted \_

Sandy silt, olive green to gray, angular to subangular sand grains; with musco- vite and biotlte, some garnet and chlorite; some pelecypod fragments \_

*ti I* siiti-san<C ayishire-e to-gray-m1caceoiis:-iran1i:ic;-sanci-

gra1ns in lower portion are very well sorted, subrounded to subangular, and consist of about 75 percent quartz; other minerals include feldspars, micas, epidote(?), garnet(?), chlorlte, and ferromagnesian minerals \_

Sand, gray, buff, with a small amount of silt ­

Sand, gray buff, and gravel, moderately clean, poorly sorted; smaller grains angular, larger ones subangular; pebbles to 1 inch in diameter, largely of vein rocks and dark igneous rocks -----------------------------------

Sand and gravel, gray; sand, fine and fairly well sorted; gravel predominant in

iugpnpeeorusporortcikosnawndithvepienbbrolecsksto 1 inch in diameter, consists of basic and acidic\_

**San** Pedro formation:

Silty sand, gray; micaceous and predominantly silty in upper part, more sandy in lower portion. Sand grains angular to subangular, fairly well sorted in lower portion, and granitic. Gastropod and pelecypod fragments present

Silt and silty sand, gray, micaceous; silt in upper portion; pelecypod fragments

in lower sandy portion -----------------------\_--------------------- --

Sand, gray, coarse, very clean, fairly well sorted, angular to subangular, granitic; larger grains of metamorphic rocks in part. Epidote, garnet, magnetite or ilmenite, ferromagnesian minerals and pyrite are common among the heavy minerals. Pelecypod fragments present but rare\_---------------------------

Sand and gravel to three-fourths inch in diameter; pebbles consist of worn fragments of vein quartz, gneiss, granite, and chlorite schist\_ \_

Fine to coarse sand, gray, poorly to well sorted, silty in lower few feet, angular

to subangular; arkosic (feldspars 50 percent, estimated); more abundant biotite associated with silty portion \_

SiFlto, rgarmayin, wifeitrha silty sand in lower portion; pelecypod fragments, an-d--numerou--s-

Fine to medium sand, gray, angular to subangular, poorly sorted; granitic,

about 65 percent quartz, 25 percent feldspar, 10 percent other minerals; some silt present, and pelecypod fragments \_

Silty sand, gray, medium to coarse, with abundant pelecypod fragments ---

Medium to coarse sand, gray, clean, fairly well sorted, angular to subangular, Sagnrdaynistiiclt;,saonmdecslialyt ,pgrerasyenbtu, fafnd pelecypod fragments --\_

**67**

**67**

**48**

25

20

13

59

4

29

10

21

44

40

30

20

10

100

30

30

35

25

9

85

142

190

215

235

248

307

311

340

350

371

415

455

485

505

515

615

645

675

710

735

744

**4/13-15All. Dominguez Water Corporation well lo-Continued**

|  |  |  |
| --- | --- | --- |
| Material | Thickness (feet) | Depth (feet) |
| Silverado water-bearing zone:  Gravel and sand, subangular to rounded, granitic; pecten fragments; pebbles  to three-fourths inch in diameter; material grades fairly evenly, from pebbles |  |  |

to fine sand --·-----·-·-·-----·-----·---·---·---------·---·--·----········- 60 804

Sand and gravel to 1 inch in diameter, angular to subrounded; **about 30 percent**

feldspar, 55 percent quartz, 15 percent other minerals•• --•··················· **20 824**

Gravel and sand; pebbles to 1 inch in diameter-----------·-···-····-·········· 47 871

Gravel to 2 inches in diameter; sand nearly absent; sand up to about 10 percent

in lower part.---····--------·----···-·------------------·---····--··-···-··· 20 891

Sand and gravel, slightly buff.gray in upper portion to clean gray in **lower por•** tion. Composition of sand averages 75-80 percent feldspars, 20-25 percent quartz, with smaller amounts of other minerals, including micas (muscovite and biotite), ehlorite, epidote, garnet, pyroxenes, amphlboles, and **magnetite** or ilmenite.

From 15 samples, taken at 10-foot intervals from 900 to1,040 feet, 78 pebbles **were** selected at random, ranging from *¾* to 1 inch in diameter. The rock **types** present among these peobles were tentatively determined as follows:

Granitic rocks (including granite, granodiorite, and other **rocks) 61**

G:ranite, gneiss••••·········-····················. **8**

Pegmatitic vein rocks and vein quartz. **9**

Gabbroic rocks•••••••••••••••••·-····························-····· **6**

Biotite and chlorlte schists. **2**

ECxhterruts(i?v)e•(•?•)••i•g•n•e•o••u•s•r•o•c•k••s••••·•-•·•·•·•·•·•·•·•·\_··.·.·.·.·..·.·.·.·.·.·.·.·.·.·.·.·.·.·.·.·.·.·.·.·.·.·..-.·.· **11 163 1,OM**

**4/13-2302. City of Long Beach, Sllverado well.**

In Dominguez Gap, altitude 23 ft. Driller's record, with modifications based on description of samples by J. O. Kimble of Oalliorma Division of Water Resources, and by W.W. Paulsen of Geological Survey. Casing perforated at 615-900 ft. Well not used}

|  |  |  |
| --- | --- | --- |
| Alluvial deposits: |  | 20· |
| i Yand sand.::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | **45** | *65* |
| Sand •••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••• | 3 | 68 |
| OaspOulrawy.a·t·e·r•·b··e·a·ri·n·g··z··o·n-e·:·············-···································-······ | 10 | 78 |
| Gravel\_•• •••••••••.•••••• ••••••••••••••••••••••••••••••••••••••••••••••••••• | 44 | **122** |
| Unnamed upper Pleistocene deposits:  8t • yellow.:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: | 20  96 | **142**  238 |
| San Gravel and coarse sand, loose•••••••••••••••••••••••·--························  Ped!ro f·ormatio;n: ..  :iiii::::::iiiiiiiiii:i:iiiiii:=:;:::::::::::::::::::;::::;  Sandy clay••···-··.····-·••••••••• •••••••••••·- ••••••••••••••••••••••  Olay•• \_. ••••••····-••••••••••••••••••••• ••••.-·.•••-··•••••••••••••••••••  SCalnayd•w• -i·th.••som•e••g•r·a-v·e••L•••·•-••••·•-•-•···-·.··-· •·•-•·•·•·••·•·•·•-•·•-·\_·•·•·•·•·•·••·•·•·•·•·•·•·•·•·•-•·•·•·•·•·•·•·  Sllverado water-bearing zone:  Gravel, clean and loose, with a few streaks of coarse sand- ·-  g ; : :;,.d:;loose•••••••••••·----···--·---······-························  fn8!'8:r! ?• gray:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::  Coarse sand••·-················-·······-··-···················-·····-·········  Fine gravel and sand.·--······----···-··-······--·-······-····················  Coarse sand, arkosic, unweathered, loose, and well-rounded ••••••••••••·--·····  Band, cemented••••••••••••••••••••••••••\_•••••••••••••••••••••••••••••••••••• | 42  50  60  10  6  4  22  34  96  **14**  20  124  10  170  50  8  40  **34**  **34**  8 | 280  330  390  400  406  410  432  466  562  576  596  720  730  900  950  958  998  1,032  1,066  1,074 |
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TABLE *28.-Materials penetrated by typical water wells in the coastal zone of the Torrance-Santa Monica* area-Continued

**4/14-8D1. California Water Sem.ce Co.**

[About 1 mile east of Redondo Beach,1.altitude 146 ft. Driller's record, with modifications based ondescrip­ tion of samples by F. B. Kelsey of ua1ifornia Division of Water Resources. Casing perforated at 198-206 248-272, 384-396, and 490-MO ft. Yield about 344 gpm; drawdown not known]

Material

Dune and beach sand:

Sandy soil, reddish brown••••••••••••••••••••••••••••••••••••·-···············

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1 l i":!S f:fwn.·ooiisic1erab1yweatiieniJ;ieiJspar.decoiii:·

posed and kaolinJ.zed, apparently beach sand······--························

Fine sand, light brown unweathered, and·containing pelecypod fragments; apparently beach sand••••••••••••••••••••••••••••••.•••••••••••••.•••••••-••

Fine to medium sand, light gray, With a few pebbles of granitic and dark• grained igneous rocks; pebbles moderately well-rounded and about 1*¼* inches

**San** Peindrmoafxoirmamtiodni:ame' tlll' --·•····--········-··············--·--····--······--···

Silverado water-bearing zone, 138-556 feet:

Sand, gravel and shells•••••••••••••••••••••••••••••••••••••••••••••••••••• Fine to medium sand, dark gray, with shell fragments••••••••.•••••••••••• Sand and gravel, dark gray, granitic; size-ranges from fine sand to pebbles up to 1 inch, in diameter; pebbles consist of granitic and dark-grained

igneous rocks; also pebbles of cherty shale••••••••••.•••.•••••••••••••••• Silt, irregularly oolored yellow and blue, fine to coarse sand, gray, granitic;

fragments **angular** and unweathered; contains a few pebbles of granitic rocks subangular, ranging in size to 2 inches in diameter••••••••••••••••• s t!el·=es ef: 1. . . .:. . -

Coarse sand, gray, gnµiitic, With a few small subangular pebbles up to one-

balf inch **1n** diameter••••••••••••••••••••••••.•.••.•-··-···--············

· Coarse **san gray, granitie,** w.tth pebbles up to 2¼ inches in diameter••••• Silt, **gray, bTegnlar,** banded, mottled light and dark••••••••••••••.•.•••••.

Sand and **gravel, gray,** granitic, ranging from fine sand to coarse gra v l with pebbl **to 5** inches in\_@.m111ter; gravel 50 percent by volume•••••••••••••

Silverado water-bearing zone, 138-556 feet-Continued:

Medium sand, gray, granitic, fragments angular.---··-·······--·-····--·-· Fine sand, dark gray, containing gastropods and pelecypods, prin¢pally

Thickness (feet)

4

**,5**

**21**

54

**51**

16,

16

*·:*

J20 8

22

10

10

24

**48**

Depth (feet)

4

9

30

84

**138**

**154**

170

**178**

**198**

228

'2**2**3**4**8**8**

**272**

**320**

small forms.·- -···-..••·--

.······--·-··--\_. ·-

··-

-- •

**18** 338

**8ilt 1** bluish gray, micaceous, With locally irregular bodies of very fine light

**gray** sand••••..•••.••••••....---·-·-•..••.•.•.•-. -. -·- --- -•• ·- -·- •· Sa,nd and gravel, gray, principally granitic; sand fine to coarse with angular

8fntsJi :!l!r - - - - - - :- . . - Fine to coarse sand, gray, griµiitic, wit.h angular fragments, and a few 1: J:su!i i :; J it i: ooarsematei:iaiupto.one=Eiiihi11-1ncli·

&e :

46

10

162

384

394

556

**lD** diameter••••••••••••••••••••••••••\_•••••.\_.•

.•••\_--·.•••••••\_••••••\_

8 564

TABLE' *28..:..,;\_Materials penetrated by typical water wells in the coastal zone of the' Torrance-Santa Monica* area-Continued

**4/14-13Fl. David E. Crutcher. Formerly City of Los Angeles, Torrance plant, well 1**

f About I mile southeast of Torrance, altitude 49 feet. Casing perforated at 245-260, 348-368; and 647-670 ft.

Yield on test 1,660 gpm with drawdown of *65* ft]

Material

DepSoosillts of upper Pleistocene age, undivided:

Thickness (feet)

\_

Depth (feet)

C:lay:, ;yieil[loJw ow,an-d--s-h-e-l-l-s ·\_

Clay, yellow "200-foot sand":

Sand and shells --------•--- ------------------------------·-----------

2 **2**

42 44

3 47

12 59

15 74

6 80

Fine sand . . - -. -- ---- ------------

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------ --

4 84

Cemented sand -. --

.. -

--- \_.- \_- - -.- - -- -- --- --- •-

1 85

8;1:f shells, sand and graveL••------------------------------·----------· ·4 89

Coarse sand .

. . .. - - \_ \_

6 95

Clay, blue - - - - • • . • - - --- ---- -- .. -- . ---

9 104

Fine sand, blue --·. . .. • .. .-------

SanPedro formation:

18 122

33 155

Clay, blue .\_ -- . -- .. . -- --- - . --- -- --- \_- -- ---

Sllverado water-bearing zone:

90 245

12 257

Cwoia:r:sei:fsaanvde.L== ==. =-=. =\_==. ==== . ======= ==.==--.===..=.==.=\_.=-==-=--=-=-=-:-=:- -=-=-=-==-=-=-=--=-==.=--=-=-=-=-=-=-=-=-

g ::::: •

fine gravel...----------------------------------------

12 269

76 345

21 . 366

27 393

Cemented sand .. ---

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.. -- .- \_ \_ - \_ ... -- -- - ---- -------- -----.

1

111

394

*505*

L: <\;l ue\_=:::::::::::::::::::::::::::::::::::::=::::::==::=::::::::::

52 557

24 581

Silty sand - - U

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| nl! i ;:e graveL. ----- ------ 27 647 | | | | | |
|  |  |  |  | 21 | 668 |
| Silty sand. . |  |  | - | 42 | 710 |

- \_.

- -

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39 620

**4/14-28JJ. Weston Ranch, well 6**

(About 3 miles southwest of Torrance, altitude 165 ft. Casing perforated at 290-306, 41()--415, *424-445,* and 470-600ft]

DepSoosiitls. of upper Pleistocene age, undivided:

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**Un** and **clay............................•........................•...**

Sand . • .

San ii:J;/J: tion:-··

Sllverado water-bearing zone: Sand .. ---- -- --

GraveL • - --------

Sand - - -- - --

Gravel.• . - - --

Sand .\_ - ----------

SGarnadvel - - .. -. ---

Fine gravel • -- .

·- --·- ·--

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25

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' 9

92

123

9

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35

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146

269

278

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.. . - -- .\_. - --- ---------------------------

12

16

104

5

9

21

25

30

290

306

410

415

424

445

470

600

TABLE *29.-Field analyses of waters from wells in the coastal zone of the Torrance­*

*Santa Monica area, 1943-46*

[Analyses by U. S. Geological Survey]

Well

Date

Chloride ion (CI)

Soap hardness as

Specific conduct- ance (mi-

Tem- pera-

Remarks

(parts per CaCOa

cromhos

ture

million)

(parts per at 25°0) million)

2/13-31KL. **Jan.** IO, 1945

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|  |  |  |
| --- | --- | --- |
| 28 | 160 572 | |
| 23 | 150 544 | |
| 25 | 140 559 | |
| 39 | ISO 654 | |
| 46 | 260 856 | |
| 27 | 230 666 | |
| 78 | 270 903 | |
| 49 | 165 640 | |
| 163 | 230 1,190 | |
| 83 | 280 1,150 | |
| 70 | 295 804 | |
| 332 | 425 2,060 | |
| 346 | 440 1,730 | |
| 68 | 220 802 | |
| 211 | 425 1,630 | |
| 123 | 315 1,100 | |
| 97 | 235 1,020 | |
| 135 | 275 1,070 | |
| 36 | 205 649 | |
| 26 | 160 670 | |
| 35 | 200 | 645 |
| 56 | 255 | 791 |
| 30 | 145 | 584 |
| 31 | 165 | 587 |
| 25 | 190 | 516 |
| 33 | 210 | 632 |
| 25 | 180 | 572 |

32F3 Jan. 13,1945

32NL Jan. 23, 1945

32N2 Jan. 13, 1945

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2/14- 3KL. June 8, 1945

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4Nl **1** Dec. 10, 1945

5D5 Junedo14, 1945

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5D76 .••••. do

--------

5Dl0 do 7M. Dec. 10, 1945

7PL Sept. 5, 1945

8011 Apr. 17, 1915

lOFJ. June 9,1945 18F2 Dec. 10, 1945

18QL••••• July 8,1944

1901.

Nov. 7, 1944

19KL•••• June 29, 1944

July 1944

-\_----...---

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--------

Time elapsed after pumping: 15min.

**22N2---- -**

Nov. 3,1944

--------

l½hr.

22N3 July 1944

22N4 July 1944

Nov. 3, 19442

Apr. 27, 1945

Nov. 8,1945

22N5

July 1944

22P2

July 1944

27D2•••••• July 1944

Nov. 3,19442 161

161

515

315

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nov. | 3,19442 | 25 | 145 | 559 |
| Apr. | 24, 1945 | 25 | 195 | 577 |

--------

1,430 ----------------

1,390

I day. **l½hr.** l½hr. 15min. 2½hr.

l½hr. 24 hr.

24 hr. Imo. l½hr.

15min,

Apr. 23,1945

27D3

July 1944

Nov. 3, 1944

27JL.

May 23,1945

**28El.** Nov. 8, 1945

156

122

121

24

23

320

450

275

120

150

1,070 --------

1,200 --------

1,190 --------

493 --------

443 ----------------

1 hr. l½hr.

15 min. 5hr.

July 1944

Nov. 6,1944

93 375

85 330

1,110

1,050

--------

.-..

24hr. 2½br.

28FL••••• July 1944

Nov. **6,** 1944

28LL ••••• July **1944**

Nov. 6,1944

**28ML.**

July 1944

Nov. 6, 1944

**32El. •..•.** Apr. 27, 1944

Nov. 7, 1944

**32FJ.**

July **1944**

Nov. 3,1944

32F2

July 1944

1'.l.ov. 3, 1944

3401

June 29, 1944

**2/15- ICL**

105 Junedo14,1945

2EL June 1945

2F2 •• June 16, 1945

do

9LL.

1101. June 30, 1945

1102 July **1,**1945

1103 July 2,1945

1105 July 4,1945

1106 June 28, 1945

1107 June 28, 1945

1108 June 29, 1945

UDL.•••. June 19,1945

11D2 July 3, 1945

11E3 June 28, 1945

June 19, 1945

June 28, 1945

11E5

June 19, 1945

June 28, 1945

11F2

June 15, 1945

See footnotes at end of table.

93

112

108

44

92

**119**

86

83

**89**

89

102

101

26

46

61

53

55

147

49

70

81

43

51

56

70

52

53

46

48

47

46

46

84

325

245

340

195

290

305

230

280

250

215

250

215

145

225

260

270

285

225

340

375

425

290

325

365

390

340

415

440

270

375

315

425

345

1,010

893 --------

1,230 --------

659 --------

990 --------

1,000 --------

927 --------

890 --------

--------

875

872 --------

895 --------

872 --------

--------

516

840 --------

824 --------

873 --------

847 --------

1,050 --------

862 --------

1,060 --------

1,090 --------

896 --------

884 --------

934 --------

1,060 --------

1,000 --------

1,030 --------

1,100 --------

960 --------

984 --------

1,020 --------

1,050 --------

969 --------

24 hr. 15min. 24hr. 20min. 24 hr.

19 min.

24hr. 24hr.

3 i hr. 5½br. 14 hr. 8hr. 12 hr.

12 hr.

10½ hr.

**7hr.**

6 hr.

10hr.

TABLE *29.-Field analyses of waters from wells in the coastal zone of the Torrance- Santa Monica area,* 1943-46-Continued

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Soap | Specific conduct-  ance - crom os at 25°0)  1,060  1,070  1,240  1,060  1,130  1,850  4,200  1,940  1,220  3,020  1,930  1,050  1,300  1,310  1,090  3,230  2,370  2,770  3,290  4,240  3,400  6,310  2,870  1,960  1,820  2,410  2,640  2,570  3,230  2,100  1,670  2,350  941  992  923  948  987  990  709  696  709  **744**  779  612  615  756  1,200  1,260  547  706  609  598  559  545  536  565  804  610  676  647  856  575  1,850  1,100  725  600  571  581  555  545  539  544  930 |  |  |
|  |  | Chloride | hardness | Tern- |  |
| Well | Date | ion (Cl) (parts per million) | as  CaCOa (parts per million) | Remarks |
| pera- ture |
| 2/15--UF3. | June 19, 1945  June 28, 1945  June 14, 1945  June 14, 1945  Sept. 5, 1945  July 7, 1944  Sept. 5, 1945  .....do.•......  do ........  May11,1945  May 4, 1945  June 15, 1945  Apr. 26, 1945  May 3, 1945  June 14, 1945  Apr. 16, 19451  .•..•do1•••••••  A.,r. 17, 1945  Apr. 28, 1945  Apr. 16, 1945  ....•do •  Apr. 17, 19451  Apr. 28, 1945  Apr. 16, 1945  .....do..•..•••  .••.•do.I••..•.  do.I•..•..  May 4, 1945  Apr. 16, 19451  Apr. 28, 1945  Aprd.o16, 1945    July 5, 1944  Aug. 25, 1944  Nov. 2, 1944  Apr. 13, 1945  July 20, 1945  Oct. 30, 1945  Aug. 25, 1944  Nov. 2, 19442  Apr. 13, 1945  July 20, 1945  Oct. 30, 1945  Jan. 9, 1945  .....do..••. •  Jan. 6, 1945  ..••.do•.••.•••  .....do........  Dec. 30, 1944  Dec. 27, 1944  Dec. 29, 1944  Dec. 28, 1944  Dec. 27, 1944  Dec. 28, 1944  .....do.••. •  Apr. 4, 1944  June 16, 1944  .•.•.do..••..••  .....do.•. •••  Apr. 4, 1944  June 15, 1944  June 16, 1944  .•••.do•. ••••  .....do ••  Dec. 3, 1943  June 16, 1944  Apr. 4, 1944  June 17, 1944  .....do...•....  .....do........  Apr. 4, 1944  June 17, 1944  Apr. 4, 1944 | 82 | 340 |  | Time elapsed after pumping: 10 hr.  15min.  15 min.  2hr.  30mln. 30min. 14min.  Sulfide odor. |
|  | 80 | 415 |  |
| 11J2.•...•. | 147 | 350 |  |
| 11J3....... | 101 | 250 |  |
| 12BL..••. | 90 | 365 |  |
| 13AL•..•. | 312 | 480 |  |
| 13J2....... | 626 | 1,050 |  |
| 13J3 •.• | 261 | 440 |  |
| 13KL..... | 115 | 340 |  |
| 13K2 •• | 447 | 525 |  |
| 13ML.••• | 204 | 665 |  |
| 1401.•.... | 85 | 240 |  |
| 14ML•••.. | 108 | 315 |  |
| 14Pl.••••. | 110 | 400 |  |
| 15A4••.... | 85 | 325 |  |
| 22B2.•.... | 223 | 700 |  |
| 22B3•••••• | 202 | 625 |  |
| 22B5.••••• | 206 | 600 |  |
| 2201.••••• | 369 | 975 |  |
| 22Fl.••.•• | 807 | 1,250 |  |
| 22F2•••••• | 521 | 1,100 |  |
| 22JL••••• | 1,640 | 2,300 |  |
| 22LL ••••• | 340 | 875 |  |
| **23AL.....** | **324** | 340 |  |
| **23A2......** | 323 | 340 |  |
| 2301•••••. | 340 | 565 |  |
| 23HL.•••• | 302 | 725 |  |
| 23J2••••.•. | 358 | 500 |  |
| 23NL.•.•. | 452 | 625 |  |
| 23P2•••••• | 266 | 565 |  |
| 24DL..•. | 286 | 340 |  |
| 24E2••.••. | 235 | 775 |  |
| **34AL.....** | 116  119 | 290  295 |  |
|  | 119 | 220 |  |
|  | 125  127 | 215  245 | 72 |
|  | 133 | 275 |  |
| **34KL.....** | 89  89 | 130  130 |  |
|  | 91  97 | 155  150 | 70 |
|  | 102 | 195 |  |
| 3/13- 5FL ••.•• | 32 | 170 |  |
| 5F2 •••••• | 30 | 170 |  |
| 9F2 ..•.•• | **73** | 190 |  |
| 9F3 .••.•• | 61 | 400 |  |
| 901.••••. | 108 | 440 |  |
| 9NL ••... | 21 | 160 |  |
| 16JL.•.••. | 37 | 215 |  |
| 16M2...••• | 28 | 155 |  |
| 16NL..••• | 29 | 165 |  |
| 16RL••..• | 25 | 155 |  |
| 17FL••.•• | 22 | 130 |  |
| 17RL.•••• | 30 | 135 |  |
| 17R2..•••• | 25 | 155 |  |
| 19AL ••••• | 107 | 200 |  |
| 19A3•••... | 55 | 175 |  |
| 19A5.••.•• | 79 | 180 |  |
| 19Bl.••••. | 129 | 180 |  |
| 19D2...••. | 121 | 240 |  |
| 19J3•...••• | 27 | 150 |  |
| 19KL••••• | 180 | 475 |  |
| 19QL•••.• | 124 | 250 |  |
| 19Q2.•.••. | 68 | 210 |  |
| 20A2.•..•• | 26 | 175 |  |
| 20B2.••••• | 26 | 155 |  |
| 20H3.••••. | 25 | 165 |  |
| 20J3.•.•••. | 24 | 165 |  |
| 20L3•••••. | 22 | 150 |  |
| 20L4..•••• | 24 | 130 |  |
| 20L5 •• | 23 | 150 |  |
| **20NL.....** | 93 | 200 |  |

See footnotes at end of table.

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TABLE *29.-Field analyses of waters from wells in the coastal zone of the ,Torrance­ Santa Monica area, 1943-46-Continued*

Well

Date

Soap Specific Chloride hardness conduct- ion (Cl) as ance(mi- (parts per CaCOs cromhos million) (parts per at 25°0)

million)

Tero- pera- ture

Remarks

3/13-20P2.••••• June 17, 1944 30 155 648

20P3•••••• Apr. 4, 1944 111 330 851

21C02L••••. Apr. 5, 1944 24 165 583

••••.do

2103

26 145 604

2104

Apr. 6, 1944 25 150 594

Apr. 5, 1944 24 130 575

21EL ••••• June 21, 1944 23 150 571

21GF22..•.•• Apr. 5,1944 21 175 1,030

•..•.do

40 370 1,380

21NL••••• Dec. 8,1943 21 130 507

P ••.•. Apr. 6,1944 23 120 557

22QL

Apr. 4,1944 22 115 502

26.JL••••• Dec. 21, 1944 35 195 685

26LL ••••. •••..do

28 195 558

26ML•••• Apr. 3, 1944 26 140 564

26QL.•••• Dec. 21, 1944 35 155 635

26RL•••• •••••do.•••••.. 32 50 399

28BL••••• Decd.o 8,1943 24 140 471

2803

368 675 2,040

28DL do •••••••• 23 120 429

28D2 do .••••••• 28 190 599

28EL.•••• do •••••••• 42 200 674

28E2••.••. ••••.do•••••••• 21 120 409

28021..•••• •••••do•.•••••• 23 190 557

Sulfide odor.

••••.do

2803

23 150 496

•••••do•••••••• 44 190 658

29AL3L••••. •••••do

24 140 545

Dec. 9, 1943 26 160 557

L••••• Dec. 8, 1943 27 160 851

29B2

Dec. 4,1943 54 175 911

3•••••. Dec. 9, 1943 70 150 855

29B4

Dec. 4, 1943 44 140 841

|  |  |  |  |
| --- | --- | --- | --- |
| 29CL••••• ••••.do.•••.••.  2902.•••.. ••••.do | 83  100 | 180  185 | 989  1,030 |
| 29E2L••••• Dec. . 3, 1943 | 39  125 | 140  275 | 900  1,190 |

29E3. Decd.o 4, 1943

do

200 300 1,500

29E5•.•••• do

133 200 1,160

208 325 1,420

29E6 Decd.o 3 1943 99 230 1,180

29E7

171 275 1,520

29E8 Decd.o 4, 1943 136 295 1,530

29FF2L •.•.. do

74 175 1,260

29F3 do

29F4 do

29F5

193 300 1,300

160 245 1,340

134 170 1,270

Dec. 3, 1943 170 255 1,490

29F6 do

183 260 1,690

1.....• Dec. 4, 1943 122 195 1,430

2903 do

42 140 776

29NL•.•. Decd.o 3, 1943 24 135 548

29N2.•....

40 95 458

30A2.•.••. Dec. 2, 1943 25 100 413

.•..•do

30CL.....

30F2 do

3004 do

66 175 723

100 250 930

191 440 1,520

30HL•... Decd.o 3, 1943 215 515 1. 760

30H2

30JL do.

30J2 do

30J3 do

30JL do

3015 do

30KL do

30K2 do

109 270 .878

25 110 471

144 250 972

185 350 1,320

400 600 2,180

127 250 , 931

94 200 808

77 205 774

30L2 Decd.o 2,1943 53 185 681

30L3

30L4...•.. do

88 245 1,010

244 325 1,390

30L5 Dec. 3, 1943 263 440 1,830

30L6 Decd. o 2,1943 82 250 771

30M2

30M3 do

251 475 2,090

83 310 995

30NL Dec. 3, 1943 35 130 625 69

See footnotes at end of table.

TABLE *29.-Field analyses of waters from wells in the coastal zone of the Torrance­ Santa Monica area, 1943-46-Continued*

Well

Date

Chloride ion (Cl)

Soap Specific hardness conduct­ as ance (mi­

Tem­

pera­

Remarks

(parts per CaCOa cromhos tore

**3/13-30QL** do

30Q2.··-·- do ..•.....

**30Q3......** Dec. 2, 1943

million)

335

275

309

(parts per at 25°0) million)

500 **1,910**

**1,750**

525 2,110

**30Q4......** Dec. 3, 1943 417 690 **2,450**

30Q5...... ....•do .\_ 211 400 1,570

30R2••.•.. .do .....•.. 23 145 536

3/14-1 B2•••... Jan. 23, 1945 24 160 **496**

**2FL.....** June 21, 1944 40 160 **588**

3AL •.... June 27, 1944 36 125 586

**3JL .....** .• do ........ 156 300 882

Nov. 7, 1944 234 260 871

8D2 .•.•.. Apr. 27, 1944 133 225 889

Nov. 7, 1944 **123** 210 869

Nov. 8, 19452 134 280 813

8GL ....• Apr. 27, 1944 188 240 1,070

Time elapsed after pumping: 10 min.

8G2 •do

217 280 1,130

8NL •... Apr. 25, 1944 202 275 1,240 3min•

.....do .

**150** 240 1,120

15 min.

8N2..••.. .do

221 275 1,470

9EL •...\_ May 24, 1944 28 125 479

9NL ..... Junedo27, 1944 **33** 145 648

9N2..•...

Nov. 7, 1944

30 135

29 **115** 547

--------

Apr. 14, 19451 29 90 542 --------

9N3 ....•. June 27, 1944 138 275 866 --------

7, 1944 ---------

Nov. 48 **135** 614

Nov. 9, 1945 38 **160** 535 --------

---------- --------

9NL •••. June 24, 1944 **31 130**

Nov. 9, 1945 **31** 160 488

**lOAL .....** May24, 1944 41 **140** 553

Aug. 25, 1944 42 155 560

lOCL••... Nov. 8,1944 31 **115** 486

lOGl.•.••• July **1944** 43 180 580

Nov. 6, 1944 39 215 550

llDL.•••• May 24,1944 75 160 **636**

***·····12·***

11G2.••••• ....•do..•--.-- 26 120 461

llJL.•••• **Nov.** 9, 1945 35 245 **606**

12BL••••• Oct. 10, 1945· **33** 195 591

12Q2..•••. Jan. 23, 1945 24 130 467

13BL•.... Jan. 24, 1945 **24** 100 465

**13FL .....** July 17, 1944 **34** 170 572

**13Ml...... .....do........** 145 150 660

**13PL.....** ••.•.do...•.... 121 225 706

**13QL.....** Nov. 15, 1943 **322** 640 **2,360**

**13QL.... .....do........ 410** 690 2,480

**14AL.....** June 21, 1944 **31 160** 590

**14Ml......** May25,1944 33 150 584

15BL•.•.. •...•do...•.... **32 110** 528

**17ML.....** July 6, 1944 145 265 862

Nov. 8, 1944 148 30 880

**18AL.....** May25, 1944 107 205 775

**18N4......** Oct. 13, 1943 **132** 160 757

19AL •..•. Oct. 9, 1943 91 150 639

19CL •.... Oct. 13, 1943 123 **160 728**

Aug. 11, 1944 116 195 759 72

Oct. 24, 1944 118 190 738 72

Oct. 30, 1945 **109** 220 745 **72**

20J2...•.•• Oct. 9, 1943 **35** 130 585

20PL•.••• **.....do........** 44 135 578

**21RL.....** Oct. 18, 1943 **32** 135 532

2201..•••• ••..•do•••••••• **33** 155 545

22RL•.•.. .....do.•••..•. 36 130 **523**

22R2•.•••• ....•do..••.... 155 250 922

Nov. 8, 1944 159 240 931

23QL.•.•• Oct. 14, 1943 434 405 2,020

**23R2......** Oct. 15, 1943 59 185 645

**24Al......** Nov. 15, 1943 147 230 945

**24A2......** .•..•do.••..... 255 410 1,900

24Bl•••••• **.....do........** 76 190 **732**

24GL ••••• Feb. , 1944 353 390 2,070

24Kl•••••• Nov. 15, 1943 268 280 1,630

**See footnotes at end of table.**

**460508-59-26**

Sulfide odor.

Time elapsed after pumping: 30min.

**13min.**

lmln.

**5min. 5min.**

TABLE *29.-Field analyses of waters from wells in the coastal zone of the Torrance-*

- *Santa Monica area, 1943-46-Continued*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Well | Date | Chloride ion (Cl) (parts per million) | | Soap hardness as CaCOs (parts per million) | Specific conduct- ance(mi- cromhos at 25°0) | Tern- pera- ture | Remarks |
| 3/14-24K3 1943  24K6 Nov. 15, 1943  24QL..•.. Nov. 16, 1943  25E4. Nov. 18,1943  25JL...... Nov. 16, 1943  25K3 do  25K4 • do  25L3...•.. Nov. 18, 1943  25N2.•••.. .....do .\_ ...  25N3....•. do •.•..---  25N4.•••.. Nov. 19, 1943  25PL••••• Nov. 16, 1943  25P2••.•.. Nov. 18, 1943  **26A2......** Nov. 17, 1943  26BL •..•. Oct. 14, 1943  26B5•••.•• Nov. 18, 1943  26CL ••.•• Oct. 14, 1943  2604••..•. Nov. 18, 1943  26E2••..•. Nov. 16, 1943  26E3•••.•• Nov. 17, 1943  26FL••••• Nov. 5, 1943  2601..•••. ..•.•do..••....  2602••..•. Nov. 17, 19431  26.TL...•. Oct. 29, 19431  26KL ..••. Nov. 17, 1943  26LL•.••. Nov. 5, 1943  Nov. 19, 1943  26L3.•••.. .•.••do..•.....  26M2••.•.. Nov. 5, 1943  26NL..•. Nov. 4, 1943  26Pl.•••.. Nov. 19, 1943  2oP2.•••.. ....•do.•••..•.  26Q2••.••. Nov. 4, 1943  26Q3.•.••• .....do..•.....  26Q5••..•• Nov. 16, 1943  26RL•••• Nov. 19, 1943  Nov. 2, 19442  - 9,1945  14, 1945  26R2.••••• Nov. 19, 1943  26R3.•.••• .....do •  27JL.••••• Nov. 4, 1943  27J32-.\_•••••• Nov. 5, 1943  •....do..•.•.•.  27KL ••••. Nov. 4, 1943  Nov. 15, 1944  Apr. 14, 1945  Nov. 9,1945  27K2.••.•• Nov. 5,1943  27K3•••••• ...•.do..•.....  Nov. 2, 1944  27K4 Apr. 14, 1945  27K5 Nov. 5, 1943  .••••do........  27LL •••.. do ••.•  27L2.••••• Nov. 17, 1943  27M3....•• ..•.•do..•.•••.  27NL•••.. ....•do.\_..  27N3.••••• ..•.•do ••  27N4••.••• do ..•. ••  27N5 ••.••do •.••  27Pp23.••.•• Nov. 5, 1943  27P4 Nov. 6, 1943  27P5 Nov. 17,1943  •....do ••  Nov. 8, 1944  r. 14, 1945  ov. 9, 1945  27P6•••.•• Nov. 17, 1943  27QL..... Nov. 5, 1943  27Q4. •••••do..•••••• | | | 354  224  574  251  50  216  51  235  263  22  25  57  280  489  685  518  1,130  265  82  146  1,020  36  2,380  50  32  31  127  127  198  36  27  29  25  121  30  1,560  1,010  1,030  1,270  24  23  76  77  188  105  110  138  123  189  89  94  97  97  66  131  78  64  129  44  64  120  55  47  52  103  83  80  130  774  139  1,120 | 480  425  500  245  120  360  180  260  300  145  160  165  275  390  775  450  1,150  340  180  300  950  130  1,950  165  125  150  195  195  240  160  130  130  185  190  140  1,500  725  1,050  1,800  155  140  240  170  245  185  245  220  290  270  180  190  250  180  195  230  230  260  150  240  300  160  150  210  280  195  180  260  150  190  800 | 2,200  1,750  2,280  1,430  722  1,900  631  1,660  1,230  528  554  654  1,600  2,300  2,670  2,630  4,070  1,250  722  900  3,890  552  7,630  587  518  546  815  815  1,290  549  498  499  506  803  506  4,900  3,210  3,270  3,640  548  521  716  694  996  790  838  854  761  1,030  743  750  747  765  686  874  723  678  978  621  688  863  653  627  641  807  722  705  690  2,920  836  3,750 |  | Sulfide odor. |
| Do. |
| Do. |
| Do. |
| Do. |
| Do• |

See footnotes at end of table.

TABLE *29.-Field analyses of waters from wells in the coastal zone of the Torrance.*

*Santa Monica area, 1943-46-Con.tin.ued*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Well | Date | Chloride ion (Cl) (parts per million) | | Soap hardness as CaCOs  (parts per million) | Swcific conduct- ance r,1- crom os at 25°C) | Tern- pera- ture | Remarks |
| 3/14-29D3  29GL  29ML.  29Nl••••••  30DL••••  30HL••••  **30ML.....**  **31AL..•••**  **31A3...•..**  **31A4.••...**  31El••••••  **32AL ••...**  32HL •••••  32H2••.•••  3211..•••••  32RL•••••  33A2.•••••  **33A3......**  33BL•••••  33EL•••••  330E12--··-- | 1945 May 29,1944  Aug. 14, 1944  May 29,1944  Aug. 14, 1944  May 29,1944  Aug. 15, 1944  Aug. 7,1944  Aug. 15, 1944  Oct. 24, 19441  Apr. 13, 1945  Oct. **8,** 1943  Oct. 15,1943  Aug. 15, 1944  Oct. 24, 19441  Apr. 13, 1945  Oct. 30, 1945  Oct. 22, 1943  Nov. 16, 1943  Aug. 14, 1944  Oct. 24, 19442  Apr. 17, 1945  May29, 1944  Aug. 14, 1944  May29,1944  Aug. 14, 1944  Nov. 9,1945  May29,1944  Aug. 14, 1944  Nov. 9,1945  May 18,1944  Sept. 4,1944  Oct. 24, 19442  Apr. 13, 1945  July 20, 1945  May29, 1944  Aug. 14, 1944  Nov. 15,1944  Oct. 22, 1943  Nov. 13,1943  Oct. 19, 1943  do ••.•  Oct. 20,1943  .•••.do.•.•••••  do ........  Oct. 19, 1943  •. do .....  Oct. 21, 1943  Oct. 20, 1943  Oct. 21, 1943  Oct. 20,1943  Oct. 20, 1943  Oct. 9, 1945  Oct. 19, 1943  do ........  .....do...•..--  do. ...  Nov. 4, 1943  Oct. 19,1943  Oct. 22, 1943  .....do .  Oct. 29, 1943  Oct. 22, 1943  do .-..-  ... do ....-.--  Nov. 3,1943  .....do\_.......  Oct. 29, 1943  .....do\_·---·-- Nov. 3, 1943  do .  . ·--..do----·-- | 45  60  57  73  71  68  62  156  160  229  351  81  **74**  74  **78**  76  75  200  330  206  175  265  57  56  50  48  59  50  48  46  56  63  68  53  51  83  60  60  53  90  59  104  125  50  44  46  51  91  53  **43**  **48**  31  30  30  47  36  74  28  41  39  39  28  105  49  55  94  53  30  113  25  fl.  51 | | 110  155  165  180  180  160  155  245  250  160  425  170  180  180  125  120  206  230  **350**  290  270  325  155  160  140  130  200  140  130  200  125  185  115  155  185  170  **190**  165  140  80  125  125  350  170  175  140  145  180  145  95  130  130  145  125  125  140  120  130  130  140  130  **120**  215  165  150  180  160  130  220  120  200  170  210  210 | 1,070  **644**  642  673  670  659  636  903  930  1,090  1,490  705  694  694  635  675  703  1,040  **1,790**  1,070  957  1,250  648  647  620  617  643  620  617  611  587  662  625  562  629  746  647  627  573  575  511  562  1,040  645  665  552  559  711  584  527  555  459  457  453  523  489  608  475  492  523  525  450  849  631  572  698  564  483  893  451  630  571  822  741 | ------7-2-  ------7-2-  ---------  72  ----------------  72  ----------------  72  --------  -----------------  ----------------  ---------  *···-·14"*  *·····14"*  --------  72  -----------------  -----------------  --------  ··-··ff  .., | Time elapsed after pumping, 7hr. |
| About8hr. |
| 5 hr. |
| 6 hr. |
| 5hr. |
| 2hr. |
| 5hr. |
| 2 hr. |
| 6hr. |
| **8hr.** |
| -------------  ----------------  ----------------  .,.  -----------------  --------  --------...  --------  ----------------  ----------------  --------  --------  --------  ----------------  ----------------  --------  --------  --------  --------  --------  --------  --------  --------  --- -----  --------  --------- |  |
| 33H4•••••• |  |
| 33H5•••••• |  |
| 33JL•••••• |  |
| 3312..•••.. |  |
|  |  |
| 33KLLl.•.••- |  |
| 33L4.••..•  33PL••  33P2.  33QL.  34AL  34B2  34CL.....  34DL  34D2  34DF23.•••.• |  |
| 34F3••••.•  3401.  34Jl\_ ·-  34K2......  34LL....  34ML... | Sulfide odor. |
|  | | |  |  |
| ! L==== =====i -=: ====! | | | 82 |  |

See footnotes at end of table.

TABLE *29.-Field analyses of waters from wells in the coastal zone of the Torrance­ Santa Monica area, 1943-46-Continued*

Well

Date

Chloride ion (Cl)

Soap Specific hardness conduct- as anceri-

Tem- pera-

Remarks

(parts per CaCOa crom os ture

million)

(parts per at 25°0) million)

**3/14-35Al.** Oct. 29, 1943

58 150

595

35A2 Nov. 4, 1943 32

504

35BL.---- Nov. 3, 1943

26 160

528

35B2 Nov. 4, 1943

78 200

692

35B3 do \_

35B4 Nov. 3, 1943

35CL Nov. 4, 1943

35HL do \_

35H2 do \_

59

28

33

63

707

170

160

150

110

550

588

504

485

566

2,500

Time elapsed after pumping: 15 gal from well.

35KL May 15, 1944 120 165 728

35L2 Nov. 3, 1943 27 160 516

35L4 do

35ML\_ do

35M3 do

55 150 538

30 130 537

27 120 448

Nov. 30, 1944 26 115 442

35Rl **1** Nov. 20, 1943 33 . 90 440

36D2 Nov. 19, 1943 22 120 507

36D3 do

36FL do

21 140 513

24 120 469

36GL Nov. 16, 1943 22 115 464

36J2 do

36J3.. do

36KL do

97 185 793

66 185 724

22 80 400

36LL..... Nov. 19, 1943 32 **120** 484

36L2 do.

36ML. do

25 120 469

32 105 469

36Q2 Nov. 16, 1943 23 115 398

36RI. do

36R2••..•. do

24 135 546

185 270 1,020

3/15-1 HL..... July 6,1944 86 250 984

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 12Gl•••••- | Aug. 11, 1944 | 85 | 140 | 793 | 71 | 8hr. |
|  | July 20, 1945  Oct. 30, 1945 | 84  100 | 215 | 798 |  |  |

12G2 Oct. 28, 1943 179 195 954

Aug. 11, 1944 189 210 1,010 70

Oct. 24, 19442 173 200 910 --------

July 20, 1945 163 210 924 --------

Oct. 30, 1945 134 185 ---------- --------

8hr.

15min,

12L5...... Oct. 28, 1943 128 155 775

Aug. 11, 1944 146 215 866

Oct. 24, 1944 147 ·175 826

Apr. 13, 1945 161 200 870

July 20, 1945 195 255 ' 1, 020

70 8 hr, 70

71

Oct. 30, 1945 282 ------···- ----·----- --------

Apr. 9, 1946 194 ---------- ---------- --------

12L6...... Aug. 11, 1944 406 475 1, 840 71

Oct. 24, 19441 507 625 · 2, 100 71

Apr. 13, 1945 355 400 1,570 --------

July 20, 1945 738 900 ---------- --------

Sept. 5, 1945a ---------- 3,190 0.

2 2 hr. 2hr. 15 min, 4hr.

---------- ---------- 3,220

---------- ---------- 3,210

---------- ---------- 3,260

---------- ---------- 3,260

---------- ---------- 3,320

---------- ---------- 3,300

---------- ---------- 3,300

886 ---------- 3,290

---------- ---------- 3,270

---------- ---------- 3,260

---------- ---------- 3,260

---------- ---------- 3,260

Oct. 30, 1945 34

1, 040 1, 450 4, 150

---------- ----------, 3,570

1 min. 3min. 8min 18 min. 33min.

1 hr 3 min.

1. hr33mtn.

2hr 18 min.

1. hr 48min.
2. hr 48mln.
3. hr 48mln.
4. hr 48min.

o.

lmin.

See footnotes at end of table.

901 ----------

·'·

3; 610

70 3min.

70 5min.

TABLE *29. Field analyses of waters from wells in the coastal zone of the Torrance.*

*Santa Monica area, 1943-46-Continued*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Well | Date | Chloride ion (Cl) (parts per million) | Soap hardness as CaCOa  (parts per  million) | Specific conduct-  ance i- crom os at 25°0) | Tem- pera- ture | Remarks |
| 3/15-12L6••••••  ..  12L7•••.•.  13.A2••.••.  13.A3. ---·-  13.A4•••••.  13HL•.••  13H2..•••.  13JL.••••  13J2•••••••  13J3•••••••  13R2••••••  13R3••••••  13R4••••••  13R5•••••.  13R6•••••• | Oct. 30, 1945u  Oct. -31, 1D46  Oct. 24, 1944  Apr. 13, lll45  July 20, lll45  Oct. 30, lll45  Apr. 9, 1946  Oct. 13, lll43  Aug. 11, 1944  Oct. 24, 19442  Oct. 13, lll43  Aug. 11, 1944  Oct. 24, 1944  Apr. 13, 1945  Oct. 30, 1945  Oct. 13, 1943  do •.••...•  Aug. 11,1944  Oct. 24, 1944  Apr. 13, 1945  Oct. 30,1945  Oct. 13, lll43  Aug. 11, 1944  Oct. 24, lll44  Aug. 11,1944  Oct. 24, 1944  Apr. 13, lll45  Oct. 30,1945  .•.••do•••••••• Oct. 13, lll43  Aug. 11,1944  Oct. 24, 1944  Apr. 13, lll45  Oct. 30, lll45  Oct. 13, 1943  Aug. 11, 1944  Oct. 24, 1944  Apr. 13, lll45  Oct. 30, lll45  Oct. 13, lll43  Aug. 11,1944  Oct. 24,1944  Apr. 13, 1945  Oct. 30,1945  Aug. 11,1944  Oct. 24, 19441  Apr. 13, lll45  Oct. 30, 1945  Apr. 13, 1945  Oct. 30, lll45 | ---------------------  ----------  ----928  923  911  8ll4  886  ··sao  814  785  750  741  160  152  176  180  201  173  196  224  128  129  148  145  109  179  68  66  137  67  68  110  130  151  76  80  51  ll3 107  80  68  70  83  99  138  133  140  141  143  74  77  79  85  98  62  61  61  68  62  66 | ----------  --------------------  --------------------  ----------  --------------------  ··- 990.  925  215  180  235  ----------  - 290  370  260  220  170  190  175  260  245  175  ·120 145  160  185  175  ----------  180  135  120  105  230  290  165  195  175  140  245  200  240  215  265  160  135  160  130  230  155  -- 130  200  150  180 | 3,650  3,650  3,670  3,660  3,650  3,590  3,480  3,450  3,410  **3,350**  **3,220**  3,150  3,150  3,060  3,040  89. 9 86.1  - 99.6  ----1--,0-6--0-  1,050  **1,180**  **·1,220**  923  ll36 903  ll33 858  **1,050**  737  740  688  725  665  808  900  ll44  772  730  727  775  886  722  713  677  729 | 70  70  70  70  ------7-0-  ---··10·  70  --------  --------  --------  71  · 70  --------  .-.--.-.-.f--f-  *-··-·1a·*  73  73  --·-·14·  ... 74  74  74  74  ··--·,s  ·····73  --------  *---··1f*  73  72  74  73  7d 73  72 | lOmin. 20min. 30min. 1 hr.  2hr.  3 hr4min. 4hr.   1. hr 31 min. 2. hr 30min.   **9** hr4min.  13 hr4min. 22hr. 26hr. 30hr.  37 hr.  Time elapsed after pumping: 2hr.  4hr.  3½hr.  -·' |
| 819 : 73  842 72  844 73  834 71  834 71  855 72  718 72  740 73  732 ·--··12·  722  748 73  720 73  697 73  705 ---··73·  682  660 72  650 73 | |

.

See footnotes at end of table.

TABLE *29.-Field analyses of water. from wells in the coastal zone of the Torrance­ Santa Monica area,* 1943-46-Continued

Well

Date

Chloride ion (Cl) (parts per million)

Soap Specific hardness conduct-

as ance <,g1i-

CaCOa crom os (parts per at 25°C) million)

Tem- pera- ture

Remarks

3/15-24Dl•••••- July 14,194434

**25Al.•....** Oct. 8,1943

Aug. 7,1944

•••••do

Aug. 15,1944

Oct. 3,1944

-----dO--------

Oct. 24,19441

Ian. 19,1945

-----dO--------

Feb. 1,19453

418 1,810 72 1 hr 53min.

418 1,780 2 hr37min.

---·-12-

385 1,720 4 hr 15 min.

379 1,710 5 hr 15 min.

370 1,690 6 hr 15 min.

366 1,650 7 hr 15min.

347 1,610 13hr 45min.

337 1,570 21 hr 53 min.

335 1,570 23hr 15min.

334 1,570 26hr 15 min.

--·--12·

324 1,540 39hr.

1,500 47 hr 15min.

* -- 319 - 410

1,400 72 Time elapsed after

since October:6: o88 850 2,280 72 5min.

549 750 2,160 72 30min•

*---··1r*

520 690 2,120 5hr.

515 565 2,100 14hr.

**499** 575 2,100 72 15hr.

524 600 1,990 72 30min.

598 725 2,280

594 **650** 2,100

632 2,670 0.

----· *\**600.

555 2,150 2min.

635 730 2,370 4min.

pumping

-------------------- ----------

2,410 6min.

2,360 8min.

------620 -- ---700- 2,320 10 min.

2,350 12min.

605 660 2,280 27min.

2,180 1 hr.

•o 550 -- 610

2,120 2hr.

**26A2.••••.**

Oct. 8,1943 123 160 778 Time elapsed afte(pumplng:

30min.

Aug. 7,1944 448 550 1,780 5min.

-----do

398 475 1,640 30min.

Aug. 16,1944 388 490 1,fl50 2hr.

25A3 do

370 475 1,600 ---··12- 5 hr.

Aug. 7,1944 301 350 1,320 5min.

-----do

311 400 1,370 72 30min.

Ian. 16,19453 343 360 1,420 o.

- 341 • 360 1,420 30min.

|  |  |
| --- | --- |
| 1,430 | 40min. |
| 1,410 | 1 hr 5min. |
| 1,420 | l hr25min. |
| 1,430 | 1 hr45 min. |

----,..------

----------

3 ---------- ----------

25HL

Jan. 16, 1945

1,430 2 hr 5 min.

342 360 1,420 2 hr 25 min.

---------- ---------- 1,430 2 hr 45 min.

---------- ---------- 1,430 3 hr 5 min.

340 350 1,430 3 hr 25 min.

|  |  |  |  |
| --- | --- | --- | --- |
| Apr. 13, 1945 | 397 | 440 | 1,600 |
| Oct. 31, 1945 | 513 |  | 2,020 |

Time elapsed after pumping: 15 min.

Oct. 8, 1943 231 280 l, 200 72 5min.

Aug. 7,1944 521 675 2,070 72 5min.

do

496 650 1,980 72 30min.

Aug. 15, 1944 427 475 1,810 2 hr.

do

440 565 1,870 5 hr.

Oct.do27, 1944 490 490 1,830 72 8 hr.

do

do

do.I.

478 440 1,860 72 10 hr.

471 475 1,880 72 12 hr.

-----------

472 450 Nearly 13hr.

468 465 1,880 72 Nearly 14 hr.

Jan. 2, 19453 403 425 1,650 o.

501 565 1,970 2min.

500 550 1,970 6min.

491 550 1,940 31 min.

478 550 1,890 53 min.

470 525 1,860 1 hr 21 min.

449 565 1,800 4hr31 min.

454 575 1,820 7 hr 31 min.

See footnotes at end of table.

TABLE *29.-Field analyses of waters from wells in the coastal zone of the Torrance­ Santa Monica area, 1943-46-Continued*

Well

Date

Chloride Ion **(Cl)** (parts per million)

Soap Specific hardness conduct­ as ance (mi­

CaCOa cromhos (parts per at 25°0) million)

Tem­ pera­ ture

Remarks

3/15-25Hl...... Jan. 3,1945

454

458

455

457

525

525

525

525

1,830

1, 20

1,830

1,830

10 hr 31 min. 13hr31 min. 18hr31 min. 20hr 26 min.

25H2 \_

4/14-5N2.. \_

Oct. 8,1943

456

110

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| May 29,1944 | 762 | 775 | 2,800 |  | 16 min. |
| June 5,1944 | 780 | 1,150 | 2,880 | 72 | 16 min. |
| Aug. 14, 1944 | 987 | 1,250 | 3,480 | 72 |  |
| Sept. 18, 19441 | 1,070 | 1,550 | 3,720 | 72 |  |
| Dec. 4, 1944 a | 1,530 | 1,700 | 4,720 | 1 min. | |
|  | 1,600 | 1,650 | 5,040 | 3min. | |
|  | 1,560 | 1,600 | 5,010 | 5min. | |
|  | 1,540 | 1,700 | 5,080 | 10min. | |
|  | 1,520 |  | 4,890 | 15 min. | |
|  | 1,520 |  | 4,850 | 21 min. | |
|  | 1,500 |  | 4,840 |  | 27min. |
| 1,500 | | 1,650 | 4,790 | 35min. | |
| 1,490 | |  | 4,760 | 40 min. | |
| 1,480 | |  | 4,740 | 45 min. | |

525

165

1,810

781

23 hr 29 min. 8min.

Apr. 13, 19453

July 20, 1945s

July 21, 1945

8011 Aug. 16, 1944

Sept. 4, 1944

Sept. 18, 1944

Oct. 9, 1944

Dec. 4, 1944

1,480

1,470

1, 730

1,870

1,820

85

87

87

85

85

1,600

2,000\_

2,060

1,800

140

140

145

140

140

4,760

4,720

5,490

5,930

6,480

6,330

6,330

6,370

6,230

6,230

6,200

6,140

6,140

6-,120

6,080

6,050

6,030

6,080

6,140

5,960

5,960

5,940

5,960

5,960

5,920

5,870

5,910

5,870

5,820

655

658

654

660

637

50min. 1 hr.

72 o. 15 min.

30min. 1 hr.

1 hr30min.7 21µ-.

2b:r30min. 3hr.

3br30min. 4hr.

4 hr 30 min. 5hr.

5hr30 min.

1. hr.
2. hr. 9hr. 10hr. 11hr. 12 hr.
3. hr.
4. hr.
5. hr. 16hr. 23hr.

23hr30 min.

1. hr 30 min.
2. hr.

Apr. 13, 1945 88 145

July 20, 1945 95 170

Sept. 3. 1945 93 175

Sept. 24, 1945 91 185

Oct. 8,1945 92 180

Oct. 22, 1945 35 105

Nov. 12, 1945 69 170

Nov. 26, 1945 64 160

11F2

Nov. 19, 1943 116 150

16L2••••-- Nov. 27, 1943 73 95

Nov. 2, 1944 70

Apr. 13, 1945 63 105

Apr. 14, 1945 63

647

685

676

696

456

546

609

793

651

631

613

609

Time elapsed after pumping: 5min.

25min. 5min.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Nov. 8, 1945 | 71 | 135 | 663 |
| 16Ql•• ---· | Nov. 27, 1943 | 95 | 125 | 702 |

See footnotes at end of table.

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TAl3LE *29.-Field analyses of waters from wells in the coastal zone of the Torrance­ Santa Monica area,* 1943-46-Continued

**Well**

Date

Chloride ion (Cl) (parts per

Soap hardness as CaCOa

Specific conduct-

anceri- crom os

Tern- pera- ture

**Remarks**

million)

(parts per at25°C) million)

**4/14-170}** Dec. 23, 1943

66 115

657 --------

**Oct.** 24, 1944

**Apr.** 13, 1945

Apr. 14., 1945

59 160

68 150

68 105

624 :

647 --------

642 --------

--------

**17HL----**

Aug. 14, 1944

Nov. 2, 1944

Apr. 13, 1945

49 110

**51** 110

53 150

588

572

579

75

--------

-------..

--------

About 5 hr.

**2107JN1 l------**

Apr. 14, 1945

Nov. 8, 1945

May 29,1944

**52**

53

**111**

115

150

160

570

617 --------

890 --------

22n2 Nov. 9, 1944

130

215

1,010

--------

**22LK2l------**

Dec. 17, 1943 **31**

Decd.o23, 1943 53

55 **485** --------

55 565 --------

**23N2** Dec. **14, 1943**

**2401** Dec. 17, 1943

56

50

390

75

110

370

587 --------

597 --------

**1,890** --------

...

--------

Nov. **2, 1944**

Nov. 9, 1944

519

----------

465

440

**2,240**

2,160

---------------

**2402.• ----**

**24El.• ----**

Apr. **14, 1945**

Nov. 8, 1945

Dec. 17, 1943

Nov. 20, 1943

Nov. 2,1944

**Apr.** 13, 1945

Apr. **14, 1945**

501

594

**146**

**24**

**24**

35

26

540

700

120

65

90

100

105

**2,240**

2,480 --------

--------

1,050

443 --------

427 ---------

456 ---------

427 --------

Nov. 8, l945

**24** 95 ---------- --------

**24R2.• ----**

**25CL.----**

Jan. 6,1944

Jan. 10, 1944

**23**

**235**

95

160

440 --------

1,200 --------

**2503** Jan. 5,1944

**25JL do**

**27Ll•.•... Jan. 3, 1944**

**27ML** Mar. **1944**

Nov. **9, 1944**

Apr. 14, 1945

Nov. 8, 1945

**27M2**

Jan. 3, 1944

Nov. 9, 1944

r. 14, 1945

66

**23**

**118**

110

107

**113**

108

90

91

**95**

115

75

**185**

**245**

215

**180**

**245**

**295**

300

350

690 --------

446 -------...

--------

960

928 --------

870 --------

**904** --------

900 --------

--------

**874**

**851** --------

876 --------

**28J3**

ov. 8, 1945

Sept. 9, 1944

94

**121**

350

**340**

898 --------

**1,080** --------

Sulfide odor.

**35Dl------**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **35El** Jan.**do**10, 1944 | **129**  **140** | **190**  **180** | **991** | -------... |
| Oct. 27, 19442 | 141 | 175 | 990 | 75 |

Oct. 27, 1944

**130**

165

960 **75**

**35E2••...\_**

984 --------

Time elapsed after pumping: Several hr.

1 Complete analysis in table 30.

2 Preliminary analysis in table 30.

a Water quality test by pumping method; elapsed time indicated under "Remarks" colwnn. 'Well yielding water only through perforations 222-248 ft below land surface.

6 Approximated because pump operation was intermittent. Well yield about 9 gpm.

**e** Well yielding water only through perforations 250-267 ft below land surface. ' Pump shut off for 30 min after preceding sample.

TABLE *30.-Chemical analyses of representative native and contaminated waters from the deposits penetrated by water wells, 1925-46*

I• Analysis taken as essentially typical of the water native to a single stratigraphic zone in the locality of the source well; b calculated; 0 iron and aluminum oxides (Fe2Oa+Al2Oa)

d includes small equivalent quantity of carbonate (0 0 3). Minor constituents and additional data are listed in notes at end of table]

Parts per million

0 0

bn 0 00,

0

Well

Source

Q)

i::i.

1

0

r:::I

Depth in feet

Date of collection

e...

j

0,

*B*a*.*

'O 0

f;O §,

'go

'a)'

8

-C)

e

a

.El

I

g S,

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e

a ·I §

i

0e,

Q)

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0

$

.*.*e*s*

1. 0e

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0

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Q)

gji

###### II

l/14-19RL\_

City of Beverly Hills:

Q)

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mQ)

Q) - § -

E-t A

§

,!:I

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'a

-0-

:21

--m

0

.P,i

iii 0

'm=

:a

0 J:'l

:z:=

l:q

Willows welL 410 La Cienaga well L

331

MAuagr.. 92,61, 9149340 •--··· ----------

b 719 10 0

b7l4 14 0

--

**456** 0

470 0

|  |  |  |  |
| --- | --- | --- | --- |
| 131 | 55 | 47 ----- | |
| 123 | 57 | 39 ----- | |
| 50 | 29 | bl75 | |
|  |  |  | |
| 103 | 40 | | 46 ----- |
|  |  | |  |
| 87 | 46 | | 51 ----- |
|  |  | |  |
| 124 | 35 | | 74 ----- |
|  |  | |  |
| 63 | 15 | | b46 |

136

148

108

110 ------------

------

14

**1.5**

**553**

541

20ML\_

410

290

Mar. 9, 1938 •------ ----- b683 30 .2

536 **e**

27 134

0 244

1/15-2501-..

Roxbury Park well 2\_

410

450

Dec. 22, 1932 •------ ----- b2, 670 ------ --------

405

185

341 -----

396 ------

171 1,363

**6.6** 0 1,771

28B2•••

32AL...

U.S. Government, Sol-

diers Home well 11. City of Santa Monica,

Arcadia plant.

410

410

300

200

July 30, 1931 •-----· -----

July 30, 1931 •----- -----

|  |  |  |
| --- | --- | --- |
| 410 | 260 | Aug. 6, 1931. |
| 410 | 800 | Feb. 25, 1938 |

b569 -----... --------

b577 ------ --------

324 ------

259 ------

127

212

50 1.1 40

48 1.4 2

422 =

**406** gC

2/13-20HL.

Goodyear Tire and Rub-

-----

b686 ------ --------

354 ------

165

73 2. 7 35

**454**

t::I

3202

ber Co., well 3. Southern California Wa-

ter Co., Towne plant

we112.

----·

496 21

**0 4. 4**

232 ------ 89

**26 .5**

------

**219**

*r.fJ*

Apr. 18, 1938. -----

652 11

0 2.7

213 0

133

**114**

.2 ------

375

Apr. 24, 1938

----------

b375 ------

1. 0

237 ------ 92

34 ------

239

Baldwin Village

Apr. 26, 1938

May 2, 1938

Nov. 30, 1944 -----

477

503

497

15

7.8

21

0 2. 7

0 3. 2

**•.4**

195

195

232

6.0

0

3.0

99

108

66

34 **.2**

**54** .2

46 Tr.

------------

-·-:2·

207

240

212

2/145-40N1.L••

Standard Oil Co

410

300

Feb. 8, 1946 •------· -----

b350 16

.03

234 ------ 82

23 .5

216

502

410

752

Mar. 30, 1931 **a** -----

b313 ------ --------

214 ------ 50

**48** ------ ------

201

City of Beverly Hills,

410

333

Feb. 10, 1936 -----

666 8 .1

387 0

60 125 ------ ------

269

Castle well 1.

Jan. 21, 1938. -----

540 16 .2

364 0

66 96 ------ 0

301

Sept. 9, 1938••••

|  |  |  |
| --- | --- | --- |
| 104 | 28 | b45 |
| 66 | 18 | b46 |
| 58 | 15 | b53 |
| 68 | 17 | b50 |
| 62 | 14 | b53 |
| 60 | 16 | 411 10 |
| 41 | 24 | b43 |
| 70 | 23 | bl30 |
| 76 | 27 | b77 |
| 54 | 36 | bl28 |

-----

629 30 .3

378 0

45 146 ------ 0

283

Parts per million

1is *5* 0

i

e

Well

Source

Depth in

A, feet

i

$

Date of collection

t "'

j

"C

'N'

0

Q>'

*'bD*

'2

a

8

'2 §

a

;

0 0

G':l .s 0

.s

=

8

0

E9,

8

e0,

0

G':l

0

j

2/14-5D5 Southern California Wa-

0

i:l

CD CD *U1*

410

266

°t'

A,

a

CD

E--4

r.:o

i.........

--A

@

.9

°'

:;::l

*U1*

--

e

§

---

a

·-5;

0

--

·1

;;j

--

\_ij

"C

0

*U1*

--

.::l

j

0

--

=0

-

P=l

--

G':l

0

.0.

--

0

---

.s

*§*

::l

*U1*

CD

:i:l 5

0

-- --

.s J"'g""

\_g !

z

t:J:!

-- --

ter Co.:

Sentney plant well 5\_

Mar. 23, 193L

Oct. 2, 1931

805 33

b573

---..,--

-----

4.0 54 30

hl26

409 ------ 49

102 ------ ------

258

Dec. 10, 1931.

------ -------- 54

32 1321-----

421 -- ---- 24

119

1. 7 0

266

5D6

410

Sept. 22, 1932 -----

Nov. 6, 1933

-----

Sept. 11, 1935

Oct. 20, 1936

Mar. 15, 1939

-----

Mar. 3, 1943

-----

Jan. 24, 1944

-----

Mar. 1, 1935

Mar. 11, 1935 -----

835 26

861 28

812 25

863 32

832 40

788 32

791 30

656 12

5.0 53 19

2.8 53 27

5.6 54 24

5. 5 61 27

5. 5 61 30

2. 7 58 32

.3 66 38

.2 69 22

h156

b154

bl43 bl46 hl26 h112

b96 b81

439 ------

415 ------

------

397

390 ------

384 ------

------

384

378 ------

336 ------

Tr.

------

263

Sentney plant well 6\_

810

Mar. 7, 1935 -----

Apr. 24, 1935 ..- -----

515 35

511 35

477 31

•. **7** 31 12

0 6. 7 26 12

C 5, 5 30 12

b88 b88 b76

244

262

238

6.0 19

6.0 18

2.9 38

70 ------

53 ------ ------

|  |  |
| --- | --- |
| 15 122 | ------ ·----- 210 |
| 53 129 | ------ ------ 243 |
| 36 128 | ------ ------ 233 |
| 65 137 | ------ ------ 263 |
| 67 118 | ------ ------ 276 |
| 84 83 | ------ ------ 276 |
| 98 84 | ------ ------ 321 |
| 74 62 |  |

41 ------ ------

127

114

124

-----

473 24

0 5. 4 44 14

b61

232 ------ 60

33 ------ ------

167

May 19, 1936 Nov. 18, 1937 -----

Sept. 5, 1939 --

--...

547 23

503 35

461 25

0 8. 3 38 14

0 4. 5 36 13

•3. 9 23 15

b88 b78 b79

268 ------ 40

244 ------ 48

226 ------ 55

64 ------ ------

45 ------ ------

35 ---·-- ------

152

143

119

5D8

Mar. 3, 1943

595 ------ -------- 44 22

b87

280 ------ 54

77 ---·-- ------

200

Sentney plant well 8.

411

425

June 6, 1939 -----

784 35

0 2. 2 63 30

hl08

390 ------ 52

102 .2 ------

281

Mar. 3, 1943 -----

Oct. 10, 1940 -----

727 37

o, 5 47 30

b108

384 ------ 13

106 ------

241

5D9

Jan. 24, 1944 -----

841 11

o, 8 72 22

bl4l

421 ------ 39

135 Tr.

------

270

7p2

Sentney plant well 9.

**411**

54 Aug. 23, 1940 "----- -----

Aug. 17, 1944 -----

b747 19

b 766 19

b969 21

0 3. 2

0 3. 8

0 4. 0

118 48

138 22

151 60

b85 b107

bll3

396 ------

378 ------

476 ------

185

214

260

113

96

147

Tr.

Tr.

Tr.

------

------

------

492

435

624

Metro-Goldwyn-Mayer

411

265

June 22, 1945 -----

1, 751 34

Tr.

133 73

b333

427 0

152

600 ------

632

AC.Foerrpn.alla

Feb. 8, 1946 ----- b2, 280 32

.07

199

122

46! 13

432 ------

156

1,100

3. 5

1. 9

998

8CL--

411

185

Feb. 8, 1946 -----

b978 25

.09

120 55

462 ------ 23

344

. 7 23

526

1402

Los Angeles Investment

**411**

1,015

Oct. 16, 1931\_ -----

b430 66

23 1 - --

183 ------

108

83 ------ 0

259

Co.

Nov. 12, 1931- -----

Nov. 20, 193L -----

Nov. 13, 193L -----

b322 ------ -------- 79 12

h273 ------ -------- 77 9

96

12

bl9 b18 b5

189 ------ 82

d236 12

-----

130 - 83

35 ------ ------

30 ------ ------

34 ------ ------

247

289

229

Sept. 8, 1937-. -----

h286 ------ --------

b371 ------ -------- 68 **16**

h47

248 ------ 83

29 ------ 4

236

Lewis A. Crank

July 24, 1939 **a**

b360 ------ -------- 63 16

441-----

245

...

85 27 ------ 2

223

2/14-18FL.

411

'265.8

Feb. 2, 1925 -----

b823 ------ -------- 97 40

bl57

408 ------

143

182 ------ ------

407

Mar. 25, 1932

b 1,338 ------ --------

163 66

2371-----

445 - ---- - 182

467 ------ 0

678

Dec. 21, 1945 --·--

1,127 21

Tr. 52 56

b242

250 ------ 97

410 ------ ------

360

19CL. FoxHills Country Club,

411

501

Nov. 17, 1923 -----

696 24

0 1. 2 74 2i

bl48

362 28

99 122 ------ ------

300

well 1.

June 3, 1930 -----

b593 ------ -------- 72 14

bl34

364 ------

103

88 ------

237

City of Inglewood:

Dec. 9, 1939a -----

b535 12

I. 5 81 18

blQl

395 ------ 57

80 ------

Tr.

276

22N3.

Well lL ••

411

290

Sept. 25, 1939 ·-

b 366 ------ -------- 67 16

b 43

230 ----- - 97

27 ------

1.0

233

22NL.

Well 12 411

283

Nov. 3, 1944 -----

100

-- ---1-----

232 0

46 29

.7 -- ----

192

22PL.

Well 19 411

314

Apr. 29, 1937 **a** ---- - --i,-355 22

0. 2

69 --if-

b 42

242 ------ 82

27 ------

230

22P2

Well 24 410

400

Mar. 22, 1940

b 400 ------ -------- 71 14

b 66

244 ------

100

27 ------ -·----

235

Nov. 3, 1944 ----- ------- ------ --------

60 ------ ----- -----

234 0

50 23 "

192

23HL\_

City of Los

Angeles,

410

827

July 8, 1942 **a** -- ---

b 371 30

.1 67 21

37 3

238 3

88 31 ----·

254

27D2.•.

Manhattan plant well 3A.

City of Inglewood:

Well 10••••.. 410

293

Nov. 3, 1944 ----- ---b-454 ------ --------

200

------ ----- ------

427 0

60 160 ------ ------

502

27D3-..

Well 14••

410

355

Aug. 6, 194L

90 19

53 -----

253 ----- - 73

91 1. 6 -·o·--

303

27JL

Well 15 410

1,097

July 31, 1931\_ -----

1,389 35

0 4. 6 16 8

b 541

1,254 ------ 17

144 ------ 73

Aug. 3, 1931 **a** -----b 1,225 19

8 4791-----

1,266 ------ 18

66 1. 6 0 80

Apr.11, 1932 •--

b 284 ------ -------- 38 7

b 60

178 - ----- 48

422 ------ ------ 124 ::-1

Apr. ll!, 1932.• -----

b 239 ------ ----; ;;,- 40 11

b 38

225 ---- -- 35

0 145 H

Nov. 14, 1932. -----

424

7.5

34 9.3

b 118

353 18

37 13 ------ ------

123

Nov. 18, 1932

Apr. 6, 1934 -- ---

|  |  |
| --- | --- |
| 410 | 398 |
| 410 | 180 |
| 410 | 210 |
| 410 | 400 |

369 16

331 33

o.5 37 11

.01 43 11

b 103

b 46

334 ------ 46

206 ------ 42

27 ------ ----- -

28 ------ ---- --

138

153

Well 25

Sept. 8, 1937

b 300 ------ ---- ---- 42 14

521-- ·--

240 ------ 48

23 1.1 0

162

28FL..

May 2, 1940

**b** 448 ------

.3 69 19

b 72

289 ------ 86

57 ------ ------

250 t,rj

Frank Abell

May 26, 194L ••

b 440 15

.4 68 23

b 63

264 ------ 88

66 ------ ---- --

264 ('.')

29KL. Wm. Krutz

Jan. 10, 1929 **a** -----

442 -.., ----- -------- 58 16

b 48

218 0

35 70 ------ 0

211 0

32EL\_

77

22

32FL.

City of Inglewood well

do ·--·-

Jan. 20, 1938 -----

b496 474

23 ------.3- - 70 27

b 82

**b** 57

337 ------ 61

268 ------ 68

87 ------ ---- ·-

71 ------ ------

286 l;:l:;I

283 t:::,

21.

Feb. 23, 1940•• -----

**b** 518 ------

2 100 27

b 54

264 ------ 74

131 ------ -- ----

361 *'C/2*

Southern California Water Co.:

2/15-102 Manning plant: Well 2..

411

261

May 26, 1941.

Oct. 16, 1936 **a** -----

**b** 506 18

b 563 43

.4 82 26

**0 5.5** 95 33

b 74

b 61

349 ------ 62

323 ------ 150

87 ------ ------

62 ------ ------

312

373

105.\_

well 5

411

865

May 3, 1944 **a**

b 1,698 48

2.0 24 23

b629

711 ------

.6 666 ------ ------

154

City of Santa Monica:

Aug. 31, 1944. -

683 8.9 0. 1 57 28

b 90

403 ------ 36

61 Tr. ------

257

9N6•••.

Marine new well 5. \_

411

204

July 30, 193L.•••. -----

b 654 ------ -------- 97 51

69 ---·-

277 ------ 178

119 1. 4

Aug. 26, 1937

Oct. 27, 1937

b 1,670

b 1,924

----- ------ --------

265

268

127

126

153 -----

255 -----

293 ------

301 ------

249

244

719 ------

873 -----·

July 3, 1939 b 2,009

Sept. 26, 1939•••••. ----- b 2,435 ------ --------

309

447

150

168

211 -----

217 -----

-----

266 ------

285 ------

245

333

959 ----- -

1,127 ------

Charnock well 6•••

Jan. 15, 1940

Apr. 24, 1940••••••

b 1,961

b 2,415

277

380

132

60

242

346 ------

250 ------

250 ------

279

323

899 ------

1,180 --- ---

1106•..

411

384

July 30, 1931 ·-----

b 483

77 33

46 -----

274 ------

134

52 .8

Aug. 26, 1937 -----

b 524 ------- -------- 85 34

58 -----

281 ----- -

138

61 ------ 7

352

11D2••.

|  |  |
| --- | --- |
| 0 | 452 |
| 10 | 1,183 |
| 7 | 1,187 |
| 2 | 1,388 |
| 0 | 1,806 |
| 7 | 1,234 |
| 1 | 1,196 |
| 4 | 328 |

Southern California

411

480

Oct. 7, 1930 -----

b 642 28

0 5.0 98 43

b 65

313 - -- ---

242

37 ------ ------

421

Water Co., Charnock

Oct. 21, 1935 **a**

b 557 28

0 3.4 99 43

**b** 36

311 0

182

41 ------ ------

424 *C>,j*

plant well 3.

Aug. 21, 1942••...• --•-- b 640 43

.47 108 49

b 42

293 ------

251

43 ------

471 i:.o

i:.o

't,;

0

Parts per million

0 0

e

e

Well

Source

'1l

i::i.

f

!

0

r:::I

'1l

*Q*

*Cl.l*

Depth in feet

Date of collection

:s

<I)

'o

1

'd

i

g!O

\_....

**'oO**

gi

8 A

0

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-

::l

*Cl.l*

-;-

e

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'as"

8

a

·:a:I

ai

0

"bil

I

I

e'as"

a

i

*Cl.l*

@

a

·i

E

0

P-i

0 0

.s 8

"§' .s

§

1

ixi --

0

0re

.s

'3

ca

:::;-

8

'1l

0

:E

0

e

.;s

0

p:i

0

0"'

0 1j

e

!.:':!

.§ 6

!

IJ:j

2/15-llEL-

McOoy (formerly Revo- Ion).

411 ---------

June 6, 1931 •------ -----

**b** 546 25

0 **2.9** 89 35

b 55

285 ------

173

51 -····· ------

366

11E3•••

Southern Oalifornia Water Co.: Oharnock

405

\_Oct. 16, 1936• .:... -- \_,

Aug. 21, 1942\_.

773 35

.35 90 38

b &2

293 ------

206

43 ---·-- ------

381

plant well 3.

773 36

.55 92 45

b 51

299 0

191

59 ------ ------

415

llJl.\_.\_

11J2••••

Sepulveda plant well 1.

Sepulveda plant well 2.

Feb. 26, 1945-·--··

411

411

402

277

Oct. 12, 1944 ·--

Dec. 18, 1931 •···-- Sept. 30, 1935•• \_•• \_ Oct. 16, 1936\_•• \_.

May 1936---··----

Sept. 5, 1939\_ •• \_•. \_

851 28

**b** 476 28

b 536 34

**b** 572 41

809 24

-----

917 42

Tr.

91

42

0 1. 1

0 4.0

0 2. 7

0 6. 7

0 27

0 5.5

107 44

61 20

77 31

80 37

84 37

92 44

b 61

b 92

b 80

**b** 79

b 82

b 99

323 ------

317 ------

345 ------

348 ------

360 ------

378 ------

240

82

96

111

107

124

47 ------ ------

62 ----·- ------

79 --·-·- ------

------

91 ---··-

------

97 ------

133 ------ ------

448

235

320

352

362

410

Mar. 20, 1940\_.\_..•

400

894

41

b728 ------

2.0 105 44

b 103

395 ------

130

148 ------ ------

443

12BL••

14Al•••

Metro•Goldwyn•Mayer

411

411,

Oct. 12, 1944•• --\_••

550

905 9.4

L 3 103 45

90

38

b 95

##### l---

b 93

372 ------

141

139 ------ ------

442

14Ql•••

Oorp.

15A2.••

E. S. Merrill Sanitarium. 411

Southern Oalifornia Water Co.:

Oity of Los Angeles, Berryman well 1.

120

Oct. 9, 1931..•.

Nov. 3, 1932.

Aug. 8, 1932 •-·-·· -----

-----

-----

b 948 ------ --------

b 899 ------ --------

**b** 558 ------ --------

127

120

390

0

144

93

Tr. ------

400

56 144 --·--

51 137 -----

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 324 ------ | 131 | 77 | .4 | 0 | 381 |
| 403 ------ | 216 | 202 | 1.0 | 0 | 547 |
| 393 ------ | 209 | 180 | 1. 4 | 4 | 509 |

15AL.

Pacific plant well 2 Pacific plant well 4

411

412

200

335

Dec. 10, 1931•••••\_ -----

June 11, 1932 •--··-

Oct 21, 1935----··-·

Sept. 24, 1936\_.

841 26

**b** 631 25

b 605 21

b 595 34

-------- 94 31

0 5.6 97 29

.2 94 38

.2 95 44

0

**b** 95

b 87

b 69

b 54

329

299

305

311

0

0

0

Tr.

185

197

173

176

75 ---··- ------

78 ---·-- ------

71 ----·· ------

70 --··-· ...-----

362

361

391

418

Apr. 24, 1940---·--

b 658 ------ -------- 113 46

691-----

312 -------

182

89 --·--· 3

471

15F2..\_

412

Oct. 12, 1944-··---·

b 641 30

1. 0

105 43

b 64

336 ------

179

82 -···--

Tr. 439

Venice High School well

200

Ma,y , 1930 **a .\_**

b 620 ------- --------

125 24

b 59

d 286 ------

204

65 ---··· ------

411

1. June 3, 1930--·-·--

Mar. 2, 1931-

b 604

b 636 ------ --------

117 26

100 28

b 56

b 85

254 ------

d 272 ---·--

218

210

60 -···-- ------

77 ------ ------

399

365

15HL. Wash ton Park Mu-

------ ---------

tual ater Oo.

412

108

Oct. 9, 1931 **a**

b 567 ----·- ......... ----- 93 40

671-----

284 -----...

151

59 .6 14

397

2/15-16J2 Southern California

Water Co., Zanja

**412**

277

Apr.16, 1930

..,

1,147 36

•2.6

155 55

b 163

385 ------ -

330

218 ------ -------

613

16J3 " Ji - : 412

210

Oct. 9, 1931- •••.•. \_ ----- b 1,468 ------ --------

240

97 151,

351 ------

32.

462

.8 16

998

22B2..•

Clarence MicheL ...•... 412

Un-

Apr. 19, UM5. -··--

2,480 31

.09

219 112

437 4.8

702 0

931

222 .3 153

1,007

22B4

412

known

Mar. 2, 1931...••..

b 893 ------

72 38

b 196

355 ------

288

121- ------

..,\_

336

22F2•.•

- -·- .do.-----------··----

Del Ray Land and

Water Co. well 2.

**412**

*'llY1*

145

Nov. 5, 1929 · bl,362

------

-,..----,..---

222 53

b 173

603

------

518

144.

·---

--- --

772

Feb. 9, 1931.••.•.. ----- bl, 220 ------ --------

182 59

b 165

483 ------

395

177 ------ ------

697

Aug. 8, 1939 ---67 bl,634 ------ --------

289 110

**b** 192

503 ------

304

427 ------ 60

1,174

Apr. 16, 1945.•••.•

2,510 3

.10

283

136

3221 8.8

550 0

716

530

.3 79

1,290

22JL •• -------------------- ------ -

412

77.3 Jan. 30,1936•...

**b** 1,876 ------ --------

204 90

b 334

592 ------

665

284

**2.8**

879

Dec. 9, 1939

b2,255 12

0 282

144

b 275

659 ·-----

805

295 ---,-8-- 124

1,295

2301...

Formerly George San- **·412**

ford.

126

Apr. 17, 1945.•••.. Apr. 16, 1945•• ----

4,300 23

1,700 28

.09

.06

432

192

319

86

5521 9.6

**242** 2.8

**578** 0

430 0

755

477

1,650

340

46

.3 **57**

2,388

833

23HL. **Machado .. -------------**

413

**114**

Jan. 30, 1936.••.... ----- b 1,285 ------ --------

154 73

b 202

582 ------

394

168

**3.4**

"10··-

**684**

Dec. 12, 1939•••

b 1,716 12

1.6

183 93

b 257

540 ------

634

20\l ------

**839**

23NL. Henry Kidson **413**

**•. do.•**

151

Apr. 16, 1945

Apr. 16, 1945. -----

2,010 34

2,300 22

.08

.10

197

199

117

105

2651 6.4

401 4.8

504 0

635 0

730

408

300

45/

.5 **2.4**

4 263

**972**

**928**

23PL..

**413**

185

Apr. 3, 1930•••....

b631 ------ --------

116 36

b 81

548 ------ 28

9 r··

**438**

Oct. 9, 1931.•••

. \_ ------

b 689 **89**

46 1231-----

616 ------ 17

]Ofi

411

Jan. 30, 1936

b 752 ------ --------

100 **45**

b 135

616 ------ 23

l.Jl 0

435

, Los Angeles

County

Dec. 9, 1939•• -----

b 937 **22**

**.2** 126 34

b 195

672 ------ 51

l 15 0

**454**

23Ql••.

Flood Control Dis- trict:

Test hole 6,----- ---

**413**

11.4

Dec. 14, 1939.

......... b5,182 5

727

186

197

b 1,321

606 - -----

2,234

1141 ------

Tr.

=:i:,

t:c.1

1,273 0

2382•.•

Test hole **2**

**413**

24.2

Dec. 9, 1939.• -----

b 1,715 3

151

140

116

**b** 266

395 ------

871

124 ------

Tr.

826 0

24 L.

Mesmer C}Z Co , Ltd. **413**

402

July 30, 1931 **a**

**b** 567 ------ -------- 88 40

591-----

314 . -----

184

38 1.1 0

384 =:i:,

24D3.•• ' Formerly acha o••

. 413

122

Jan. 30, 1936 **a**

----- bl,111 ------ --------

150 60

b 152

444 ------

419

106

1. 7

621 t:I

24L2•.•

Formerly Joseph Mes-

mer.

413

200

July 31, 1931 **a**

Aug. 26, 193•7

---...

**b**1,163

b 1,719 ------ --------

b1, 721

153

230

82

130

162 -----

436 ------

586 ------

------

437

701

142

200

3.3

2.2

-·o··-

1

719 fD

1,108

Loyola University

July 3, 1939

Apr. 25, 1940.••....

b 1,744 ------ --------

240

266

127

63

179 -----

220 -----

484

590 ------

"l

760

670

196 ------ 0

206 ------ 1

1,121

923

26Bl•••

**41** 400

Mar. 29, 1932 **a**

b 492

49 32

97 -----

372 ------ 39

87 1. 3 1

254

26B3

Formerly Mesmer

**413**

176

Oct. 21, 1929•••. .

**b** 695 ------- -------- 83 45

b 119

475 ---- --- 90

120 ------ ------

392

**Ranch.**

Oct. 2, 1930 -----

b 714 ------ -------- 91 44

b 118

464 ------ 105

124 ------ ------

408

Oct. 1, 1931.••.. .

b784 ------ -------- 87 61

b 128

476 ------ 144

126 ------ 0

468

Joseph Memier•••

Dec. 12, 193Q

bl,419 ------ --------

170 65

**b** 248

659 ------

444

162 ------ 0

692

26FL.

**413**

101.0 Oct. 9, 1931\_ ,.\_ bl,005

136

70 12l

430 ------

284

172

**1.2** 0

627

27RL. Palisades del Rey Water

Aug. 8, 1932••.. .

bl,089 ------ --------

146 74 135 -----

457 ------ 318

181 .9 6

668

CoW.:ell6

**413**

237

Aug. 26, 1937

**b481** ------

48 23

101L•••

325 ------ 29

111 .8 -------

214

34Al

Plant 2 well 3•• **413**

305

Oct. 21, 1929••••••• -----

Nov. 18,1929 **a**

Apr. 1, 1931•• --

**b** 915 ------ ---------------- 62 19

b 521 ------ -------- 65 18

------ --------

67

17

**b** 286

b 94

**b** 114

832 ------ 32

330 -----· 33

343 ------ 29

100 ------

123 ------ ------

98 ------ ------

233

237

236

July 31, 1931\_ -----

May 14, 1932

b 478 56

b478 58

b 474 ------ --------

23 1001-----

23 97 -----

348 ------ 29

336 ------ 32

94 1. 9 0

98 1. 2 1

234

239

July 13, 194\_4. ---- -----

**b** 516 34

0.6 65 23

b 104

349 ------ 36

113 ------ ------ 257 I-'

TABLE *30.-Chemical analyses of representative native and contaminated waters from the deposits penPfraterl by water wells, 1925-46-Con.*

Parts per million

....

0

ol 0

e

Well

Source

CD

bJ)

"'

A

*$*

Depth in feet

Date of collection

t

j

o,\_l,

CD

sA

£

:'d o 0

@

**i** "'

0

'ec3'

s'2

s

·:s:i

*I*

s

-ffi

en

'2 g

s

e

J ·i

0

.,C.D,

0:

i::

0

..0

*1;E*

0

0

s

*2*co

i::

*2*

0

{;

;:;-

CD

s

s

e0,

..C.D.

0

ol

0

0 rn8'

e .".,',.Eol

Ji

*w*$ *.*

CD ........

A

**a***w.* §

"' 0*w* 0p..

c:., co

0

:3 *:a*

00

0

"s'

l:Q

""''c:....>....

2/15-34HL.

Formerly Barnard 412

250

Jan. 8, 1930 a -- --

b 445 ------ ---- -- -- 56 *22*

b 85

300 - -- - -- 46

86 -----. - -- ---

230

34KL\_

Palisades del Rey Water 412

208

Oct. 21, 1929

b 485 .., ------- - 42 20

b 122

344 ------ 29

100 ------ ----- -

187

.Co. well 1.

May 14, 1932

b 386 ------ -------- 38 18

b 85

168 ------ 30

103 0. 7 27

169

Aug. 26, 1937

b 339 ------ ----- --- 28 12

b 79

146 ------ 30

86 1. 9 29

119

,, June 23, 1944. . ---- -

b 327 42

0 40 14

b 66

180 ------ 29

88 ------ --- ---

157

Southern California

•Water Co.:

Nov. 2, 1944

------- ------ --- ---- -

28 ------ -- ---1--- --

189 0

24 89

. 7 ------

116

3/13-6GL..

Figueroa plant well1.

412

301

Dec. 18, 1933 *a* - - ---

b 363 11

c3. 9 60

2.4

b 74

250 0 76

26 0

------

160

802...•

Delmar plant well 1 •

412

549

Aug. 6, 1931.

b 319 ------ -------- 57 15

401 ---

220 ------ 72

23 1. 6 0

204

Feb. 25, 1938

b 320 21

. 25 58 16

b 38

220 0 72

26 .3

------

211

Sept. 19, 1939 -----

b 312 ------ ----- - -- 56 12

b 41

210 ------ 75

23 --•·--- 0

189

Nov. 29, 1944.

457 15

Tr. 60 13

441-----

226 Tr. 72

27 Tr.

------

203

17QL\_

H. Hellrner\_s. --·

**412**

362

May 23, 1924. ---- -

b 270 46

5. 3

b /iO

232 0

26 27 ------

137

20Hl

Southern California

412

250

Aug. 6, 1931\_ July 23, 1931 a

b 270 ----- - ------- 41 13

b 362 ------ ---c-i: 7 71 16

441-- ---

47 -----

217 ---- -- 38

229 ------ 84

20 5. 4

27 1. 9

0

Tr.

15(l

243

Water Co., Wads-

412

Dec. 29, 1933... -----

487 11

(ll

6. 7 b 63

232 0 85

27 0 ------

180

worth plant well 1.

Feb. 25, 1938... \_. \_

48b 22

. 01 65 19

b 33

232 0 84

20 3 ------

240

27BL\_

Test hole

Nov. 30, 1945 -----

b 349 19

Tr. /jg 15

b 38

23'.? 0 83

28 ------ ------

234

30PL\_

-- ---

412

Formerly Ren Ayala 412

8 Feb. 15, 1932 a

42 Apr. 6, 1932

b 954 ------ ----- ---

b 1,171 ------ --------

120

188

52 168,

66 134 -----

479 ------

473 ------

185

154

181 2.1 6

371 1. 2 20

513

741

Jan. 4, 1933 a

b 1,125 ------ -------

166 67

Hi7 ---·.

384 ------

157

348

1. 3 27

690

31H4...

Joe Claro.\_-------------

**412**

50 Apr. 10, 1942 a -----

924 20

1. 6

146

38 1051 3. 1

244 0

160

255

.2 16

521

36DL. City of Long Beach,

North Long Beach well 2.

Southern California Water Co.:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Normandie plant **412 598** Nov. 29, 1944 .. ------ b 349 **19** 0 2.1 65 | | | | | | | | 12 | b 49 | 244 | Tr. | 73 | 28 |
| Yukon plant well 2. | **413** | 756 | Aug. 31, 1944 "---- ----- | b 335 | 6.3 | .1 | 50 | 16 | b 58 | 281 | 0 | 34 | 36 |

3/14-lGL...

412

200

1932-37 a -----

404 17

•. 49 61

9. 6

b 45

242 ------ 54

24 ------ ------

Tr. ------

192

212

3K2

4Nl.••.

well 3.

Truro plant well L.

413

636

Aug. 21, 1945 -----

Sept. 19, 1932 -----

b 386 20

b 315 17

Tr. 54

.1 45

16

7. 6

b 71

b 72

281 0

293 0

59

7.2

Tr. ------

46 ------ ------

37 Tr. --- ---

191

201

144

Sept. 23, 1932

b 283 17

'l'r. 35 10

b 65

256 0 14

31 Tr.------

129

Oct. 11, 1932

-----

b 310 16

Tr. 48 8

b 66

293 0

Tr.

41 0.3

------

153

Aug. 14, 1934

Dec. 2, 1935 -----

-----

Dec. 3, 1935 "'------

June 15, 1944 -----

b 32.5 18

b 311 18

b 305 22

b 297 28

0 2. 8 39

0 42

. 05 42

Tr. 42

5.5

16

16

16

b 85

b 59

b *57*

b 54

299

250

293

253

0

0

0

9.0

14

13

9.6

7. 2

32 ------

*56* ------ ------

34 ------ ------

42 ------ ------

120

171

171

171

3/14--8D2

Airways Water Co.:

. WellL

413

200

Nov. 9, 1944

----- ------- ----- - ------- -

80 J\_

251

--- ..... --

30 132

.7 ------

**258**

8E2

Well 2\_ -------------

413

279

-------- - --- --- -- -- - --- -

988

5.4

* 17

192, 43

b 111

324 ------ 39

420 ------

656

9N2

CityWoef lHl2 awthorne:

413,

679

A Feb. 12, 1929

-·---

b 332 28 •1.1 70 11

b 48

340 ---- -- 0

33 ------ ------

220

**B** July 31, 1931\_

C Sept. 8, 1937

b 316 ------ -------- 37 17

**'b** 324 ------ ---- ---- 41 13

b 67

b 69

320 ------ 6

327 ------ 4

28 1.0

32 1. 0 0

162

156

D Sept. 25, 1939..

b 289 ------ --- ----- 31 14

651-----

307 ------ 0

*25* ------ ------

135

E Sept. 9, 194L

-----

b 334 22

.2 32 15

b 84

343 ------ 0

31 ------ ------

142

F June 12, 194L \_ -----

b 329 42

.1 41 12

h 70

316 16

Tr.

32 ------ ----- -

152

G Apr. 13, 1945

345 31

. 05 34 15

681 5.8

324 0

0 28 1.0 .2

147

9NLJ\_

Well 3 ------------

413

760

Sept. 9, 1941 "'----- -----

b 327 18

. *75* 42 *15*

b 70

323 ---- --

. 5 38 ------ ------

167

lOCL\_

Southern

California

413

437

June 12, 1944 -----

Aug. 7, 1940 -----

b 464 36

b 279 22

. 25 74 21

* 3. 8 42 13

b 69

b 52

225 13

271 0

26

4. 8

148 ------ ------

31 ------ ------

271

158

Water Co., Kornblum plant well 1.

June 15, 1944 -----

Aug. 21, 1945 e. -----

b 315 26

b 347 19

32

Tr. 44

4. 9

14

b 90

b 71

287

275

Tr.

0

4. 8

42

39 Tr. ------

38 Tr. ------

100

167

lOGL City of Inglewood well

'28.

413

798

Apr. 29, 1943 a -----

b 425 26

*.05* 42 15

b 112

431 ------ 3

36 ------ ------

167

t;,:j

Southern California

12Q2

Water Co.:

800

July 21, 1943

451 11

.2 44

9.8

b *65*

232 0

59 28

.9 ------

150

Adelaide plant well L . 413

-----

Sept. 7, 1945 -----

411 19

Tr. 34 10

b 60

238 ------ 22

28 Tr.

126 **t::tl**

t;,:j

**13J3**

Southern plant well

413

620

Dec. *5,* 1940 "'------

b 319 18

0 1. 7 *57* 13

b 43

220 0

66 29

1.1

------

196 **C**

15GL\_

17JL \_.

3.

·. Cerise plant well L \_ Loren Hillman "West

413

413

410

Sept. 7, 1945 -----

Aug. 7, 1940 "'-----

Aug. 1-5, 1946 a -----

b 329 10

b 359 22

b 481 59

Tr. 58 12

.1 *56* 17

c2 35 16

b 48

b 56

b 137

226 0

262 0

427 0

70 28 ------

62 36 1.1

27 *52* ------

------

194

210

153

**0**

**t::tl**

t::;

Hawthorne No. 1".

------------- - - -- - -- -----

472 20 0

6 Tr.

b 123

143 60 16

34 ------ ------

15 *U).*

17LL\_,\_

o. T. Johnson Ranch

well 9.

414

506

July 31, 1931\_ \_ ---- -----

b 389 ------ -------- 38 21

90,

396 ------

Tr.

41 1 0

181

18N3 General • Chemical Co.

well 3.

414

428

A Mar. 25, 1930

**B** Nov. 25, 1930

C Mar. 16, 1931-\_ -----

-----

-----

b 421 ------ ------- - 49 20

b 393 ------ -------- 47 16

b 369 ------ --------

51

17

b 90

b 102

l---

b 73

336 ------ 26

333 ------ 7

320 --- ---

10

68 ------ ------

54 ------ ------

58 ------ ------

205

183

197

E July 3, 1939.

D Sept. 8, 1937

F Sept. 26, 1939

G Jan. 15, 1940

-----

-----

-----

b 484 ------ -------- 68 *25*

b 480 ------ -------- *65 25*

b 387 ------ --------

62

20

b 520 ------ -------- 70 *25*

84 -----

86 -----

94 -----

10

274 ------ 18

229 ------

267 ------ 21

273 ------ 20

101

.54

1

152 ------ 0

148 ------ 1

173 ----- - 1

237

273

265

**278**

H Apr. 24, 1940 --..

b 654 ------ -------- 89 33 108 -----

266 ------ 43

246 ------ 2

358

I Aug. 27, 1942

b 418 ------ ----- --- 80 23

b 49

273 --- -- - 15

114 0

294

J Jan. 9, 1945 -----

425 ------ -------- 54 19

b 74

250 ------ 14

109 ----- - ------

213

K June 22, 1945

-----

446 **28** c2

53 19

b 80

256 ------ 22

107 ------ ------

210

Southern

California

L Jan. 14, 1946 -----

442 --- .,

-------- *55* 19

b 77

262 ------ 16

107 ------ ------

215

2rn2

Water Co.:

Rosecrans plant

414

527

1930 **(?)e.\_** --------- -----

b 319 12

0 2.6 39 11

b *75*

b 54

318 ------

3. 2 32 ------

**143**

180

\_..,

well 2.

Mar. 2,1937 -----

b 313 17

C 4.4 44 17

262 0

28 39 ------ ------

May 11, 1944 -----

b 309 42

.3 48 15

b *55*

296 ------ 7

36 ------ ------

182

Oct. 1, 1945 ----- b 318 13

Tr. 43 15

b 65

308 0

2.4

39 ------ ------

169 0

**C,l,j**

TABLE *30.-Chemical analyses of representative native and contaminated waters from the deposits penetrated by water wells, 1925-46-Con.*

Parts per million

..,. 0 1

Well

Source

*i*

*Q*

P.

."as'

$

IXI

Depth in feet

Date of collection

f;'

f

Ee

s

*Q*

E-i

"'

g

'O

;o

'oO

.la§

A

--

May 9, 1941. -----

8

r£.

--00

-;-

e

g

'2

8

1

-0a

0

e'bli

s

.E!

i

e'2

10

*w\_*

g

s

j

0

P-t

--

0

0

e3.

.s

§

.0

-- iii

0

8

.s

§

.0

!is

0

--

0

r£.

..as

*w*'3*\_*

......

§

*Q*

I

'O

0

e

.s

0

"'

lXl

0 I

0["Q' i

r

0

e

.s "'"'

!-

z

--P:I

3/14-22Al••.

Chadron **plant** well 1.

414

**710**

May 5, 1941....••. -----

523 21

507 19

**0** 2.6 60 24

0 2.2 49 19

**b 54**

b 67

220 12

238 15

48 82 0

31 67 0

------

------

**248**

200

May 29, 1941••.... -----

450 22

0 3.6 46 18

b 46

238 2.9 40

34 ------

189

May 11, 1944.•.•.•

Sept. 17, 1946••...• -----

b294 42

473 26

.05 55 15

**0 1** 50 **15**

b35 b 53

221 ------ 42

260 ------ 41

36 ------ ------

38 Tr. ------

199

187

23LL.

-----

b 45

Compton plant well 1.

414

397

JDaenc..45,,11994450 "------

Apr. 23, 1945.

67.6

54

b323 21

b309 23

----- b 3,907

0 2. 2 54 15

-------- 50 12

.03

517

177

b44 b 51

223

226

234 ------

0 69

Tr. 50

217

28 1.1

33 Tr.

2,150

.3

------

197

174

2,018

2602••.

26JL.•• Mrs. E. U. Knape

29

222

Brattud.

Feb, 11, 1946a -----

b 311 25

------ --------

b377

20

13

Tr. 51 15

i1J--

226 0

58 29 ------ ------

189

414

414

26RL••

Beatrice M. Henderson.

414

132.5 Oct. 24, 1944

----- ------- ------ --------

240

103 ------

10 1,020

. 2 ------

960

29Nl.•• Calilornia Water Serv-

ice Co., station 12.

414

500

A Oct. 24, 1930...

B Feb. 13, 1931...

Feb.8, 1946 "- ----

0 Mar. 9,1931...

D AJ\_.r· 6, 1931..• E J y 13, 1931..\_

F July 21, 1931...

-----

b368 64 9

b358 ------ -------- 58 11

.02

61

17

b406 ------ -------- 94 9

b4Q5 ------

-------- 65 15

b361 ------ -----·-- 56 16

b367 ------ -------- 55 18

b 66

b 65 b49 b 70

b 61

ha----

248 ------ 31

236 34

------

260 ------ 32

260 ------ 33

254 ------ 35

256 ------ 33

74 ------ ------

72 ------ ------

230 ------

89

92 ------ ------

----

92 ------ .,.\_

66 ------ ------

------

69 ------

197

190

.6

4.0

272

224

206

211

G June 19, 1945. \_

b353 63

.36 54 20

254 ------ 43

56 ------ ------

217

City of Manhattan

H Jan. 29, 1946

b346 ------

.23 54 13

b64

249 ------ 30

60 ------ ------

**188**

30A2.•.

BeWacehll:10 414

525

Oct. 4, 1945 "------ -----

b343 21

.2 45 14

b75

337 ------ 0

40 ------

170

30DL.

----------

Well8 415

350

Oct. 20, 1938 -----

528 ------ -------- 55 20

b57

262 ------.. 32

67 Tr. ----------

220

Mar. 31, 1944

------

------ ------

Aug. 15, 1944

Sept. 25, 1944

b428 36

b 507 36

b560 30

.1 65 19

.3 80 19

.1 89 26

b 73

b 86

b 86

252 34

220 40

212 ------ 41

111 ------ .,.

172

212 ------ ------

240

278

329

Oct. 24, 1944 """73

677 25

.w 90 26

**b93**

215 0

41 226 .6

2.0

332

**SOHi...**

Well 9.-...,••••••••••• 415

Oct. 29, 1944..••••• -----

b 717 28

.1 135 27

b 95

210 ------ 52

303 ------ ------

448

390

tE\_r, 9, 1941. -----

529 ------ -------- 59 21

b66

214 6

27 116

1. 6 ------

234

ar. 31, 1944

Aug. 4, 1944.

•401 36

•385 30

.2 60 17

.4 57 17

b 72

b 69

273 ------ 24

271 ------ 26

91 ------

80 ------ ------

220

212

Aug. 15, 1944.

•387 ------

.3 58 17

b 68

271 ------ 27

81 ------ ------

215

Oct. 24, 1944 72 b379 26

.02 55 16

b 69

271 0 26

76 .7 0.2

203

Oct. 4, 1945..••••••

231

b378 26

.05 62 17

b61

272 ------ 26

76 -----· ------

225

3/14-30ML\_ Star Nursery 415

276. 5 Apr. 10, 1944.

b 555 24 . 35 80 22 b 100

219 ------ 41

202 ------ ------

290

Oct. 24, 1944 ·---- ------ -------- 80 - -;i; -- ---b 1"., ---

253 0

22 165 . 6

--- --

246

31A6

502

Dec. 14, 1944

b633 40 .10 98 :.:6

1""

220 ------ 48

247 ------ ------

352

California Water Serv- ice Co., station 5, well

415

July 21, 1931

b849 -------- 54 16 61 *ct---*

247 ----- 37

57 .3

201

31EL\_

6.

Howard

.J. Lovely .

415

260

Oct. 6, 193L Mar.-24, 1932

Sept. 2, 1937

b387 61 b314 48 b 354 57

21 61 : ---

14 55 -----

17 53 -----

268 ------

253' ------

255 ------

33 76 .5 0 239

16 53 . 8 0 177

48 56 .8 0 212

Oct. 24, 1944

48 ------ ----.. -----

262 0

50 57 0 0 142

32AL\_

California Water Serv- ice Co., station 8, well 8.

415

449

A Nov.13, 1929 B Oct. 21, 1930

C Mar. 9, 193L D July 21, 193L\_ E Sept. 2, 1937.

b373 61 b 344 75 b353 61 b 364 57 h361 57

12 b64

0 b57

·2 b70

17 61/-----

15 58 -----

242 ------

223 ------

177 ------

244 ------

237 ------

49 66 ------ ------ 202

34 66 ------ ------ 188

46 85 ------ ------ 161

45 62 ------ ------ 212

42 69 1.5 0 204

F Jan. 4, 1945

384 27 .06 56

16 b59

249 ------

44 59 ------ ------ 206

35RL. Southern California Ed-

ison Co., Ltd.

415

550

July 23, 1931 "

Sept. 20, 1937 Sept. 26, 1939 Feb. 8, 1946

b251 35 b232 28 b237 28 b241 13 11 29

12 52 -----

11 51 -----

18 47 -----

12 39 12

241 ------

2341 ------\_

230 ------

3 27 1. 4 'fi. 137

Tr. 29 . 7 Tr. 115

4 24 ------ 0 144

4. 0 28 . 5 1. 3 122

3/15-lHL.\_ Andrew Bennett\_ 415

625

July 31, 1931 a

Sept. 21, 1939

b583 66

b585 61

32 123 - ----

28 131 -----

548006 ------\_

30 91 .8 Tr. 296

27 85 ------ 0 267

12BL\_

CityWoef lEl l10Segundo:

415 400

Aug. 15, 1945a

----- h484 30 .2 63

21 b 103

427 ------

1 82 ------ ------ 244

12GL\_ Well6 414 349

Dec. 18, 1939 Feb.17, 1942

425 69

420 55

13 b 64

17 b77

159 ------

206 ------

45 133 ------ ------ 226

41 116 ------ ------ 207

1202

Well5

414 394

Feb.25,1945

Oct. 14, 1939 May 4, 1941. Feb. 7, 1942

b422 15 .5 60

470 64

596 110

660 99

20 b 78

19 b79

27 b63

28 b 101

310 ------

171 ------

188 ------

181 ------

17 92 ------ ------ 232

39 162 ------ ------ 238

64 214 ------ ------ 386

74 252 ------ ------ 362

Well!

Oct. 24, 1944-. 100

Feb.25, 19'45 b508 11 .3 88

20 b73

182 0 180 \_

85 173 . 8 ---\_-- 207

57 180 ------ ------ 302

3/15-12LL\_

414 355

A Dec. 6, 1929 B Mar. 4, 1930 C Mar. 28, 1930

D May 9, 1930

E June 9, 1930 F Nov.25, 1930

G Feb. 13, 193L H Mar.16, 1931..

I Apr. fl, 1931. J Aug. 25, 1936 K Sept, 15, 1936--

L Oct. 14, 1936--

M Sept. 8, 1937

h303 61 b 426 59

b 377 80

b 397 66

b 439 98

h 390 59

b 340 ••...• 61

b 408 67

h 440 71

b 445 72

b 427 68

b 472 74

b 672 90

11 b37

23 b 80

6 b 55

19 b 60

11 b 54

17 b 67

9 b 60

22 b 68

18 b 72

22 b 75

21 b 72

24 b 84

49 771-----

132 ------

297 ------

214 ------

250 ------

249 ------

282 ------

223 ------

312 ------

236 ------

180 ------

180 ------

180 ------

205 ------

28 100 ------ ------ 198

23 92 ------ ------ 242

33 96 ------ ------ 225

27 100 ------ ------ 243

27 124 ------ ------ 290

14 92 ------ ------ 217

0 98 ------ ------ 189

7 88 ------ ------ 258

33 128 ------ ------ 251

42 144 ------ ------ 270

44 132 ------ ------ 256

44 156 ------ ------ 283

161 190 1. 3 1 426

TABLE *30.-Chemical analyses of representative native and contaminated waters from the deposits penetrated by water wells, 1925-.t,6--Con.*

Depth

Date of

Parts per million

o:s 0

t

bJJ 0

s*QJ* o

g

6 ..s

0

0 o:s

Well

Source

Cl)

o:s

bJ)

in collection

.C.l.) ] '2 6 '2 g e *8*s 0 0

0. feet

"'

.s

E 'O

*8* e s

e El

so:s s

0 s 0 e j

i:: 0.

oo .s

.0.

*$* Cl) *$ g*

§ - g

s .i

i:: C)

s

go:s Cl)

sli .!:l j

a .0. .s £

.o.:.s 'E8

*w* E-i A s*w* .§ 0"'

o:s "g

*w*

0 C) ,Ci O:S'-'

p.,. 0 *w* 0 i:q

Well7

'3

-- --- -- -- ------ -- ----- -- -- --

3/15-12L6

414 350 A Nov. 16, 1939

B Nov. 16, 1939

----- 550 ------ ----- --- 79 15 b 95 144 ------ 69 195 259

----- 570 ------ -------- 82 17 b 96 159 ------ 75 195 275

C Nov.16, 1939

----- 420 ------ -------- 44 9 b 94 105 ------ 43 157 .., 147

D Jan. 4, 1940 ----- 695 ------ -------- 82 15 b 107 184 ------ 90 181 267

E Mar. 30, 194L\_ ----- 553 ------ ------- - 80 22 b 86 213 ------ 73 160 290

F Feb. 8, 1942

G Sept. 2, 1942

H Apr. 24, 1943

570 ------ -------- 90 24 b 84 206 - ----- 72 186 323

----- 808 ------ -------- 115 27 b 43 215 ------ 20 208 0 398

630 ------ -------- 102 28 b 89 211 ------ 76 220 370

I Oct. 24, 1944\_. 71 1,330 18 0.06 194 61 b 145 250 0 119 520 .4 0.1 735

Standard Oil Co.:

J Feb. 25, 1945

----- 966 21 .25 202 49 b 82 232 ------ 97 420 706

13A2 \_

Well 13 414 450

Oct. 10, 1939 Dec. 19, 1940

589 12 61

b 393 39

20 b 76

22 b 85

323 0 --------

256 ------ 11

96 ------ ------ 235

108 ------ ------ 188

Dec. 18, 1941 June 22, 1942 June 21, 1943

June 1944

b 510 27 • 2 80

b 531 87

h 526 87

859 28 97

25 b 82

26 b 80

,

27 b 76

25 b 122

296 0 23

284 ------ 31

287 ------ 29

366 18 6

152 ------ ------ 303

165 ------ ------ 324

163 ------ ------ 328

194 ------ ------ 345

Well 4b

Oct. 24, 1944 160

------ \_

319 0 36

224 • 6 ------ ------

13EL\_

13RL.. Well9

414 -!04

414 400

Aug. 8, 1929 June 5, 1930 June 12, 1930 Mar. 25, 1930 Mar. 26, 1942 •

942 34 c 29 75

6,618 25 c 305 400

1,516 19 c 20 158

h -!04 21 c 10 52

h 367 29 c 2 52

14 b 230

260 b 1,163

50 b 101

17 b 99

17 b 72

321 ------ 117

230 ------ 1,020

283 ------ 320

329 6 5

337 0 0

253 ------ ------ 245

2,400 ------ ------ 2,066

210 ------ ------ 600

60 ------ ------ 200

57 ------ ------ **200**

13R4

13R5..\_

Well 19

Well 20

**414** 4-ro

**415 *504***

June 21, 1943

Apr. 27, 1943 Jan. 6, 1944 Jan. 10, 1945

Jan. 8,1946 June 1944 :.\_

h 360 53

b 368 53

585 53

h 423 29 c2 60

b 444 31 e 1 69

603 28 \_ 56

17 b 68

19 h67

16 b 81

19 b 82

23 b 73

|  |  |  |  |
| --- | --- | --- | --- |
| 18 | b 76 | 345 0 | 1 |
| 19 | b 79 | 368 0 | 1.6 |

323 ------ --------

311 ------ 1

329 0 2

327 ------ 3

317 0 11

60 ------ ------ **202**

72 ------ ------ 210

**73** ------ ------ 198

**95** ------ ------ 228

109 ------ ------ 267

68 ------ ------ 214

Oct. 24, 1944 73 422 31 ----- 43 53

59 .8 .1 210

Jan. 10, 1945

545 *'n* 1 *66*

18 b 78

336660 ------

T3r.

61 ------ ------ 214

July 16, 1945

445 24 e 1 58

19 b 79

66 ------ ------ 223

Jan. 8, 1946

464 33 **e** 2 59

19 b **83**

363 0 3

75 ------ ------ **225**

3/15-24DL\_

City of Manhattan BeWacehll:5 **415**

**390**

JAuplyr. 134,,11993464" ------ ----------

**b 433 17**

**b906 34**

**b 349** ------ --------

b 5.4

71 21

176 47

**337 10**

306 ------ 16

b 71

**b 100**

**b 72**

**b 58**

**b 109**

b 71

b 56

b 74

b 128

b 137

b 122

621-----

b 72

b 1,28

b 114

52 -----

44 -----

b 95

580 -----

42 -----

681 -----

638 -----

b 171

67 -----

62 -----

60 -- --

62 -----

61 -----

62 ------

56 -----

59 -----

b 63

b 105

b 130

b 67

681 3.9

156 -----

621-----

152 -----

b 74

531 1. 9

------

------

91 ------ ------------

**264**

**633**

25AL.\_

Well3 **415**

**547**

Nov. 13, 1929 ,.. Oct. 22, 1930 Feb. 13, 193L

Apr. 6, 1931.

,.\_

b 357 ------ -------,- 53 **10**

**b412** 43 **8**

------ --------

68

6

**b390** ------ -------- 62 **13**

236 24

223 ------ 29

------

**283** 30

236 ------ **23**

80 ------

103 ------ ------

**414** ------ \_ ..

76 ------ ------

------80 ------

**174**

**195**

**140**

**208**

Sept. 4, 1942 -----

**784** ------ --------

**100** 29

**222** ------ **15**

208 0

------

369

June 11, 1943. ----- b 615 **10** •5

107 34

177 ------ **41**

**270** ------

**407**

Aug. 15, 1944 ----- b 1,106 30

.1 209 **52**

219 ------ 62

**545** ------ ------

**736**

Oct. 24, 1944 -- 72

1,220 **24**

0 180 **54**

216 0

63 **522**

**.5 19**

**671**

Jan. 15, 1945

203 ------

b 1,068 30 • 10 205 49

219 ------ 62

**520** ------ ------

**713**

25A4...

Well2 **415**

Mar. 24, 1932 •----

b 365 ------ -------- 51 **15**

247 ------ 23

89 1. 0 ------

**189**

25HL.

Well L 415

1,000

June 11, 1943

Feb. 29, 1944 -----

b 526 7

b 766 28

•4 89 25

.3 139 **38**

171 ------ **51**

260 **47**

------

**317** ------ ------

**325**

503

Sept. 25, 1944 ---.... b 1,090 28

-----

.1 200 **54**

219 ------ 63

535 ------ ------

**721**

Oct. 27, 1944

170

**213** 0

50 **465**

.7 ------

**518**

Oct. 3, 1945

-i;1 200 30

.45

259 62

220 ------ 71

**634** ------

902

4/13-2P4.

George Mlndrup 415

161

Joly 22, 1931 a -----

b 338 ------ -------- 65 9

223 ------ 72

27 1.9 0

199

6JL

Dominguez Estate Co.\_

415

95 Aug. 19, 1931\_

Mar. 31, 1932 a

b 318 ------ -------- 55 16

b 308 ------ -------- 56 10

d216 66

217 ------ 67

27 1. 6 0

23 .7 0

203

181

8LL ..

Joseph Loria

415

32.2 Apr. 11, 1932. ---- - b 3,454 ------ --------

July 5, 1932 ----- b 4,014 ------ --------

-----

331

408

190

22.'i

250 ------ 1,356

253 ------ 1,596

870

1,021

1. 5 0

1. 6 0

1,607 t'-"j

1,934 ti

Mar. 6, 1933 a ----- b 3,611 ------ --------

317

214

259 ------

1,300

967 2

0 1,670 ti

12A2

City of Long Beach, North Long Beach

415

1,946

Junp 12, 1946 a - ----

b 452 48

* 10

8.2

2. 0

413 ------

6. 7

58 ------ ------

29

t'-"j

14QL\_

well 6. BPll Ranch

415

900

July 22, 193L - -

.,.\_

b 230 ------ ----- --- 24 2

168 ------ 28

168 36

21 2.2 2

23 .8 0

68 **C**

85 **0**

Mar. 21, 1932 a -----

May 11. 1932 -----

Aug. 8, 1932 -----

*'-'l"ov.* 2, 1932 -----

fan. 4. 1933. -----

b 236 ------ -------- 24 6

b 224 ------ -------- 24 5

b 239 ------ -------- 23 7

b 225 ------ -------- 24 5

b 233 ------ -------- 23 5

------

168 ------ 30

171 ------ 36

165 ------ 31

171 ------ 34

20 .8 0

25 .8 0

21 .8

23 .7

0

81 t,

86 *r:Jl*

81

78

71

Dominguez Water

Aug. 7, 1939

i5 b 219 ------ -------- 22 4

173 ------ 29

21 ------

15A2

Corp.:

416

998

July 23, 1931 a --- ..

b 208 ------ -------- 20 7

174 ------ 9

23 **1.** 6 1 79

Well 8---------------

June 1, 1945 -----

b 239

16 Tr. 21

6.8

159 12 32

25 Tr. 80

15A3...

Well 10.. 416

**158**

July 23, 1931 **a** -----

b449 ------ -------- 83 17

253 ------

108

52 0.27 ------

277

July 20, 1943 -•---

Oct. 11, 1943 -----

May 2, 1944 -----

693

768

689

15 .4

16 .4

26 Tr.

85

84

105

7.9

8. 9

16

268 0

256 0

244 0

128

182

137

84 Tr. ------

91 Tr. ------

94 Tr. ------

245

246

329

19HL

F. L. Forrester 416

90 Apr. 22, 1942 a 69

518 22

. 41 76 17

196 0

58 132 ------

**2.1**

260

19J4 Mrs. Addie V. Stewart

416

100

Apr. 11, 1932 a -----

b 787 ------ --------

100 34

265 ------ 37

325 .7 2

389

Aug. 7, 1939 -----

b 849 ------ --------

113 37

287 ------ 39

358 ------ 6

434

21QL. Shell Oil Co., Inc.. WU-

416

750

Feb. 7. 1938 a

b 218

31 0

**13** 2. 5

204 ------ 0

26 ------ ------ 45

22EL\_

mington well 1.

Richfield on Corp., well 5.

416

650

Apr. 10, 1942 a

-----

221 24

.01 20

5.1

185 0

2.8

22 ------ ------

71

**--.:r**

TABLE *30.-Chemical analyses of representative native and contaminated waters from the deposits penetrated by water wells, 1925-46-Con.*

00

Parts per mlllion

... *5*

Well

Source

Oil

i:i.

¢

D pth

Ill

feet

Date of collection

!!.;

j

f:

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P=l

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0

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'3 :;::;

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0

P=l

z al

00

City of Los Angeles:

l

|  |  |  |  |
| --- | --- | --- | --- |
| Lomita  4/13-30KL\_ Wel | p7lant: 416 | 675 | Dec. 11, 1941\_  Jan. 14, 1942 **a** |
| Well  31E4 Well | 3  4 | 671 | Mar. 25, 1932 **a**  July 26, 1932 |

-----

Jan. 8,1923 **a** ---------

-- --- -- --

b 272 24 13

-- -- --

b 66

|  |  |  |
| --- | --- | --- |
| 224 | 9 | 6 |
| 211 | 22 | 1 |
| 311 |  | 0 |

-- ---

-- -- -- --

113

------

31:E3

416

-----

b 239 ---,..--- ---------------- 15 10

18 9

b 377

b 61

42 ------ ------

24 ------ 79

82

35M3

416

680

-----

-

**a**

b 38S 16

1231-----

7 b 131

------

..,.\_.. 36

258 ----

69 2.0

69 ------

------ 69

Southern California Edi-

son Co., Ltd., west

Qaqpur well.

416

201

b 318 ------ -------- 27 11

b 82

b 235

40 40 ------ ------

113

4/14-lH

Apr. 28, 1942••

69 8,200

20 0.97 438

418

1,8651 56

193 0

565

4,410 ------

1.8

3,809

Aluminum Company of

417 ---------

Aug. 28, 1942 **a** -----

b 252

13 C 6,0 41

**8.1**

b 46

196 ------ 25

34 ------ ------

136

5NL

America.

California Water Serv- ice Co., station 19,

417

533

Sept. 2, 1942 -----

b 392 ------ -------- 65 30

b 43

l---

259 ------ 20

104 ------ ------

286

5N2

well 1.

Redondo Union

High

417

312.8 Oct. 6, 1931 a

Mar. 24, 1932

-----

b 303 -

b 299 .. --

----- --------

43 18

43 13

223 ------- 16

57 .5 0

57 1.0 1

12

181

161

School.

May 11, 1932•• ----

b 283

-------- 37 15

56 -----

220

7 59 .9 0

154

Nov. 3, 1932

235 ------

-----

b 301 ------ -------- 43 14

54 -----

220 \_

..,\_ 14

62 .9 1

165

Sept. 24,, 19472-.· ----- -----

-----

b 369 ------ ----------

'45 13

..... ,.

56 -----

56 ·----

337 ------ 15

70 1. 3 0

166

. Sept. 18, 1944 -----

-----

b 647 ------

140 34

b 57

256 ------ 10

278 ------ ------

489

713

Apr. 13, 1945

............

2,280

3,370

b 195

2931 14

226

216

0

0

...,.

85

142

1,060 . 5

1, .1

2.5

2.0

1,306

2,130

SOL ••

California Water Serv-

ice Co.

Dominguez Water

416

416

306

518

Aug. 26, 1930 •--·- -----

Apr. 7, 1944•• \_ •••• --.---

b 320

b 361 16

.1 **78** 17

|  |  |  |  |
| --- | --- | --- | --- |
| 29 | 0 | '350 | 105 |
| 25 | .13 | 547 | 186 |
| 32 | .05 | 43 | 13 |

b 67

b 38

251

262 0

3.0

3.8

93 Tr. ..

161

265

Corp., well 12A.

July 20, 1944. -----

b3M

20 Tr. 46 13

b 77

259

Tr.

3.9

84 Tr. ------

168

Oct. 30, 1944

b 344 23

.08 42 15

b 73

252 0

2.5

**Sl** ·o.\_6

.• 1

167

June 1, 1 5

b 369 17

Tr. 46 16

b 77

250 0

1,2

93 ------

**181**

4/t; sE1:· ..

California Water Serv- ice Co., station 3, well

4.

416

440.5 July 21, 1931-...•• -----

b 327 42

**17** 1---

244 ·----- 3

71 .3 1

**175**

Oct. 3, 1936..•..... -----

b 346 ------ -------- 50 16

214 ------ 2 96 --·--· ------

191

9Kl.

Sept. 25, 1939---.. - -----

b 402 ------ -------- 54 18

781....•

251 -...,----- fl 119 1

209

Chanslor, Canfleld,Mid-

way on Co.

416

557

Oct. 21, 1929....... -----

383 32 ----···- 39 11

b 87

348

Tr.

33 ---··· ------, 143

Aug. 5, 1946.-·•·-· -----

553

28 011

80 18

b 100

270 ------

3 189 ---,.

.30

**274**

1102•..

Columbia Steel Co., well 1.

416

613

Oct. 21, 1929 "··--- -----

b 267

24 ·------- 29 13

**b** 62

279 ------

Tr.

23 --···- ------

126

July 23, 193L....• -----

b 277 ------ -------- 32 17

001.•.••

244 ------ 6

39 1. 4 ------

150

16L3..

Charles H. Quandt 416

300

Oct. 21, 1928 ,. -----

b 291

37 -·---·-- 21

5.0

b 94

293 ------

Tr.

24 -----· **73**

17EL. California Water Serv-

416

556

Oct. 3, 1929..•..... -----

923 40

2.9

88 134

b 186

304 ------

7.4

404 ------ ------

769

17GL..

ice Co., well 10.

Ellenwood Ranch•..•••. 416

418

Mar. 24, 1932 -----

May 11, 1932 ,. -----

325 **34** 11

b 325 ------ -------- 34 13

b ------ --------

83,.....

81 ·----

293 0

290 ------ 0

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 0 | 91 | .3 | 0 | 209 |
| 17  15 | 126  133 | ------  1.6 | 0  1 | 323  310 |

50 .3 0

52 .2 0

130

138

17Nl... California Water Serv-

------

416

400

Nov. 5, 1930 a.--·- -----

b427 45

.12 46 20

b 97

341 ------

7.1

86 ·---·- ------

197

ice Co., station 11.

July 21, 1931-. -----

b 442 - --- --

..,.,.

46 23

351 ------

20JL ••

s. Correia (Ellenwood well3).

416

367

July 23, 1931. \_ -

Sept. 8, 1937 •.•

. -----

b 560

b 573

------ -------- 70

----- 70

------

36

1061-----

103 --·--

33

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 19 | 6 | b 110 | 300 | ------ | 1 | 46 | ·----- | ------ | 72 |
| 60 | h8 | b 148 | 389 | 0 | 5 | 129 | 2.0 | ------ | 183 |

415

431

------

23N2...

Narbonne Ranch Water

Co., well 2.

416

640

-----

1934 "-·····- -----

b 332 ------

* 1 ....... -

104 ·----

------

35E2•..

36Hl..\_

Los Angeles County Water Works District No. 13.

Palos Verdes Water Co., well 1.

417

417

630

610

Oct. 27, 1944 "····- -----

June 29, 1925 "---· -----

June 11, 1930.. ·--- -----

b 547 ------ --------

b 334 ------ -------- 28 15

h-387 ------ -------- 14 6

b 86

b 138

281 ------ 0

324 ------ 2

------

62 ------ ------

64 ·----- ------

65 --·--- ------

132

60

pj l":I C

0

Ang. 6, 1935. -----

b 454 ------ -------- 26 13

b 143

388 6

72 -·---- ------

118 pj

Dec. 26, 1940...... -----

------

b 368 23

.1 17 8

b 123

293 ------ 0

73 --·--- ------

75 t:I

5/13'-3H.. -..

on wen

417

1,300

May 20, 1942.-·--- -----

Mar. 11, 1942(?)".. -----

b 408 -------- 18 7

750 ------ -------- 18 5

h 141

h240

354

b 487 ------

3

5 130 ------ ------

74 *'Cf).*

66

6/14-1201...

Royal Palms Golf Club, well 1.

417

200

May 23, 1930.·---- ----- b 1,004 ------ --------

Oct. 30, 1930...•••• ----- b 1,059 ------ --------

166 33

145 36

b 163

b 169

473 ------

485 ------

150

94

255 ------ ------

372 ------ ------

550

510

Mar. 19, 1931. -----

b 999 ------ -------- 127 42

b 187

414 ------

161

275 ------ ------

490

July 5, 1939. ----- b 1,270 ------ --------

172

71 1871----- 471 ------

356

244 ----- 4

721

Sept. 26, 1939..•••\_ ----- b 1,271 ------ --------

167

67 193 --··· 454 ------

256

354 ------ 7

692

Notes to table 30

l/14-19Rl. Drilled public-supply well; diameter 16 in; casing perforated 195-217, 255-266, and 303-312 ft below land surface in deposits of Pleistocene age. Essentially native calcium bicarbonate water. Analysis by California Division **of** Water Re­ sources.

l/14-20Ml. Drilled public-supply well; diameter 14 in; casing perforated 156--174, 206--234, and 258-271 ft below land surface in deposits of Pleistocene age. Sodium bicarbonate water, native to range penetrated. Analysis by city of Beverly Hills. 1/15-2501. Drilled public-supply well; diameter 12 in; casing perforated 318-450

ft below land surface, probably in the upper division of Pico formation of Pliocene age. Inferior calcium, sodium chloride water; locally native. Analysis by Cal• ifornia Division of Water Resources.

l/15-28B2. Drilled public-supply well; taps deposits of Pleistocene age. Native calcium bicarbonate water. Analysis by California Division of Water Resources. 1/15-32Al. Drilled public-supply well; taps deposits of Pleistocene age. Calcium sulfate, bicarbonate water, locally native. Analysis by California Division of Water

Resources.

2/13-20Hl. Drilled industrial well; diameter 18 in; casing perforated 93-125, 133- 145, and 156--170 ft below land surface in the westerly arm of the Gaspur water-bearing zone; lowest perforations probably in unnamed upper Pleistocene deposits. Essen­ tially native calcium bicarbonate water. Analysis by California Division of Water Resources.

2/13-3202. Drilled public-supply well; diameter 14 in; casing perforated 604-645 ft below land surface in lower part of San Pedro formation. Analysis of Apr. 18, 1938, on water reported from 390 ft below land surface in the upper part of the San Pedro formation but probably not native to that range. Analyses of Apr. 24 and 26, 1938, reported from 630 ft below land surface; analysis of May 2, 1938, reported from 790 ft below land surface in the lowermost part of the San Pedro formation. Analysis of Nov. 30, 1944, represents a calcium sodium bicarbonate water essentially native to the lower part of the range tapped out may be blended in small part with inferior waters. Analysis of Apr. 24, 1938, by Dr. Carl Wilson; others by Smith-Emery Co. 2/14-4Nl. Drilled irrigation well; casing perforated 123-147 and 182-219 ft below land surface in the San Pedro formation. Native calcium, sodium bicarbonate water. Fluoride 0.2 ppm; electrical conductivity 582 micromhos. Analysis by U. S. Geo­

logical Survey. Field analysis in preceding table.

2/14-501. Drilled unused well; diameter 12 in. Taps San Pedro formation of Pleistocene age. Calcium, sodium bicarbonate water; locally native. Analysis by Los Angeles Department of Water and Power.

2/14-502. Drilled public-supply well; diamel;er 26 and 16 in; casing perforated 201-320 ft below land surface in the San Pedro formation of Pleistocene age. Sodium to calcium, sodium bicarbonate water, resulting from a blend with one or more in­ ferior waters of unknown source. Ana,lyses by city of Beverly Hills.

2/14-5D5. Drilled public-supply well; diameters 30 and 16 in; casing perforated 152-160, 174-199 and 214--266 ft below land surface in the upper part of the San Pedro formation. Sodium bicarbonate water; fluctuations in chloride and sulfate probably due to blending with an inferior water, present locally. Analysis of Oct. 2i 1931, by California Division of Water Resources; others by Smith-Emery Co. Fiela analysis in preceding table.

2/14-5D6. Drilled public-supply well; diameter 16 in; casing perforated 326--342 **1µ1d** 92-515 ft below land surface in the middle and lower parts of the San Pedro **formation.** Sodium bicarbonate water, essentially native to range penetrated.

tion. Calcium bicarbonate water, native to range tapped. Analysis by Los Angeles Testing Laboratory.

2/14--22P2. Drilled public-supply well; casing perforated 216--227, 267-277, and 285- 290 ft below land surface in San Pedro formation. Analysis suggests calcium bicar­ bonate water, native to range tapped. Analysis of 1944, iodide absent, electrical conductivity 570 micromhos. Analysis in 1940 by Dr. Carl Wilson, that in 1944 by

T. Downer, U. S. \_Geological Survey. Field analyses in preceding table.

2/14--23H2. Drilled public-supply well; diameter 20 in; casing perforated 455-480, 495-520, and 725-775 ft below land surface in Silverado water-bearing zone in San Pedro formation. Native calcium bicarbonate water, a blend from all parts of range tapped. 2/14--27D2. Drilled public-supply well; diameter 18 in; casing perforated 110-130 ft below land surface in unnamed upper Pleistocene deposits, and 181-197 and 256--273 ft in San Pedro formation. AnalysIS suggests calcium bicarbonate water, essentially native. Well located just west of Potrero fault; chloride content markedly higher than from wells inland from the fault. Iodide absent, electrical conductivity 1,420

micromhos. Analysis by T. Downer, U. s. Geological Survey. Field analyses in

preceding table.

2/14--27D3. Drilled public-supply well; diameter 18 in; casing perforated 102-104 ft below land surface in unnamed upper Pleistocene deposits, and 169-189 and 24Q-242 ft in San Pedro formation. Native calcium bicarbonate water. Well located just west of the Potrero fault; chloride content higher than from wells inland from the fault (analyses 22N4, 22Pl, and 22P2). Analysis by California Division of Water Resources.

2/14--27Jl. Drilled irrigation well; diameter 18 in; casing perforated 236--283 ft below land surface in the Silverado water-bearing zone **of** San Pedro formation. Analyses of 1931 on water from 1,047-1,087 ft below land surface in the upper division of the Pico formation of Pliocene age; represent a native sodium bicarbonate water. Later samples indicate a sodium, calcium bicarbonate water native to the Silverado zone. Analyses of July 31, 1931, Nov. 14 and 18, 1932, by Los Angeles Testing Laboratory; analyses of Aug. 3, 1931, and Sept. 8, 1937, b\_y California Division of Water Resources; analysis of Apr. 11, 1932, by Los Angeles Department of Water and Power; that of Apr. 6, 1934, by Los Angeles Health Department. Field analyses in preceding table. 2/14-28Fl. Drilled public-supply well; diameter **18** in; casing perforated 166-176 ft below land surface in "200-ft sand" of unnamed upper Pleistocene deposits, and 274- 294 ft in "400-ft gravel" in upper part of San Pedro formation. Calcium, sodium bi­ carbonate water, a blend of native waters from the zones tapped. Analyses by Dr.

Carl Wilson. Field analyses in preceding table.

2/14--29Kl. Drilled domestic well. Probably taps "200-ft sand" in unnamed upper Pleistocene deposits. Native calcium, sodium bicarbonate water. Analysis by Los Angeles Testing Laboratory.

2/14-32El. Drilled irrigation well; diameter 10 in. Taps unnamed upper Pleisto­ cene deposits. Sodium, calcium bicarbonate water, locally native. Analysis by Los Angeles Testing Laboratory. Chloride content 83 parts in 1944. Field analyses in preceding table.

2/14-32Fl. Drilled public-supply well; casing perforated 175-205 ft below land surface in "200-ft sand" in unnamed upper Pleistocene deposits, and 327-357 ft in "400-ft gravel" of San Pedro formation. Calcium bicarbonate water, blend of waters from the two zones. Analysis of 1940 may represent a blend with an inferior water, present locally. Analysis of 1938 by Los Angeles Testing Laboratory; others by Dr. Carl Wilson. Field analyses in preceding table.

Analysis of Mar, 1,1935,on water from 330ft below land surface; that of Mar. 7,1935, on water from 462 ft below land surface; that of Mar. 11, 1935 on water from 504 ft below land surface. Analysis of 1943 by Los Angeles Testing Laboratory; all others by Smith-Emery Co. Field analysis in preceding table.

2/14-5D8. Drilled public-supply well; casing perforated 70-80, 16o-224, 248-282, 342-355, and 362-370 ft below land surface in the San Pedro formation. Sodium bicar­ bonate water, a blend of waters from the San Pedro formation. Analyses by Smith­ Emery Co.

2/14-5D9. Drilled public-supply well; casing perforated 26-50 ft below land surface in the "50-ft gravel" of Recent age. Calcium sulfate, bicarbonate water. Analyses by Smith-Emery Co.

2/14-7P2. Drilled industrial well; diameter 16 in; casing perforated 122-213 ft below land surface in the San Pedro formation. Sodium chloride water; marked contam­ ination indicated. Analysis of 1946, fluoride 0.2 ppm, electrical conductivity 4,050 micromhos. Analysis in 1945 by Smith-Emery Co.; that in 1946 by U. S. Geological Survey.

2/14-801. Drilled stock **well.** Probably taps San Pedro formation. Sodium calcium chloride water, resulting from contamination. Fluoride 0.3 ppm1 electrtcai conductivity 1,780micromhos. Analysis by U.S. Geological Survey. Firudanalysis

in preceding table.

2/14-1402. Drilled public-supply well; diameter 16 in; casing perforated at inter­ vals 41o-973 ft below land surface. Well taps most of San Pedro formation. Analysis of Oct. 16, 1931, on sample from 622 to 632 ft below land surface. Analysis since Nov. 12, 1931 indicate native calcium bicarbonate water. Sulfate content in analy­ sis of Nov. 13, 1931 probably in error. Analyses of Oct. 16, 1931 and Sept. 3, 1937 by California Division of Water Resources; others by Los Angeles Department of Water and Power.

2/14-18Fl. Drilled irrigation well; diameter 12 in. Taps San Pedro formation. Water initially sodium, calcium bicarbonate, chloride in character, probably native but may be influencea by blending with Tertiary waters. (See analysis fer well 5/14-1201.) Later analyses show contamination; that of 1945 on bailed sample, from or slightly below water surface. Analysis in 1932 by California Division of Water Resources; that in 1945 by Smith-Emery Co.

2/14-1901. Drilled domestic and irrigation well; diameter 18 in; casing perforated at intervals 55-305 and 419-428 ft below land surface in San Pedro formation. Analy­ sis of 1928 suggests contamination but analyses in 1930 and 1939indicate an essentially native sodium bicarbonate water. Chloride content of about 100 ppm in 1944 sug­ gests recurrence of contamination. Analysis in 1928 by Los Angeles Testing Labora­ tory; in 1930 by Los Angeles Department of Water and Power; in 1939 by Dr. Carl Wilson. Field analysis in preceding table.

2/14-22N3. Drilled public-supply well; diameter 18 in; casing perfcrated 104-117 ft below land surface in unnamed upper Pleistocene deposits, and 176-196 and 246-267 ft in the San Pedro formation. Well is east of the Potrero fault and yields regionally native calcium bicarbonate water. Analysis by California Division of Water Re­ sources. Field analysis in preceding table.

2/14-22N4. Drilled public-supply well; diameter 18 in; casing perforated 104-115 ft below land surface in unnamed upper Pleistocene deposits, and 122-130, 175-195, and 239-260 ft below land surface in the San Pedro formation. AnalysiS suggests a oalcium bicarbonate water, regionally native. Iodide absent, electrical conductivity 598 micromhos. Analysis by T. Downer, U.S. Geological Survey. Field analyses in preceding table.

2/14-22Pl. Drilled public-supply well; diameter 18 in; casing perforated 190-211 and 26o-292 ft below land surface in the middle and lower parts of San Pedro forma

2/15-102. Drilled abandoned well; formerly public-supply; diameter 14 in. Well taps San Pedro formation of Pleistocene age. Calcium, sodium bicarbonate water, essentially native. Analysis by Smith-Emery Co.

2/15-105. Drilled public-supply well; diameter 20 and 10 in, gravel-packed well; casing perforated initially 672-852*U* below land surface in upper division of Pico forma­ tion; subsequently plugged by cement bridge at 464 ft and reperforated 146-321 and 37o-374 ft below land surface, in San Pedro formation. Analysis of Aug. 31, 1944, represents sodium, calcium bicarbonate water, native to San Pedro formation. Analysis of May 3, 1944, on water from well before lower perforations were plugged indicates a saline water native to the upper division of the Pico formation. Analysis of May 311944, by Dr. Carl Wilson; that of Aug. 31, 1944, by Smith-Emery Co. Field

analysis m preceding table.

2/15-9N6. Drilled abandoned well; formerly public-supply; diameter 16 in; casing perforated 35-146 ft below land surface in the "50-ft gravel" of Recent age and in the San Pedro formation of Pleistocene age. Calcium, sodium bicarbonate water. All analyses indicate contamination. Analyses by California Division of Water Resources.

2/15-1106. Drilled public-supply well; diameter 18 in; casing perforated 178--198 and 22o-228 ft below land surface in San Pedro formation of Pleistocene age. Calcium, sodium bicarbonate water, native to the range penetrated. Analyses by California. Division of Water Resources. Field analysis by California Division of Water Resources.

2/15-11D2. Drilled public-supply well; diameter 18 in; casing perforated 24o-276 and 30o-340 *ft* below land surface in the San Pedro formation of Pleistocene age. Calcium..t sodium bicarbonate, sulfate water, locally native. Analyses by Smith­ Emery uo. Field analysis in preceding table.

2/15-llEl. Drilled well, now abandoned. Chemical character suggests water from the San Pedro formation of Pleistocene age. Native calcium, sodium bicar­ bonate, sulfate water.

2/15-11E3. Drilled public-supply well; diameter 18 in; casing perforated 210-393 ft below land surface in San Pedro formation. Calcium, sodium bicarbonate, sulfate water, locally native. Analysis by Smith-Emery Co. Field analyses in preceding table.

2/15-llJl. Drilled abandoned well; formerly public-supply, diameter 18 in; casing perforated 164-222 ft below land surface in San Pedro formation. Sodium, calcium bicarbonate water; initial analysis represents water essentially native to zone tapped. Subsequent analyses show increasing contamination. Analyses by Smith-Emery Co. 2/15-11J2. Drilled public-supply well; diameter 16 in; casing perforated 177-253 ft below land surface in San Pedro formation. Well 11J2 taps range similar to that tapped by llJl. Analyses show increasing contamination. Analyses by Smith­

Emery Co. Field analysis in preceding table.

2/15-12Bl. Drilled industrial well; gravel-packed; casing perforated 134-191 ft below land surface in the San Pedro formation. Calcium, sodium bicarbonate water, incipiently contaminated. Analysis by Smith-Emery Co. Field analysis in preceding table.

2/15-14Al. Drilled well; diameter 16 in; casing perforated 163-168, 200-212, and 230- 244 ft below land surface in San Pedro formation of Pleistocene age. Native calcium, sodium bicarbonate water. Analysis by California Division of Water Resources.

2/15-14Ql. Drilled unused well; diameter 12 in. Probably taps the "50-ft gravel" in Recent deposits and the San'Pedro formation beneath. Calcium, sodium blear• bonate chloride water; incipiently contaminated. Analyses by California Division of Water Resources.

2/15-15A2. Drilled unused well; diameter 14 in; casing perforated 62-116 ft below

Notes to table SO-Continued

land surface in San Pedro formation of Pleistocene age. Native calcium, sodium bi• carbonate, sulfate water. Analysis by Smith-Emery Co.

2/15-15A4. Drfiled public-supply well; diameter 16 in; casing perforated 70-178 ft below land surface in San Pedro formation of Pleistocene age. Calcium sodium bicarbonate, sulfate water, locally native; analyses beginning in 1940 show incipient contamination. Analysis ln 1940 by California Division of Water Resources; others by Smith-Emery Co. Field analysis in preceding table.

2/15-15F2. Casing perforated 74-104 ft below land surface in San Pedro formation of Pleistocene age. Native calcium bicarbonate, sulfate water; analysis of 1931 indi­ cates Incipient contamination. Analysis by Los Angeles Department of Water and Power.

2/15-15Hl. Drilled public-supply well; diameter 16 in; casing perforated 84-108 **ft** below land surface in San Pedro formation of Pleistocene age. Native calcium, sodium bicarbonate water. Analysis by California Division of Water Resources.

2/15-16J2. Drilled abandoned well; diameter 18 in; casing perforated 55-136 and 196-211 ft below land surface in San Pedro formation of Pleistocene age. Calcium, sodium sulfate, bicarbonate water, definitely contaminated. Analysis by Smith­ Emery Co.

2/15-16J3. Drilled unused well; diameter 12 in. Probably taps San Pedro forma­ tion of Pleistocene age. Water badly contaminated. Analysis by California Divi­ sion of Water Resources.

2/15-22B2. Drilled irrigation well. May tap deposits of both Recent and Pleisto­ cene age. Sodium sulfate water. Analysis indicates contamination although periodic chloride determinations show no increase in intensity since 1935. Strontium 14 ppm; electrical conductivity 3,270 micromhos; fluoride, barium, and iodide absent. Analysis by T. Downer, U.S. Geological Survey. Field analysis in preceding table. 2/15-22B4. Drilled unused well; diameter 16 in; casing perforated 120-124 and 150- **171** ft below land surface in San Pedro formation. Sodium sulfate, bicarbonate water;

analysis indicates contamination.

2/15-22F2. Drilled irrigation well; diameter 12 in. May tap depl)sits of both Recent and Pleistocene age. Calcium sulfate water: early analyses indicate moderate contamination, with consistent increase in intensity becoming ultimately a calcium sulfate chloride water. Analysis of 1945, fluoride 0.1 ppm; strontium 22 ppm; elec­ trical conductivity 3,450 micromhos; barium and iodide absent. Analyses ln 1929 and 1931 by Los Angeles Department of Water and Power; in 1939 by California DivisiCln of Water Resources: in 1945 by T. Downer, U.S. Geological Survey. Field analysis in preceding table.

2/15-22Jl. Drilled domestic and irrigation well; diameter 12 in. Taps "50-ft **gravel"** of Recent age and possibly uppermost part of San Pedro formation of Pleistocene age. Calcium, sodium bicarbonate sulfate water: all analyses show marked contamination. Analysis of 1945, fluoride 0.3 ppm; strontium 30 ppm; electrical conductivity 6,350 micromhos; barium and iodide absent. Analyses in 1936 and 1939 by Dr. Carl Wilson; ln 1945 by T. Downer, U, S. Geological Survey. Field analysis in preceding table.

2/15-2301. Drilled irrigation well: diameter 16 in. Taps the "50-ft gravel" of Recent age and probably the San Pedro formation of Pleistocene age. Sodium. calcium sulfate, chloride water, analysis indicates marked contamination. Fluoride

0.4 ppm: strontium 8.5 ppm; electrical conductivity 2,460 micromhos: barium and iodide absent. Analysis by T. Downer, U. Geological Survey. Field **analysis** in preceding table.

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Los Angeles Department of Water and Power: on July 31.,J931, and in 1932 by Cali­ fornia Division of Water Resources; in 1944 by Dr. Carl wllson. Field analyses in precedinl!: table.

2/15-34Hl. Drilled unused well; diameter 12 in; casing perforated 185-203 ft below land surface In the San Pedro formation. Native sodium, calcium bicarbonate water. Analysis by Los Angeles Department of Water and Power.

2/15-34Kl. Drilled public-supply well; diameter 16 in; casing perforated 97-133 ft below land surface in the San Pedro formation. Sodium bicarbonate water, essen­ tially native. Analysis of November 1944, electrical conductivitY: 710 micromhos; iodide absent. Analysis ln 1929 by Los Angeles Department of Water and Power in 1932 and 1937 by California Division of Water Resources; in June 1944 by Dr. Cari Wilson; and in November 1944 by T. Downer, U.S. Geological Survey. Field anal­ yses in preceding table.

3/18-601. Drilled public-supply well; diameter 12 in; ca.'ling perforated 250-256 and 271-298 ft below land surface ln the upper and middle parts of tho Silverado zone of Pleistocene age. Sodium bicarbonate water, typical of that zone but possibly blended to a small extent with waters above the Silverado water-bearing zone. Analysis by Smith-Emery Co.

3/13-802. Drilled public-supply well; diameter 12 in; casing perforated 165-175, 301- 319, and 390-425 ft below land surface in the unnamed upper Plesitccene deposits and ln the Silvera.do water-bearing zone. Calcium bicarbonate water, a blend of waters essentialll" native to range tapped. Analyses in 1931 and 1939 by California Division of Water Resources; others b\_y Smith-Emery Co.

3/13-17Ql. Drilled unused well, formerly irrigation; diameter 14 in; ca.'ling per­ forated at intervals 136-356 ft below land surface in the unnamed upper Pleistocene deposits and in the Silvera.do water-bearing zone. Calcium, sodium bicarbonate water, a blend of native waters. Analysis in 1931 by California Division of Water Resources.

3/13-20Hl. Drilled public-supply well, diameter 12 in; casing perforated 178-195 **ft** below land surface in the '200-ft sand" in the unnamed upper Pleistocene dep\_osits. Native calcium bicarbonate water. Analysis ln 1931 by California Division of Water Resources; others by Smith-Emery Co.

3/13-27Bl. Bored well. Taps shallow unconfined water. Sodium calcium bicarbonate, chloride water, probably native. Analysis by California Division of Water Resources.

3/13-80Pl. Drilled well, now abandoned; diameter 8 in. Taps shallow, unconfined water. AnalY:ses by California Division of Water Resources.

3/13-31H4. Domestic well; diameter 3 in. Well taps shallow unconfined water. Calcium., sodium chloride, bicarbonate water. Fluoride 0.2 ppm; iodide 0.0 ppm; electricaJ conduetivity 1,470 micromhos. Analysis by E.W. Lohr, U.S. Geological Survey.

3/13-36Dl. Drfiled public-supply well; diameter 10 in. Taps Ga.'lpur zone in alluvial deposits of Recent age. Calcium bicarbonate water native to the Gaspur. Periodic analyses indicate virtually no range ln chemical character over 5-year term beginning in 1932. Average of 24 analyses between July 5, 1932, and Mar. 3, 1937, by city of Long Beach chemical and physical testing laboratory.

3/14-lGl. Drilled public-supply well; diameter 14 in; ca.'ling perforated 220-256 and 265-270 ft below land surface ln the Sllverado water-bearing zone of the San Pedro formation. Calcium bicarbonate water, locally native. Analysis by Smith-Emery Co.

2/15-23Hl. Drilled irrigation well: diameter 14 in; casing perforated 33-102 ft below land surface in the "50-ft gravel" of Recent age and in the San Pedro formation of Pleistocene age. Sodium, calcium bicarbonate, sulfate water. Analyses show contamination. Analysis in 1945, fluoride 0.3 ppm: strontium 16 ppm: electrical

"'"' conductivity 2;670 micromhos; barium and iodide absent. Analyses in 1936 and 1939 by Dr. Carl Wilson: analysis in 1945 by T. Downer, U.S. Geological Survey. Field

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3/14-3K2. Drilled public-supply well; casing perforated 368-404 ft below land surface in the Sllverado water-bearmg zone. Initial analysis indicates sodium, calcium bicarbonate water, probably locally native although both analyses indicate possible blending with slightly inferior waters native to overlying zones.

3/14-4Nl. Drilled public-supply well: diameter 12 in; casing perforated 323-336, 499-537, 548-576, and 586-628 ft below land surface in the Silverado water-bearing zone.

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analysis in preceding table.

2/15-23Nl. Drilled domestic well. Taps the "50-ft gravel" of Recent age and the

Sodium, calcium bicarbonate water, typically native to the Silverado zone. Sample of Sept. 19, 1932, from 329 ft, that of Sept. 23, 1931, from 504 ft below land surface.

•tt San Pedro formation. Sodium chloride, bicarbonate water, contaminated. Fluo­

-• rlde 1.1 ppm; strontium 17 ppm; electrical conductivity 3,330 micromhos; barium and iodide absent. Analysis by T. Downer, U. S. Geological Survey. Field analysis in preceding table.

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2/15-23Pl. Drilled irrigation well; diameter 14 in; casing perforated 45-101 and 119- 140 ft below land surface in the "50-ft gravel" and in the San Pedro formation of

age.

00 Pleistocene Initially a native calcium, sodium bicarbonate water, contaminated since 1931. Analysis in 1930 by Los Angeles Department of Water and Power; that in 1931 by California Division of Water Resources: others by Dr. Carl Wilson.

2/15-23Ql. Bored well; n0w abandoned. Taps shallow unconfined waters. Sodium sulfate water, probably concentrated by evaporation from the capillary fringe. Analysi<; by Dr. Carl Wilson.

2/15-23Q2. Bored well: now abandoned. Probably taps both shallow, unconfined body and "50-ft gravel". Sodium, calcium sulfate water. Analysis by Dr. Carl Wilson.

2/15-2401. Drilled unused well: diameter 16 in; casing perforated at intervals from 215 to 350 *it* below land surface, in the San Pedro formation. Calcium, sodium bicarbonate water, essentially native. Analysis by California Division of Water Resources.

2/15-24D3. Drilled unused well; diameter 14 in; casing perforated 35-65 ft below land surface in the "50-ft gravel" of Recent age. Calcium, sodium sulfate, bicarbon• ate water, definitely contaminated. Analysis by Dr. Carl Wilson.

2/15-24L2. Drilled unused well; casing perforated 30-75 ft below land surface, principally in the "50-ft gravel" of Recent age. Calcium, sodium sulfate water, definitely contaminated. Analyses by California Division of Water Resources.

2/15-26Bl. Drilled irrigation and public-supply well; diameter 18 in; casing per­ forated 152-164, 218-221, and 276-292 ft below land surface in San Pedro formation ;)f Plei.'ltocene age. Sodium, cakium bicarb,mate water, locally native. Analysis by California Division of Water Resources.

2/15-26B3. Drilled abandoned well: diameter 16 in: casing perforated 40-68 ft below land surface in the "50-ft gravel" of Recent age. Initial analysis indicates possible incipient contamination. Analysis in 1939 by Dr. Carl Wilson; others by Los An­ geles Department of Water and Power.

2/15-26Fl. Drilled unused well; diameter 10 in; casing perforated 55-67 ft below land surface in the "50-ft gravel" of Recent age. Calcium, sodium bicarbonate, sulfate water, definitely contaminated, although analyses of chloride in 1942 indicate little increase in intensity. Analyses by California Division of Water Resources.

2/15-27Rl. Drilled unused well. Taps San Pedro formation of Pleistocene age. Sodium bicarbonate water, incipient contamination. Analysis by California Divi­ sion of Water Resources.

2/15-34Al. Drilled public-supply well; diameter 18 in; casing perforated 137-200 ft below land surface in the San Pedro formation. Sodium bicarbonate water: initial analysis suggests incipient contaminaticn by a S'>dium bicarbonate water, although subsequent analyses show no inrrease in intensity to 1944. Chloride determinations since 1944 show definite increase in salinity. Analyses in 1929 and on Apr. 1, 1931, by

Analyses by Smith-Emery Co.

3/14-8D2. Drilled public-supply well; diameter 10 in. Presumably taps unnamed upper Pleistocene deposits. Analysis suggests a calcium bicarbonate water, probably a blend with shallow waters which here may be definitely inferior. Electrical con­ ductivity 890 micromhos; iodide absent. AnalysiS by T. Downer, U.S. Geological Survey.

3/14-8E2. Drilled public-supply well; casing perforated 111-135 and 162-177 ft below land surface in "200-ft sand" within the unnamed upper Pleistocene deposits, and 270-275 ft in the Silverado zone. Calcium chloride water probably locally native but may be contaminated by an overlying inferior water of local origin.

3/14-9N2. Drilled public-supply well; diameter **14** in: casing perforated 321-360, 400-403, 454-460, and 622-634 ft below land surface in the Silverado water-bearing zone and underlying basal Pleistocene deposits. Native sow.um bicarbonate water. Analysis of 1945, fluoride 0.4 ppm: strontium 1.5 ppm: electrical conductivity 555 micromhos; barium and iodide absent. Analysis *A* by Smith-Emery Co.; *B, 0, D,* by California Division of Water Resources; *E, F,* by Dr. Carl Wilson: *G,* by T. Downer, U. S. Geological Survey. Field analyses in preceding table.

3/14-9N3. Drilled public-supply well; diameter 16 in; casing perforated 295-318, 322-348 ft in upper part of Silverado water-bearing zone. Analysis of 1941 indicates sodium, calcium bicarbonate water locally native to that zone; analysis of 1944 sug­ gests blending with inferior waters in the unnamed upper Pleistocene deposits. Analysf's by Dr. Carl Wilson. Field analyses in preceding table.

3/14-1001. Drilled public-supply well; diameter 12 in; casing perforated 361-368, 370-374, and 378-396 ft below land surface in the "400-ft gravel" in the upper part of the San Pedro formation. Analyses indicate blending in varying proportions of two or more native water types. Analysis of 1945 indicates water most characteristic of the "400-ft gravel." Analyses by Smith-Emery Co. .Field analysis in preceding table.

3/14-lOGl. Drilled public-supply well; diameter 18 in; casing perforated 492-527, 546-568, 638-654, 676-680, and 703-711 ft below land surface in the Silvera.do zone. Sodium bicarbonate water, characteristic of that zone. Analysis by **Dr.** Carl Wilson. Field analyses in preceding table.

3/14-12Q2. Drilled public-supply well: diameter 16 in: casing perforated 250-260, 269-279, and 360-395 ft below land surface in Silverado water-bearing zone. Sodium bicarbonate water. Analyses by Smith-Emery Co. Field analysis in preceding table. 3/14-13J3. Drilled publir-supply well; diameter 16 in; casing perforated 359-368, 400-452, 498-538, and 586-602 ft below land surface in the Silvera.do water-bearing zone. Calcium bicarbonate water possibly locally native. Analyses by Smith-Emery Co. 3/14-15Gl. Unused public-supply well; diameter 10 in; casing perforated 363-379 and 383-397 ft below land surface in the "400-ft gravel" in the upper part of the San Pedro formation. Calcium, sodium bicarbonate water, believed native to the range

tapped. Analysis by Smith-Emery Co.

3/14-17Jl. Originally an oil WP,ll, but reperforated at intervals from 1,089 to **1,294** ft below land surface in the upper division of the Pico formation of Pliocene age, for pumping test of that water-bearing zone. Initial analysis, a composite of 7 samples collected during pumping test from Aug. 1 to about Aug. 4, 1946; sodium bicarbonate

Notes to table 30-Continued

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watPr believed essentially representative of interval tapped. Second analysis col­ lerted at srime time during bailing test, Aug. 19-2fi, 1946; believed not representative. Analyses by Standard Oil Co.

3/14--17Ll. Drilled wPll: diameter 14 in: casing perforated 196-206, 304-370, 420-435, and 470--485 ft behw land surface, principally in the Silverado water-bearing zone but also in the unnamed upper Pleist,,cene dep·isits. Water essentially native to Sil­ verado zonP. Analysis indicatr!'I only slight increase in chloride due to blending with shall0w waters. Analysis by Smith-Emery Co.

3/14-18 3. Drilled industrial well: diameter 16 in; casing perforated 200-377 ft below land snrfacr, alm st whPlly in sn,,erad•) water-bearing zone but also in bottom few feet of "200-ft sano" in unnamed upper Plristocene deposits. Initial analysis indicat<'S P'>Ssible in<'ipirnt contaminafr,n. Latrr analysPs to 1940 indicate definite and progressive contamination. Chloride cc,ncPntration of sample depends on when taken after pump started. Analyses *D, E, F, G, I-I.* by California Division *cf* Water Rrsources: *I.* by Los Angeles County Fluod Control District: others by Standard Oil Co.

3/l4-21B2. Drilled public-supply wPll; diamPter 14 in; casing perforated 323-356,

379-406, and 430-468 ft bebw land surface in the Silverado water-bParing zone of the San Pedro formation. Sodium, calcium bicarbonate water, essentially native. Analysis of 1930 by L0s Angeles County Flor d Control District; analysE!S of 1937 and 1945 by Smith-Emery Co.: that of 1944 by Dr. Carl Wilson.

3/14-22Al. Drilled public-impply well: diamrter 16 in: casing perfotated 319-382 ft behw land surface in "400-ft gravel" and at intervals from 540 to 668 ft in Silverado water-bearing zone, both in San Pedro f)fmation. Sample of May 5, 1941, from 325 ft and that 0f May 9, 1941, from 548 ft helow land surface. Calcium bicarbonate to calcium, sodium bicarbrnate water, na.tive blend from the two zones but analyses indicate water is largely from the 1'4:00 -ft gravel." AnalyRis of 1944 by Dr. Carl Wils -n: 0thers by Smith-Emery Co. ·

3/14-23Ll. Drilled public-supply well; diameter 16 in: casing perforated 334--353 ft bel0w land surface in the "400-ft grave114 in the San Pedro formation. Water essen­ tially native. Analyses by Smith-Emery Co.

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3/14-2602. Drilled irrigation well; diame.ter 6 in. Taps shallow unconfined water. Inferior s0dium, calcium chloride water, n4tive to the unconfined body at shallow depth. Fluoride 0.2 ppm; electrical conductivity 6,770 micromhns. Analysis by

U.S. Geological Survey. Field analysis in preceding table.

3/14-26.Jl. Drilled d0mestic and irrigati0n well; diameter 8 in: casing perforated 17.'i-231 ft bel0w land surface in "200-ft sand" ln unnamed upper Pleistocene deposits. Calcium, sodium bicarbr,nate water, possibly incipiently contaminated. ·Fluoride

0.3 ppm: electrical conductivity 676 micromhos. Analysis by U. S. Geoloiical SurVPy. Field analysiR in preceding table.

3/14-26Rl. Drilled irrigathn and stock wPll: diameter 7 in. Taps shallow un­ confined water. Native inferior water. Electrical conductivity 3,320; iodic\e absent. Analysis by T. Downer, U.S. Geological Survey. FiPid analyses in preceding table. 3/14-29NI. Drilled public-supply well: diameter 16 in; casing perforated 206-227 and 265-275 ft below land surface in the upper part of the Silverado water-bearing zone. Calcium, sodium bicarbonate water, locally native to the range tapped. Analyses *A, B, C, D,* by Les Angeles Department of Water and Power: *F,* by California Divi­ sion of Water Resources: others by Califrmia Wat.Pr Service Co. Field Analyses in

prereding table.

3/14-30A2. Drilled public-supply well: diameter 16 in: casing perforated 235-281

ft below land surface in the Silvcrado water-bearing zone of the San Pedro formation. Native sodium bicarbonate water, similar to that produced from lHl. Analysis by Dr. Carl Wilson.

3/15-1201. Drilled public-supply well; diameter 16 in; casing perforated 139-155 ft below land surface in the "200-ft sand" of the unnamed upper Pleistocene deposits, also 205-221 and 292-332 ft in the Silverado water-bearing zone of the San Pedro forma­ tion. Lower zone probably correlative with that tapped in well 12Bl. Analyses Indicate blending of waters of the two zones in varying proportions. Analyses by Dr. Carl Wilson. Field analyses in preceding table.

3/15-1202. Drilled public-supply well; diameter 16 in; casing perforated 135-153 ft below land surface in the "200-ft sand" of the unnamed upper Pleistocene deposits; also 197-203 and 318-323 ft in the Silverado water-bearing zone of the San Pedro forma­ tion. Analyses indicate water chiefly from upper part of range penetrated. Calcium, sodium chloride water, definitely contaminated. Analysis of October 1944, electrical conductivity 936 micromhos; iodide absent. Analysis of 1944 by T. Downer, U.S. Geological Survey, others hy Dr. Carl Wilson. Field analyses in preceding table.

3/15-12Ll. Drilled public-supply well now abandoned; diameter 16 in; casing perforated 236-256 ft below land surface in the "200-ft sand" of upper Pleistocene age, also 29(}-320 ft in the Silverado water-bearing zone. Initially calcium bicarbonate water, essentially a native blend; later analyses indicate contamination, beginning about in mid-1931. Analyses *B, F,* and *I-I* by Standard Oil Co., *M* by California Division of Water Resources; others by Los Angeles Department of Water and Power.

3/15-12L6. Drilled public-supply well, now abandoned; diameter 16 in; casing

perforated 222-248 ft below land surface in the "200-ft sand" of the unnamed upper Pleistocene deposits, and 298-318 ft in the Silverado water-bearing zone of the San Pedro formation. Calcium, sodium chloride water, contaminated. Analysis of September 1942, iodide, trace. Analysis of 1944, fluoride 0.2 ppm; strontium 12 ppm; electrical conductivity 2,150 micromhos; barium, trace; bromide, less than 10 ppm; iodide, absent. Analysis *A* from 21(}-222 ft below land surface; *B* from 222-248 ft below land surface; *Cfrom* 320-336 ft below land surface. Analysis *G* by Los Angeles County Flood Control District; *I* by T. Downer, U. S. Geological Survey; others by Dr. Carl Wilson. Field analyses in preceding table.

3/15-13A2. Drilled industrial well; diameter 16 in; casing perforated 249-276, 294--302 ft below land surface in the Silverado water-bearing zone of the San Pedro formation. Analysis of 1939 indicates sodium, calcium bicarbonate water essentially native to zone tapped. Later analyses indicate progressive contamination. Analysis of October 1944, electrical conductiv-ity 1,270 mlcromhos; iodide absent. Analysis of Oct. 24, 1944., by T. Downer, U. S; Geological Survey; others by Standard Oil Co. Field analyses in preceding table. '

3/15-13El. Drilled industrial well, now abandoned; diameter 26 in; casing per­

forated 169-181 and 181-204 ft below land surface in the upper part of the Silverado water-bearing zone cf the San Pedro formation. Water highly contaminated. Analyses by Standard Oil Co.

3/15-13Rl. Drilled industrial well; diameter 16 in; casing perforated 294--342 and 372-396 ft in the middle and lower parts of the Silverado water-bearing zone of the San Pedro formation. Native sodium, calcium bicarbonate water. Analyses by Standard Oil Co.

3/15-13R4. Drilled industrial well; diameter 16 in; casing perforated 368-408 ft in the lower part cf the Silverado water-bearing zone in the San Pedro formation.

ft below land surface In the Silverado water-bearing zone. Sodium bicarbonate water, lrcally native to the lower part of the range tapped. Analysis by Dr. Carl Wilson.

3/14-30Dl. Drilled public-supply well: diameter 16 in: casing perforated 225-252 ft below land surface in the Silverado watcr-bea.ring zone in the San Pedro formation. lTnder native conditions, water probably similar to that of well 31A6: however, analyses indicate prcgressive cont'llmination beginning in 1938 or earlier. Analysis of Oct. 24, 1944, fluoride 0.2 ppm;. strontium 4.1 ppm: electrical conductivity 1,120 micromhos; barium. lodide, and bromide absent. Analysis in 1938 by Smith-Emery Co.: that of Oct. 24, 1944, by T. Downer, U.S. Geological Survey: others by Dr. Carl Wilson. Field analyses in preceding table.

3/14-3GH1. Drilled public-supply well: diameter 16 in: casing perforated 142-154 ft below land surface in the unnamed upper Pleistocene deposits and at intervals from 218 to 300 ft in the Silverado water-bearing zone. Analyses since that of 1941 indicate a calcium, sodium bicarbonate water, probably a blend of native waters in the two zones tapped. Analyses of October 1944, fluoride 0.2 ppm: strontium 3.4 ppm: elec­ trical crnductivity 691 micromhos: barium, iodide, and bromide absent. Analysis in 1941 by Smith-Emery Co.: that of Oct. 24, 1944, by T. Downer, U.S. Geological Survey:, thers by Dr. Carl Wilson. Field analyses in preceding table.

3/14-3( Ml. Drilled irrigatic,n well. Probably taps chiefly the unnamed upper PleistocPne deposits. Water markedly contaminated. Analysis of Oct. 1944, electrical conductivity 977 micromhcs: iodide absent. Analysis of Oct. 24, 1944, by

T. Downer, U.S. Geological Survey: others by Dr. Carl Wilson. Field analyses in preceding table.

3/14-31A6. Drilled well, formerly public-supply: diameter 16 in: casing perforated 190-472 ft below land surface in the Silverado water-bearing zone. Of the several public-supply wells in this local area, 31A6 spans the largest vertical range in the Silverado zone. Native calcium, sodium bicarbonate water. Analysis by California Division of Water Resources.

3/14--31El. Irrigation well; diameter 6 in. Position of perforations not known but comparatively low chloride content suggests that only the topmost part of Silverado water-bearing zone is tapped. Calcium, sodium bicarbonate water, essentially native. Analysis of October 1944, electrical conductivity 644 micromhos; iodide absent. Analyses in 1931, 1932, and 1937 by California Division of Water Resources; that in 1944 by T. Downer, U.S. Geological Survey. Field analyses in preceding table.

3/14-32Al. Drilled public-supply well; diameter 16 in.; casing perforated 173-327 ft below land surface in the Silverado water-bearing zone. Native calcium bicar­ bonate water. Analyses *A, B, C* by Los Angeles Department of Water and Power; *n, E,* by California Division of ater Resources; *F,* by California Water Service Co. Field analyses in preceding table.

,v'

3/14/-35Rl. Drilled industrial well; diameter 8 in; casing perforated 470-485 and 522-528 ft. below land surface in the Silverado water-bearing zone of the San Pedro formation. Sodium, calcium bicarbonate water, native to this zone. Analysis of February 1946, fluoride 0.3 ppm; electrical conductivity 435 micromhos. Analysis in 1946 by U.S. Geological Survey; others by California Division of Water Resources. Field analysis in preceding table.

3/15-lHl. Drilled, dcmestic and irrigation well; diameter 12 in; casing perforated 120..,132 and 180--190 ft below land surface in the Silverado water-bearing zone of the San Pedro formation. Sodium bicarbonate water, presumed native to the range tapped. Analyses by California Division of Water Resources. Field analysis in preceding table.

3/15-12Bl. Drilled public-supply well; diameter 16 in; casing perforated 18& to 21

Analyses in 1943--44 indicate a sodium, calcium bicarbonate water slightly contami• nated; later analyses show definite contamination. Analyces by Standard Oil Co. Field analyses in preceding table,

3/15-13R5. Drilled industrial well; diameter 16 in; casing perforated 284-310 and 426-456 ft below land surface in the middle and lower parts of the Silverado water­ bearing zone of the San Pedro formation. Sodium, calcium bicarbonate water native to range perforated. Analysis of Octooer 1944, fluoride 0.2 ppm; strontium 4.6 ppm; electrical conductivity 716 mkromhos; barium, bromide, and iodide absent. Analysis of Oct. 24, 1944, by T. Downer, U.S. Geological Survey; others by Standard Oil Co. Field-analyses in preceding table. -

3/15-24Dl. Drilled unused well, formerly public-supply; diameter 16 in; casing

perforated 159--184, 196--212, and 242-250 ft below land surface in the Sllverl;l,do water• bearing zone of the San Pedro formation. Sample of 1936 a calcium, sodium bicar­ bonate water, probably native; later sample contaminated. Analysis *of* 1936 by Smith-Emery Co.; that of 1944 by Dr. Carl Wilson. Field analyses in preceding table.

3/l,5--25Al. Drilled public-supply well; diameter 14 in; casing perforated 214-218 and 225-235 ft below land surface in the Silverado water-bearing zone of the San Pedro formation. Earliest analysis of a sodium, calcium bicarbonate water essentially native; later analyses indicate contamination beginning in 1931. Analysis of 1942, iodide absent. Analysis of October 1944, strontium 23 ppm; electrical conductivity 2,080 micromhos; bromide, iodide, barium, and fluoride absent. Analyses in 1929, 1930, and 1931 by Los Angeles Department of Water and Power; that in 1943 by R. G. Osborne; that of Aug. 15, 1944, and of Jan. 15, 1945, by Dr. Carl Wilson; that of Oct. 24, 1944, by T. Downer, U. S. Geological Survey. Field analyses in preceding table. 3/15-25A 4. Drilled public-supply well; now abandoned; diameter 16 in; casing per­ forated 222-252 and 284-293 ft below land surface in the Silverado water-bearing zone of the San Pedro formation. Sodium, calcium bicarbonate water, locally native.

Analysis by California Division of Water Resources.

3/l5-25Hl. Drilled public-supply well; diameter 16 in; casing perforated 221-240 ft below land surface in the Silverado water-bearing zone of the San Pedro formation; also 527-541 ft below land surface, probably in the upper division of the Pico formation of Pliocene age. Series of analyses show increasing contamination. Probably most of the water is produced from the upper zone perforated. Analysis of October 1944, electrical conductivity 1,920 micromhos; iodide absent. Analyses in 1943 by R. G. Osborne; on Oct. 27, 1944, by T. Downer, U.S. Geological Survey; others by Dr. Carl Wilson. Field analyses in preceding table.

4/13-2P4. Drilled stock and irrigation well; diameter 14 in. Doubtless taps Gaspur zone in alluvial deposits of Recent age. Essentially native calcium bicar­ bonate water; incipient contamination possible. Analysis by California Division of Water Resources.

4/13-611. Domestic and stock well; diameter 4 in. Taps unconfined water in unnamed upper Pleistocene deposits. Analyses by California Division of Water Resources.

4/13-8Ll. Dug domestic and irrigation well; diameter 36 in. Taps water in un­ confined body at shallow depth. Sodium sulfate water, probably concentrated by evaporation or possibly by blending with saline waters. Analyses by California Division of Water Resources.

4/13-12A2. Drilled unused well; diameters 26 and 16 in. Native sodium bicar­ bonate water, from upper division of Pico formation. Analysis by city of Long Beach chemical and physical testing laboratory.

4/13-14Q4. Drilled domestic and irrigation **well;** casing perforated 800--900 ft below land surface, in central part of Silverado zont in S® :Pedro formation. Sodium

Notes to table 30-Continued

bicarbonate water; character essentially native to upper and central parts of Silverado water-bearing zone. Analyses by California Division of Water Resources.

4/13-<-15A2. Drilled public-supply well; diameter 10 in; casing perforated 830--980 **ft** below land surface, in central part of Silverado water-bearing zone in San Pedro formation. Sodium bicarbonate water; native to the zone perforated. Analysis in 1931 by California Division of Water Besources; that in 1945 by Smith-Emery Co. 4/13--15A3. Drilled public-supply well; diameter 10 in; casing perforated 100-135 ft below land surface, in Gaspur zone in alluvial deposits of Recent age. Initial analysis indicates calcium bicarbonate water essentially native to the Gaspur zone, though perhaps incir,iently contaminated; later analyses indicate definite contami­ nation. Analysis in 1931 by California Division of Water Resources; later analyses

by Smith-Emery Co.

4/13--19Hl. Domestic well. Taps unnamed upper Pleistocene deposits. Calcium chloride, bicarbonate water; essentially native to zone perforated. Fluoride 0.4 ppm; bromide 0.0 ppm; iodide 0.0 ppm; electrical conductivity 849 micromhos. Analysis by E.W. Lohr, U.S. Geological Survey.

4/13--19J4. Formerly domestic and irrigation well. Taps unnamed upper Pleisto­ cene deposits. Sodium chloride, bicarbonate water; locally native to zone perforated. Analyses by California Division of Water Resources.

4/13--21Ql. Drilled industrial well; diameters 20 and 12 in; casing perforated 435-625 and 641-661 ft below land surface, in upper and central parts of Silvcrado water­ bearing zone in San Pedro formation. Sodium bicarbonate water, essentially native to the deeper part of the range perforated. Analysis by Shell Oil Co.

4/13--22El. Drilled industrial well; diameter 18 in; casing perforated 415--425, 447-527, and 59o--645 ft below land surface, in upper and central parts of Silverado water­ bearing zone in San Pedro formation. Sodium bicarbonate water, essentially native to the zones perforated. Fluoride 0.2 ppm; electrical conductivity *3i0* micromhos. Analysis by E.W. Lohr, U.S. Geological Survey.

4/f3--30Kl. Drilled public-supply well. Probably taps Silverado water-bearing zone in San Pedro formation. Sodium bicarbonate water; character essentially native to upper part of Silverado zone. Analyses by Los Angeles Department of Water and Power.

4/13-31E3. Drilled public-supply well, now abandoned; diameters 16 and 12 in;

casing perforated 206---212, 235-240, 3-io-420, 44o-450, 475-530, and 610-630 ft below land surface in upper and central parts of Silverado water-bearing zone in San Pedro formation. Sodium bicarbonate water, locally native to zone perforated; character probably influenced by connate water in the Silverado zone southeast of well. Analy­ sis by California Division of Water Resources.

4/13-31E4. Drilled public-supply well, diameter 20 in; casing perforated 440--560 and 605-655 ft below land surface, in central part of Silverado water-bearing zone in San Pedro formation. Sodium bicarbonate water; local native character, probably influenced by connate water in the Silverado zone southeast of well. Sulfate content here greater in the central part of the Silverado zone than in the upper part. (See analysis 31E3.) Analysis by Los Angeles Department of Water and Power.

4/18-351\13. Drilled industrial well, diameter 12 in; casing perforated 115-139 ft below land surface, in Gaspur zone of alluvial deposits of Recent age. Analysis of

.laimtµ-y 1923 is approximate but may indicate roughly the character of water locally native to the Gaspur; later analysis indicates gross contamination. Analysis of 1942, fluoride, bromide, and iodide, 0.0 ppm; electrical conductivity 13,500 micromhos.

4/14-7J3. Drilled abandoned well; diameter 14 in; casing perforated 210-241 ft below land surface in upper part of Silverado water-bearing zone in San Pedro formation. Native sodium bicarbonate water. AnalySis by California Water Service Co.

4/14-801. Drilled public-supply well; diameter 16 in; casing perforated at intervals 232-450 ft below land surface in the Silverado water-bearing zone of the San Pedro formation. Analysis of October 1944, strontium 3.0 ppm; fluoride 0.2 ppm; electrical conductivity 644 micromhos; bromide, iodide, and barium absent. Analysis of Oct. 30, 1944, by T. Downer, U.S. Geological Survey; others by Smith-Emery Co. Field analyses in preceding table.

4/14-8El. Drilled unused well; formerly public-supply. Diameter 18 in; casing perforated 228-259 ft below land surface in the Silverado water-bearing zone of the San Pedro formation. Initialanalysis indicates sodium bicarbonate water, presumed native; later analyses show definite contamination. Analyses in 1931 and 1939 by California Division of Water Resources, that in 1936 by Los Angeles Department of Water and Power.

4/14-9Kl. Drilled industrial well; diameter 12 in; casing perforated 241-252, 300--312, and 3S0--395 ft below land surface in Silverado water-bearing zone of San Pedro for­ mation. Sodium bicarbonate water native to range tapped in central part of Tor­ rance plain. Analysis in 1946 indicates contamination, doubtless from local source. Analyses by Chanslor, Canfield, Midway Oil Co.

4/14-11G2. Drilled industrial well, now abandoned; diameter 14 in; casing per­ forated 293-304, 350--364, 380--388, and 577-598 ft below land surface in Silverado water­ bearing zone of San Pedro formation. Native sodium bicarbonate water, typical of the Silverado zone in the trough of its syncline in Torrance-Inglewood subarea. Analysis in 1929 by Smith-Emery Co.; that in 1931 by California Division of Water Resources.

4/14-16L3. Drilled abandoned well, formerly public-supply; diameter 14 in; casing perforated 244-275 ft below land surface in upper part of Silverado water-bearing zone of San Pedro formation. Sodium bicarbonate water, essentially native to range penetrated in central part of Torrance plain. Analysis by Smith-Emery Co.

4/14-17El. Drilled abandoned well; diameter 18 in; casing perforated 257-268 and 3i9-400 ft below land surface in the Silverado water-bearing zone of the San Pedro formation. Inferior water, possibly locally native. Analysis by California Water Service Co.

4/14-17Gl. Drilled domestic and irrigation well; diameter 16 in; casing perforated at intervals 305-390 ft below land surface in Silverado water-bearing zone of San Pedro formation. Water essentially native. Analyses by California Division of Water Resources. Field analyses in preceding table.

4/14-17Nl. Drilled public-supply well; diameter 18 in; casing perforated 224-338 ft below land surface in the Silverado water-bearing zone of San Pedro formation. Water native. Analysis in 1930 by California Water Service Co.; that in 1931 by California Division of Water Resources. Field analysis in preceding table.

4/14-20Jl. Drilled irrigation well; diameter 12 in; casing perforated 282-297 and 346-360 ft below land surface in the Silverado water-bearing zone of San Pedro for­ mation. Sodium, calcium bicarbonate water; a blend of native Silverado water with diluted connate water underlying the flank of Palos Verdes Hills. Analyses by California Division of Water Resources. Field analysis in preceding table.

4/14-23N2. Drilled public-supply well; diameter 16 in; casing perforated 560-614 ft below land surface in the lowermost part of tbe Silverado water-bearing zone **of**

Analysis in 1923 by A. R. Maas Laboratories, Los Angeles; that in 1942 by E. W. Lohr, U.S. Geological Survey.

4/14-lH. Drilled industrial well; diameter 14 in. Sample may be from Hl, H2, or H3, whose reported depths below land surface are respectively 600, 596, and 596 ft. All tap the Silverado water-bearing zone of the San Pedro formation. Calcium, sodium, bicarbonate water, locally native. Analysis by R. G. Osborne.

4/14-5Nl. Drilled observation well; formerly public-supply. Diameters 28 and 16 in. Gravel-packed from 98 ft to bottom of well. Taps Silverado water-bearing zone in San Pedro formation. Calcium, sodium bicarbonate water, incipiently contaminated. Analysis by Los Angeles County Flood Control District.

4/14-5N2. Drilled abandoned well; formerly public-supply. Diameter 12 in; casing perforated 224-230 and 250-267 ft below land surface in the upper part of the Silverado water-bearing zone of San Pedro formation. Sodium, calcium bicarbonate water, locally native within upper part of range penetrated. Analyses since 1932 indicate increasing contamination. Analysis of 1942, iodide, trace. Analysis of 1944, strontium 36 ppm; electrical conductivity 3,680 micromhos; bromide, iodide, and fluoride absent. Analysis of 1945, strontium 32 ppm; electrical conductivity 5,580 micromhos; iodide barium, and fluoride absent. Analysis in 1942 by Los Angeles County Flood Control District; those in 1944 and 1945 by T. Downer, U.S. Geological Survey; others by California Division of Water Resources. Field analyses in preceding table.

San Pedro formation. Sodium bicarbonate water, of a type generally native to that part of range tapped. Analysis by Dr. Carl Wilson. Field analysis in preceding table. -

4/14-35E2. Drilled public-supply well; diameter 18 in; casing perforated 348-402, 43(}--460, and 570-630 ft below land surface in Silverado water-bearing zone of San Pedro formation. Analysis shows effect of blending with diluted connate waters underlying the flank of Palos Verdes Hills. Electrical conductivity 982 micromhos; iodide absent. Analysis by T. Downer, U. S. Geological Survey. Field analyses in preceding table.

4/14-36Hl. Drilled public-supply well; diameters 26-12 in; casing perforated 208-214 and 332-610 ft below land surface in Silverado water-bearing zone of San Pedro for­ mation. Water essentially native. Analyses by Dr. Carl Wilson.

5/13-31-I. Formational sample at 1,300 ft below land surface in upper division of Pico formation of Pliocene age. Sodium bicarbonate water, probably native to the zone locally.

5/14-1201. Abandoned well, formerly irrigation. Probably taps San Pedro for­ mation and possibly also underlying deposits of Tertiary age. Sodium, calcium chloride, bicarbonate water, native within range tapped. Analyses in 1930 and 1931 by Los Angeles Department of Water and Power; in 1939 by California Division of Water Resources.

TABLE *31.-Chemical analyses representing the character of known or potential contaminants in the Torrance-Santa Monica area*

[" When analyzed, 0.03 ppm in solution; b calculated; • iron and aluminum oxides (Fe2Oa+ AI2Oa). Minor constituents are listed in notes at end of table. For representative **.,p..**

chemical analyses of connate waters from the Dominguez and Wilmington oil fields, oil-field wastes, industrial and miscellaneous wastes, and streams contaminated by

those wastes, sec an earlier report (Piper, Garrett and others, 1953, table 29). Analyses **of** connate waters from the Inglewood oil field after Jensen (1934)] **00**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Well | Source | Depth (feet) | Date of col- lection | Tern- per- ature (o F) | Parts per million | | | | | | | | | | | | |
| Dissolved solids at 180° C | Silica  **(Si02)** | **Iron**  (Fe) | Cal- cium (Ca) | Mag- ne- sium (Mg) | Sodium (Na) | Po- tas- sium (K) | Bicar- bonate (HCOa) | Car- bon- ate (COa) | Sul- fate **(SOt)** | Chlo- ride (Cl) | Bo- rate **(BOa)** | Hard- ness as **CaCOa** (caleu- lated) |

**Ocean water**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Standard analysis as of 1940.  Gan Pedro, from·seaward side of breakwater, 1 mile offshore. | -----------  ------ ----- | ---------------  May 18, 1941 | ------  65 | 34,482  34,100 | -------  0.8 | -------  a0.04 | 400  393 | 1,272  1,228 | 10,556 bl0,220 | 380  353 | 140  139 | ----- - 0 | 2,649  2,560 | 18,980  18,360 | 25  ------ | -------  6,030 |

**Connate waters from the Inglewood oil field**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2/14--7H  7H\_  78EJ-- -- -- | Tidewater Associated Oil Co.:  Vickers well 5  Vickers well 34 Vickers well 2  The Texas Co., Meynier well 1.  Standard Oil Co.: Baldwin well 19 Baldwin well 2L | 2,545  2,177  3,210  1,750  2,741  2,410 | Oct. 20, 1925  Aug. 30, 1925  Apr. 19, 1926  Oct. 15, 1925  Mar. 19, 1926  July 27, 1925 | ------  ------  --- ---  ------  -- ----  ------ | b 32,695  b 32,876  b 31,078  b 30,275  b 28,210  b 33,160 | -------  -------  \_..,  -------  -------  ------- | -------  ----- --  ------ -  ------ -  ----..,--- | 404  304  468  400  590  668 | 673  650  537  583  345  540 | b 11,195  b 11,527  b 10,802  b 10,407  b 9,745  b 11,466 | 1,925  823  1,335  1,981  297  1,730 | ------  ------  - -----  ------  ------  ------ | 54  13  56  37  53  39 | 19,406  19,970  18,547  17,857  17,328  19,582 | ------  ------  ------  ------  ------  ------ | 3,769  3,425  3.372  3,390  2,890  3,884 |
| 8K  17H |

**Connate waters from the Rosecrans oil field**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/13-7 | Athens lease, well J\_  Union Oil Co.: Rosecrans lease, well  1.  Rosecrans lease, well 24.  Rosecrans lease, well 34.  Rosecrans lease, well 40.  Superior Oil Co., Max- well well 12. | 4,948 | Apr. 24, 1924 | ------ | b 30,652 | ------- | ------- | 599 | 151 | **b** 11,237 | 65 | 116 | 6.1 | 18,510 | ------ | 2,117 |
| 19A | Unknown | Mar. 17, 1924 | ------ | b 33,569 | 80 | * 13 | 436 | 591 | b 12,135 | 1,222 | ------ | 52 | 19,744 | -- ---- | 3,513 |
| 19A | Unknown | Apr. 29, 1940 | ----- - | b 515 | ------- | ------- | 19 | 8 | b 117 | 410 | ------ | **1** | 165 | ------ | 80 |
| 19B | Unknown | do | ------ | b 24,557 | ------- | ------- | 616 | 142 | b 8,882 | 3,532 | ,..\_ | **1** | 13,150 | ------ | 2,122 |
| 19G | Unknown | do | **-a ..,** | b 20,488 | ------- | ------- | 503 | 78 | b 7,487 | 3,052- | ... | 8 | 10,886 | ------ | 1,577 |
| 19H(?)\_ | Unknown | Mar. 14, 1939 | ---- -- | b 31,335 | .,. | ------- | 959 | 204 | b 11,139 | 5,431 | 0 | 5 | 16,312 | -- ---- | 3,234 |

**Connate waters Crom the Playa del Ray:ou field**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2/15-21M(?)\_ | Union Oil Co.:  Del Rey well I\_  Del Reywell2  Elmer Oil Co., Venice well 6.  Twin Buttes Oil Co., Byrens well 1.  Pacific Western Oil Co., Stanley Lieber well 1. | 3,585  5,740  Unknown | May 12,1930  Feb. 20, 1931  Feb. 16, 1931 | ------  ----- -  ------ | b 30,726  b 17,864  b 13,496 | -------  -------  ------- | -------  -------  ..------  -------  .. | 436  356  136 | 368  157  32 | b 11,039  b 6,695  b 5,183 | 437  9,481  2,267 | 0  0  0 | 191  51  4 | 18,473  5,864  7,007 | ------  ------.., | 2,599  1,534  471 |
| 21N(?)\_ | 6,190  6,100 | Feb. 17, 1931  Feb. 16, 1931 | ----- -  - ----- | b 26,247  b 24,820 | -------  ------\_- | 262  311 | 52  17 | b 10,183  b 9,458 | 7,077  1,989 | 0  0 | 13=  25 | 12,198  14,014 | ------  ------ | 868  847 |

**Connate waters Crom the Torrance oil field**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Southern Midway Co., Grindy lease, well 1. Southland Petroleum  $gii1. Winship lease,  Fullerton Oil Co., Lenz lease, well 1.  Chanslor, Canfield, Mid- way Oil Co., '1'orrance lease, well 12. | 3,421 | Feb. 2, 1924 | ------ | b 33,147 | ------- | ------- | 497 | 265 | b 12,116 | 162 | ------ | 38 | 20,150 | ------ | 2,329 |
|  | 3,514 | Apr. 10, 1924 | ............ - | b 30,641 | ------- | ------- | 465 | 292 | b 11,220 | 632 | ------ | 18 | 18,332 | ------ | 2,360 |
| 4/14-9D  15A---- | 3,925  Unknown | July 3, 1923  Oct. 22, 1923 | ------  ------ | b 28,970  b 26,560 | 165  ------- | "170  ------- | 393  576 | 224  223 | b 10,444  b 9,375 | 650  445 | 0  ------- | 23  4.2 | 17,561  16,159 | ------  ------ | 1,901  2,i54 |

Notes to table **31**

Ocean water, standard. Referred to a standard "chlor1nity" ofl9,000ppm (Sverdrup and others, 1942, p. 166). Strontium 13 ppm, bromide 65 ppm, fluoride 1 ppm.

Ocean water, San Pedro. From seaward side of breakwater, 1 mile offshore. Iodine less than 0.5 ppm, bromide 49 ppm. Analysis by G. J. Petretic, Geological Survey. 2/14-7H. Vickers well 5. Water shutoff reported at 1,309 ft. Ammonium 305 ppm. 2/14-7H. Vickers well 34. Water shutoff reported at 1,379 ft. Ammonium 254 ppm.

2/14-7J. Water shut off reported at 2,566 ft. Ammonium 168 ppm. 2/14-SE. Water shutoff reported at 1,255 ft. Ammonium 331 ppm. 2/14-8K. Plugged at 2,500 ft. Ammonium 157 ppm.

2/14-17H. Water shut off reported at 1,775 ft. Ammonium 201 ppm. 3/13-7. Sampled from interval 4,938 to 4,948 ft.

3/13-19A (Rosecrans lease, well1). Sampled during swabbing after fourth re-cement job. Analysis by Union Oil Co.

3/13-19A (Rosecrans lease, well 24). Sampled from flow line. Ammonium 85 ppm. Analysis by Union Oil Co.

3/13-19B. Sampled from flow line. Analysis by Union Oil Co. 3/13-190. Sampled during swabbing. Analysis by Union Oil Co.

3/13-19H(?). Sampled from dehydrator. Analysis by Union Oil Co. Del Rey well 1. Sampled during swabbing. Analysis by Union Oil Co, 2/15-21M(?). Analysis by Union Oil Co.

2/15-21N(?). Analysis by Union on Co.

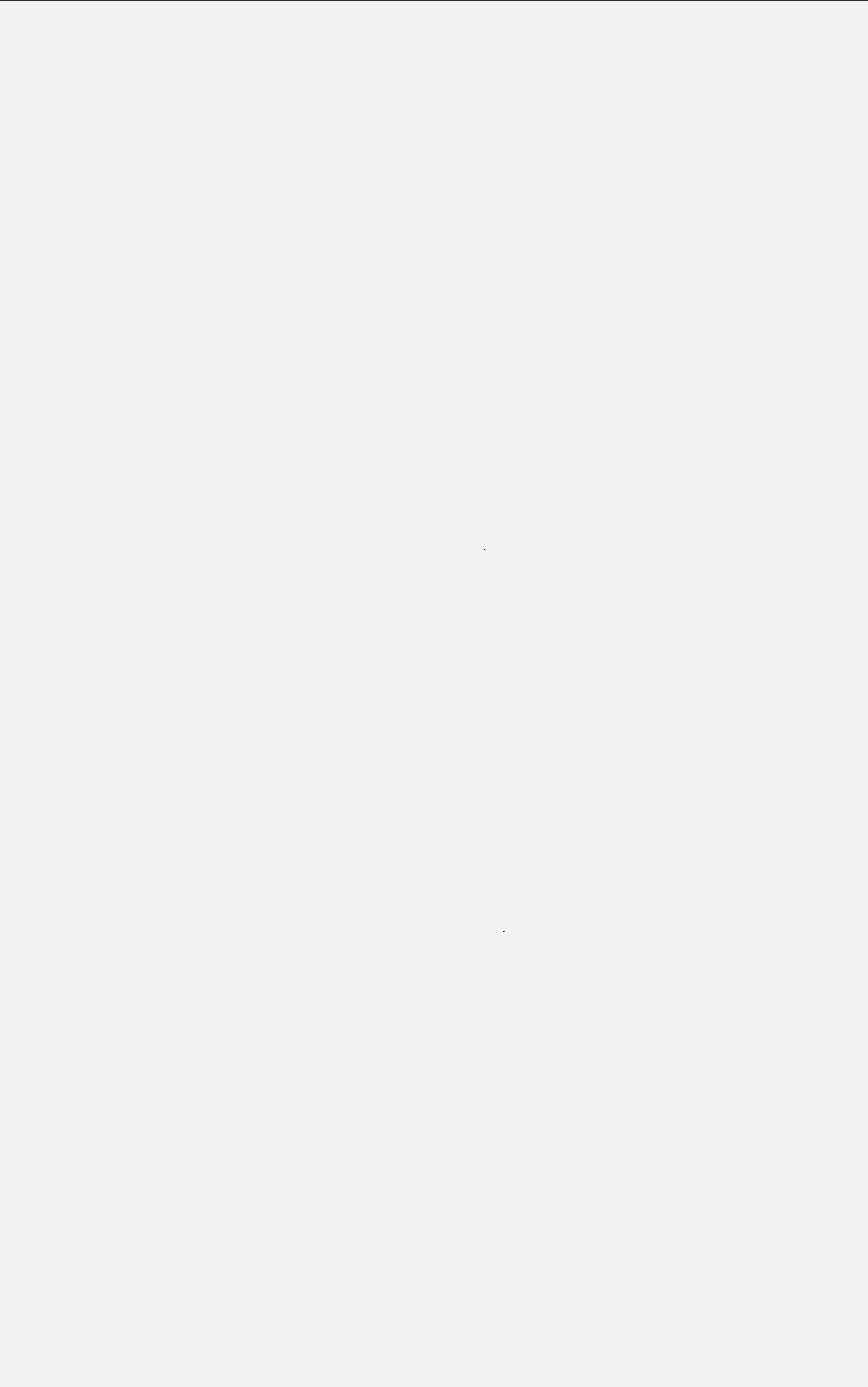
Stanley Lieber well 1. Analysis by Union Oil Co.

Grindy lease, well 1. Sampled from flow llne. Analysis by Standard Oil Co. Winship lease, well 1. Sample bailed from bottom of well. Analysis by Union

Oil Co.

4/14-9D. Sampled from settling tank. Ammonium 213 ppm. Analysis by Pacific Oil Co.

4/14-15A. An 8¾-inch casing perforated 3,514 ft below land surface. Analysis by Pacific Oil Co.



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