Geology and Ground-Water Features of Point Arguello Naval Missile Facility Santa Barbara County California

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1619-F

Prepared in cooperation with the Department of the Navy

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By R. E. EVENSON *and* G. A. MILLER

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GEOLOGY AND GROUND-WATER FEATURES OF POINT ARGUELLO NAVAL MISSILE FACILITY, SANTA BARBARA COUNTY, CALIFORNIA

By R. E. EVENSON and G. A. MILLER

ABSTRACT

A study of the geology and hydrology of the area of the Point Arguello Naval Missile Facility indicates that the anticipated water demand by the Navy of 0.6 to 1.6 mgd can be supplied by water from wells drilled within the missile facility. Two nearly separate ground-water basins are potential sources of supply—the Santa Ynez Valley proper and the Lompoc Terrace. In the Santa Ynez Valley, wells less than 200 feet deep tap the younger alluvium and yield about 1,000 gpm at moderate drawdown. In the Lompoc Terrace ground-water basin the water is of slightly better quality, but wells will probably each yield only about 500 gpm at moderate to large drawdown. It is estimated that sufficient ground water is in storage to supply the anticipated demand for 60 years.

INTRODUCTION

PURPOSE AND SCOPE

In March 1958 the District Public Works Office, 11th Naval District, San Diego, Calif., requested the U.S. Geological Survey to investigate the possibilities of developing a ground-water supply for the proposed Point Arguello Naval Missile Facility, Santa Barbara County, Calif., at the seaward end of the Santa Ynez River valley. Specifically, the work entailed a review of earlier pertinent studies, sampling of streams and existing wells on the missile facility for chemical analysis, mapping the geology, selection of test-well sites, supervision of test-well drilling, the construction and development of a supply well, and the preparation of a report summarizing the geology and ground-water features of the area.

Test-well drilling began in March 1958 and ended in July 1958 with the completion of the 11th test well. The selection of sites was made on a well-to-well basis because the information gained from each well generally affected the selection of the next site.

This report summarizes the geologic and hydrologic features, describes the test-well drilling, suggests additional supply-well sites, and discusses the chemical quality of the water. The work was done under the general supervision of G. F. Worts, Jr., and H. D. Wilson, Jr., successive district supervisors in charge of ground-water investigations in California.

LOCATION OF THE AREA

The Point Arguello Naval Missile Facility occupies the part of the area that was formerly Camp Cooke Military Reservation. The area is south of the Santa Ynez River and includes about 33 square miles in southwestern Santa Barbara County, Calif. The area extends southward along the Pacific Coast from the Santa Ynez River to the south side of Canada Honda, a distance of about 6 miles. The southern boundary follows the crest of the Santa Ynez Mountains eastward from the coast for about 7 miles. From this point the eastern boundary extends northward to the Santa Ynez River which bounds the property on the north. The area is shown on the Army Map Service 7½-minute quadrangle maps (series V895) 1947 for El Tranquillon, Point Arguello, and Surf.

Access is by State Highway 150, a hard-surfaced two-lane road, which skirts the western and northern edges of the area. A gravelled road from Highway 150 through La Salle (Rodeo) Canyon to Canada Honda serves the southwestern part of the area. The Southern Pacific Railroad crosses the northern and western parts of the area.

ACKNOWLEDGMENTS

Dibblee (1950) described the general geology of the area in detail and his report was relied upon throughout the preparation of this report. The geological map (pl. 1) is largely from Dibblee's report except for changes and modifications of structural features in the northern part of the area.

Mr. Joe Ernst, district geologist for the Texas Co. in Santa Maria, furnished geologic data on exploratory oil test wells drilled in the northern part of the area.

A comprehensive geologic and hydrologic study of the extreme northern part of the area was included in a report on the water resources of the Santa Ynez River basin by Upson and Thomasson (1951), and a ground-water appraisal was made more recently by Wilson (1959). Hydrologic data collected since 1942 for the Santa Ynez Valley are on file in the subdistrict office of the U.S. Geological Survey, Ground Water Branch, in Santa Barbara, Calif.

CLIMATE

Like much of coastal southern California, the area has a relatively mild and even climate throughout the year. Practically all the 12 to 25 inches of annual rainfall occurs during the winter months. The average annual temperature over the area is between 50° and 60°F. Temperatures below freezing or above 90°F seldom occur. Nightly fogs along the coast and the almost-constant daily sea breeze cool the area during the summer.

Long-term climatological data for the area are not available; however, table 1 shows the general conditions of rainfall for the northern and coastal parts of the missile facility.

TABLE 1.—*Precipitation, in inches, at Surf, Calif., 1948–57*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total by year
1948	------	------	------	------	------	------	0.00	0.00	0.00	0.13	0.00	------	------
1949	0.79	1.55	2.46	0.18	0.87	0.00	.00	.00	.00	.03	.77	------	------
1950	1.70	1.76	.89	.28	.08	.00	.60	.00	.00	.54	.71	0.49	7.05
1951	1.94	1.59	.51	1.86	.05	.00	.00	.00	.00	.72	.63	2.50	9.80
1952	5.53	1.02	7.70	.49	.00	.00	.00	.00	.00	.00	2.97	3.94	21.64
1953 [1]	.97	------	------	------	.00	.10	.00	.00	.00	.00	3.06	.19	------
1954 [1]	3.44	1.11	3.46	.23	.00	.00	.00	.00	.00	.00	.69	1.57	10.50
1955 [1]	3.49	1.17	.35	1.80	.15	.00	.00	.06	.00	.00	2.00	3.87	12.89
1956 [1]	2.26	.47	.00	1.14	.71	.00	.00	.00	.00	.15	.00	.00	4.73
1957 [1]	2.41	2.56	.59	1.00	.35	.16	.00	.00	.00	.61	.15	2.26	10.09
Average	2.50	1.40	2.00	.87	.25	.03	.06	.01	.00	.22	1.10	1.85	10.96

[1] Record taken 2.3 miles NNE. of Surf, Calif.

Precipitation in the Santa Ynez Mountains is greater than at either Lompoc or Point Arguello; Dibble (1950, p. 15) states that the yearly rainfall in the mountains is about 25 inches.

Paul R. Nixon, project leader of the Agricultural Research Service, U.S. Department of Agriculture, Lompoc, Calif., furnished the unpublished long-term data on the frequency distribution of precipation in the vicinity of Lompoc (table 2). The data for the first 39 of the 44 years tabulated are from a station 2 miles west of Lompoc and were obtained from the Burpee Seed Co., Lompoc, Calif.

Table 2 shows that during the 44-year period the annual precipitation equaled or exceeded 11.98 inches in 50 percent of the years. Average annual precipitation near Lompoc for this 44-year period was 13.15 inches.

TABLE 2.—*Precipitation, in inches, in the vicinity of Lompoc, Calif., 1913–57 (unofficial record)*

Percent of time equaled or exceeded	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year Oct. 1–Sept. 30
100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.45
90	.29	.67	.12	.00	.00	.00	.00	.00	.00	.00	.00	.20	7.28
80	.85	.89	.41	.12	.00	.00	.00	.00	.00	.00	.08	.96	8.89
70	1.17	1.11	.79	.19	.00	.00	.00	.00	.00	.00	.15	1.23	9.89
60	1.56	1.38	1.01	.35	.00	.00	.00	.00	.00	.07	.35	1.62	11.00
50	2.05	1.70	1.41	.53	.03	.00	.00	.00	.00	.17	.68	2.25	11.98
40	3.25	2.51	2.06	.97	.06	.00	.00	.00	.00	.29	1.00	2.51	13.35
30	3.60	3.00	2.76	1.22	.15	.00	.00	.00	.00	.44	1.39	3.58	14.38
20	4.72	3.57	3.40	1.50	.40	.00	.00	.00	.05	.64	2.04	4.18	15.72
10	5.86	5.39	4.27	2.46	.76	.12	.00	.00	.40	.90	2.73	5.67	18.67
0	13.42	11.55	8.35	3.14	1.81	1.11	.51	.19	1.92	2.68	3.69	7.93	32.72

TOPOGRAPHY

The topography of the missile facility is varied and generally reflects the local geologic conditions. North of State Highway 150 the gently seaward-sloping flood plain of the Santa Ynez River is underlain by unconsolidated younger alluvium. South of the highway a gently undulating plain rises southeastward away from the Pacific Ocean and the Santa Ynez Valley. This plain, called the Lompoc Terrace, is covered by the Orcutt sand of Pleistocene age, and is incised by Lompoc, Bear, Spring, and La Salle Canyons, whose valley floors are 100 to 300 feet below the surrounding terrace. The Lompoc Terrace extends south and east to the foothills of the Santa Ynez Mountains.

The Santa Ynez Mountains have been carved out out of older consolidated rocks that are folded and faulted.

The range crosses the southern part of the missile facility. Tranquillon Mountain, which is approximately 2,170 feet above sea level, is the predominate peak in southwestern Santa Barbara County. The mountains are physiographically mature, as indicated by the sharp divides, steep valley walls, and flood plains along the streams.

WELL-NUMBERING SYSTEM

Test wells drilled during this investigation were assigned preliminary numbers 1 through 11 in the sequence in which they were begun. They were renumbered later according to the system used in California for most of the ground-water investigations of the Geological Survey and the California Department of Water Resources. This system, as explained below, is based on the rectangular subdivisions of public land and serves to locate the well within a 40-acre plot. Section lines have been projected into unsurveyed areas for reference only.

Test well 2, for example, has been assigned the number 7/35–33R1. The number before the slash mark indicates that the well is in T. 7 N., and the number between the slash mark and the hyphen indicates that the well is in R. 35 W. Most of Santa Barbara County is north and west of the San Bernardino base line and Meridian and therefore the "north" and "west" designations are omitted. The number following the hyphen indicates that the well is in section 33 and the letter "R" corresponds to the 40-acre plot as shown in figure 1.

Wells are numbered serially within the 40-acre plot as indicated by the number following the letter.

A similar numbering system was used to designate sites from which surface-water samples were collected. In numbering the localities of surface-water samples, however, the final digit was omitted. Thus, the number 7/35–33R indicates the location of a sampling point at a seep or along a stream.

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

FIGURE 1.—Sketch showing well-numbering systems.

TEST-WELL DRILLING PROGRAM

Eleven test wells, ranging in depth from 59 to 475 feet, were drilled by the cable-tools method on the missile facility from March through July 1958. The total footage drilled was 2,663 feet. New 8 5/8-inch outside diameter steel casing was placed in the hole in sections and welded as drilling progressed. This method permitted the collection of samples that were relatively uncontaminated and therefore, were representative of the formation that was penetrated. At the completion of each well a concrete plug was set in the bottom whenever the natural bottom was judged not to be sufficiently firm to prevent "heaving."

The test wells were logged by the authors as drilling progressed. On completion of each hole the log was studied and the casing was perforated at appropriate intervals. The interval to be perforated normally was selected opposite material that was sufficiently coarse grained to allow a natural "gravel pack" to form during development of the well. The casing was perforated with a small "Mills knife" which cut a vertical slit approximately 3/16 by 1½ inches.

After perforation, the test wells were surged for several hours by rapidly pulling a snugly fitted bailer through the water. The surging process served to draw water into the well faster and to wash in the finer grained particles of the surrounding sediment near the perforations. The fine material was periodically bailed from the well.

When the surging process progressed to the point where it was thought that a natural envelope or "gravel pack" had formed, and little or no sediment was being washed into the hole, the well capacity was tested by bailing. If the well produced more water than the bailer could withdraw, a test pump was installed to develop the well further and to determine its capacity. Samples of water for chemical analysis were taken during the bail or pump test. Results of these analyses are given in table 6.

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Seven of the test wells were drilled to explore the sediments of the Lompoc Terrace ground-water basin, three were drilled to explore the alluvium of Canada Honda, and one was drilled in the alluvium of the Santa Ynez River valley. Pertinent data on these test wells are summarized in table 3, and logs of all test wells and supply well 1 are given in table 5.

TABLE 3.—*Summary of data from test wells, Point Arguello Naval Missile Facility*

Well	USGS No. and location	Date completed	Depth (ft)	Approximate elevation of land surface (ft)	Interval perforated (ft)	Yield (gpm)	Drawdown (ft)	Static[1] water level (ft below land surface)	Remarks
1	7/35-30G1. 1.4 miles south of Surf, Calif., west of highway.	4-14-58	277	130	115-270	Not enough water for bail test.		97	
2	7/35-33R1. 2.2 miles up Lompoc Canyon from State Highway 150.	4-28-58	432	216	402-420	180	280	110	Cemented 425-432 ft.
3	7/35-28K2. 0.9 mile up Lompoc Canyon from State Highway 150.	5-15-58	315	89	22-23 46-48 60-63	5	(2)	14	Cased to 284 ft. Gravel-cement to 235 ft.
4	7/35-32N1. 0.75 mile up Bear Canyon from highway.	5-27-58	300	175	10-210	21	(2)	10	Fine sand when pumped. Cemented to 292 ft.
5	6/35-5F1. 1.3 miles up Bear Canyon from highway.	5-29-58	77	220	5-57	4	(2)	25	Cemented at 70 ft.
6	7/35-33J1. 1.75 miles up Lompoc Canyon from highway.	6-17-58	380	177	113-155 173-255	125	65	112	Casing damaged at 240 ft. 6 ft of preperforated 6-in casing set from 236-242 ft.
7	6/35-15J1. Canada Honda, near junction of Honda and La Salle Roads.	6-6-58	78	585	20-75	7	(2)	21	
8	6/35-16P1. Canada Honda, 1.4 miles northwest of Tranquillon Mountain.	6-12-58	76	400	20-68	10	(2)	18	
9	6/35-21D1. Canada Honda, 1.3 miles west northwest of Tranquillon Mountain.	6-16-58	59	380	14-17 30-55	5	(2)	17	
10	6/35-2D1. Canyon between La Salle and Lompoc Canyons.	7-7-58	475	289	250-470	20	107	215	Fine sand bailed.
11	7/35-22N2. Mouth of Lompoc Canyon between Highway 150 and railroad.	7-18-58	194	24	96-181	380	30	7	

[1] Date measured the same as date completed.
[2] Well was bailed dry during test.

GEOLOGY

The rocks and unconsolidated deposits exposed at the missile facility range in age from Jurassic to Recent. Their areal distribution is shown on plate 1 and their lithologic character, stratigraphy, and water-bearing properties are summarized in table 4. Detailed descriptions of the stratigraphic units are given by Dibblee (1950). The most promising ground-water supplies occur in the unconsolidated deposits that range in age from Pliocene to Recent.

TABLE 4.—*Stratigraphic Units of the Point Arguello Naval Missile Facility*

	Geologic age	Stratigraphic unit	Thickness (ft)	Lithologic character	Water-bearing properties
Quaternary	Recent	Dune sand	0–50±	Windblown sand, in part actively drifting.	Unconsolidated, but probably above the zone of ground-water saturation.
Quaternary	Recent	Younger alluvium	0–200±	Gravel, sand, silt, and clay underlying the alluvial plains of the Santa Ynez River and tributaries; of fluvial origin, except in Lompoc Canyon where estuarine clay and silt are predominant; lower part underlying the Lompoc plain is predominantly gravel.	Unconsolidated; lower part constitutes the main water-bearing zone and is the principal source of water to the Lompoc plain; low permeability in smaller valleys.
Quaternary	Pleistocene	—Unconformity— Orcutt sand	0–300±	Sand, clay, and some gravel, predominantly nonmarine; locally includes indurated caps of eolian beach sand; locally may include beds equivalent to the Paso Robles formation of the eastern Santa Ynez Valley.	Unconsolidated; yields water to wells but is generally of low permeability.
Tertiary	Pliocene	—Unconformity— Careaga sand	0–1,000±	Fine- to medium-grained marine sand and some gravel; locally fossiliferous; poorly consolidated in exposures.	Unconsolidated where saturated with water; gravel zones are less permeable than those of the younger alluvium.
Tertiary	Pliocene	Foxen mudstone	0–800±	Compact claystone; not exposed at surface, but identified in some well logs.	Consolidated; probably would not yield water to wells.
Tertiary	Pliocene and Miocene	Sisquoc formation	0–3,000±	Diatomite and diatomaceous clay shale.	Consolidated; would not yield water to wells.
Tertiary	Miocene	Monterey shale	0–2,000±	Siliceous and diatomaceous shale and some limestone.	Consolidated; contains some water in fractures.
Tertiary	Miocene	Tranquillon volcanics of Dibblee (1950)	0–700±	Rhyolite and rhyolitic agglomerate and tuff; exposed in the area of Tranquillon Mountain.	Consolidated; fracture systems supply water to several small springs.
Tertiary	Miocene	—Unconformity— Rincon shale	1,500±	Bentonitic and siliceous brown to gray claystone.	Consolidated; would not yield water to wells.

TABLE 4.—*Stratigraphic Units of the Point Arguello Naval Missile Facility*—Con.

	Geologic age	Stratigraphic unit	Thickness (ft)	Lithologic character	Water-bearing properties
Tertiary—Continued		Vaqueros formation	300	Sandstone and conglomerate.	Consolidated; possibly would yield small amounts of water to wells.
	Oligocene and Eocene	—Unconformity— Gaviota formation of Effinger (1935) and Sacate formation of Kelley (1943)	2,600±	Interbedded sandstone and shale and minor conglomerate beds.	Consolidated; thick sandstone units might yield some water to wells.
	Eocene	Cozy Dell shale member (Kerr and Schenck, 1928) of Tejon formation	700±	Gray and brown clay shale.	Consolidated; would not yield water to wells.
		Matilija sandstone member (Kerr and Schenck, 1928) of Tejon formation	1,000±	Thick bedded bluish-white sandstone and minor shale and conglomerate.	Consolidated; locally yields water in small quantities to wells south and east of the Missile Facility.
		Anita shale of Kelley (1943)	1,000±	Dark gray clay shale and minor beds of greenish-brown micaceous sandstone.	Consolidated; would not yield water to wells.
Jurassic and Cretaceous		—Unconformity— Espada formation of Dibblee (1950)	4,000±	Dark greenish-brown silty shale and thin beds of sandstone.	Consolidated; would not yield water to wells.
Jurassic(?)		—Unconformity— Honda formation of Dibblee (1950)	1,500±	Dark greenish-brown clay shale, thin beds of sandstone, and nodules of calcareous concretions.	Consolidated; would not yield water to wells.
		Franciscan formation (as used by Dibblee, 1950)	?	Dark greenish-gray coarse-grained serpentinized pyroxenite.	Consolidated; may contain some water in fractures.

CONSOLIDATED ROCKS (JURASSIC TO PLIOCENE)

The consolidated rocks exposed on the missile facility are predominantly of marine origin and range in age from Jurassic to Pliocene They include all rocks older than the Careaga sand, and consist of a series of sandstone and shale units distributed throughout the southern half of the missile facility; volcanic rocks occur in the series near Tranquillon Mountain. Several springs in the area yield small amounts of water from the consolidated rocks, generally less than about 20 gpm (gallons per minute). Locally, sandstone, volcanic rocks, and brittle siliceous shale may yield small quantities of water from fractures or other openings. The most likely sources of small supplies of water from the consolidated rocks are fractures or other openings in the following formations: the Franciscan, the Matilija sandstone member (Kerr and Schenck, 1928) of the Tejon, the Sacate (Kelley, 1943), Gaviota (Effinger, 1935), and Vaqueros formations, the Tranquillon volcanics of Dibblee (1950), and the Monterey shale. The remainder of the consolidated rocks probably would not yield water to wells.

UNCONSOLIDATED WATER-BEARING DEPOSITS

CAREAGA SAND (PLIOCENE)

The Careaga sand underlies much of the northern half of the missile facility, but it is for the most part masked by a combination of dense vegetation, surface wash, and overlying formations that are similar to it. Generally the Careaga sand consists of two members—the Cebada fine-grained member and the Graciosa coarse-grained member (Woodring and Bramlette, 1950, p. 42). The lower (Cebada) member is an olive-gray very fine grained silty, somewhat indurated sand containing abundant fossil shells and lenses of fossiliferous gravel. The upper (Graciosa) member comprises a sequence of yellowish-brown medium- to coarse-grained unconsolidated sand locally pebbly. The contact between the two members generally may be identified easily in well cuttings—the olive-gray silty Cebada contrasts with the yellowish-brown coarse-grained sand of the Graciosa. According to Dibblee (1950, p. 46), the contact between the two members is marked by a persistent pebble bed at the base of the upper member; however, the pebble bed was not recognized in outcrop nor in the test drilling. In test well 4 the two members appear to intertongue.

The Cebada member is exposed on the southwest side of Bear Creek west of test well 5, where it is in contact with the underlying Sisquoc formation. A fossiliferous gravel bed, presumably part of the Cebada member, crops out about four-tenths of a mile west of La Salle Canyon. The Cebada member was penetrated in test wells 2, 3, 4, 5, 6, and 10, in well 7/35–33M1, and in supply well 1 (7/35–33J2). The Cebada is about 400 feet thick at well 7/35–33M1 (a wildcat oil well). A fossiliferous gravel was tapped in the Cebada in test well 2, supply well 1, and in well 7/35–33M1. Computations based on the position of the gravel in these wells indicate that it strikes N. 20° E. and dips 5° W.

The Graciosa member was not recognized in any exposures; however, it was found in test wells 3, 4, and 6, supply well 1, well 7/35–33M1, and possibly in test well 1. The base of the Graciosa member, as defined by test well 3, supply well 1, and 7/35–33M1, strikes S. 70° E. and dips about 1° S. The thickness of this member is estimated from well logs to be about 200 to 300 feet.

More is known about the water-bearing characteristics of the Careaga sand than most of the other formations at the missile facility. Seven of the test wells penetrated varying thicknesses of the unit. Within the Lompoc Terrace basin the lower member of the Careaga sand, the Cebada, probably contains a considerable amount of stored water; however, the low permeability of this fine-grained deposit makes the extraction of water difficult. Test well 2 and supply well 1 penetrated a bed of fossiliferous gravel in the Cebada member, and probably would derive water from this fine-grained material. The coarse-grained Graciosa member is considered to be the most productive aquifer on the missile facility, except for the younger alluvium of the Santa Ynez River. The test wells that tapped the Graciosa yielded 4 to 125 gpm—the yield generally is proportional to the amount of coarse material penetrated. Properly constructed and developed gravel-packed wells probably would yield substantial amounts of water (200 to 300 gpm) from the Graciosa, even from wells which penetrate little or no gravel. Supply well 1 (7/35–33J2) yielded a maximum of 900 gpm at a drawdown of 262 feet during a test made on October 14, 1958.

ORCUTT SAND (PLEISTOCENE)

The unconsolidated Orcutt sand covers most of the northern half of the missile facility. It is as much as 300 feet thick (Upson and Thomasson, 1951, p. 28) and is comprised of sand and pebbly sand. The upper 128 feet of stratigraphic section in test well 1 is believed to be the Orcutt sand, although the lower 30 feet may represent the age equivalent of the Paso Robles formation which is exposed in the eastern part of the Santa Ynez Valley (Upson and Thomasson, 1951, pl. 3). Preliminary foundation drilling by the Corps of Engineers north of Bear Creek shows that the upper 40 to 70 feet of Orcutt is fairly well sorted medium- to coarse-grained reddish-brown sand.

On the Lompoc Terrace west of Lompoc Canyon, the Orcutt sand appears to have been eroded only slightly since its deposition. The drainage system is poorly developed and several small areas have internal drainage.

The Orcutt sand would be a productive aquifer if saturated. However, it forms a thin blanket over the older sediments and in most places it is above the water table. A few clayey beds in the Orcutt sand locally support small perched bodies of ground water, as is indicated by small seeps in gullies high along the west side of Lompoc Canyon. The sandy soil developed on the Orcutt sand is very permeable and tends to absorb most of the rainfall.

YOUNGER ALLUVIUM (RECENT)

Santa Ynez Valley.—The younger alluvium of the Santa Ynez Valley, which has been described in detail by Upson and Thomasson (1951, p. 43–50), is the most productive source of water in the area. In general the deposit is about 200 feet thick near the missile facility, and consists of gently seaward dipping sand, gravel, and clay deposits. Commonly the lower part consists of gravel and sand, which are overlain by a fine-grained upper unit composed principally of silt and clay.

Wells in this part of the river flood plain generally tap confined water in the lower part of the alluvium and yield as much as 1,000 gpm or more of water to irrigation wells. Test well 11, drilled in the younger alluvium north of Lompoc Canyon, penetrated about 190 feet of alluvium, the lower half of which was gravel and gravelly sand. The test well had a specific capacity of about 11 gpm per foot of drawdown. Irrigation wells that tap the alluvium commonly have specific capacities of more than 100 gpm per foot of drawdown. The water level in this part of the valley is generally less than 10 feet below the land surface.

The quality of water in the alluvium is relatively poor for domestic use because it contains 1,000 to 1,500 ppm dissolved solids and 250 to 500 ppm chloride.

Lompoc Canyon, Canada Honda, and Bear Canyon.—The younger alluvium that underlies the flood plains of Canada Honda and Lompoc and Bear Canyons is a heterogeneous mixture of silt, sand, gravel, and clay. Generally the deposit is 50 to 80 feet thick, and the coarser water bearing strata are in the lower third of the section.

Test well 2 penetrated 400 feet of sand, clay, scattered angular gravel, and slightly carbonized wood—sediment unlike the older strata exposed in the valley walls. The upper part is typical of the younger alluvium, but the bulk of the section may represent estuarine or slough deposits of the ancestral Santa Ynez River. The water-yielding character of this thick alluvial deposit is not known, because the well casing was perforated only opposite the underlying fossiliferous pebble bed in the Careaga sand. However, owing to the heterogeniety of the material, the deposits probably would not yield much water to wells.

The younger alluvium in Bear Creek and Canada Honda was explored as part of the test-well program. The water level in the test wells ranged from 20 to 30 feet below the ground surface, and the yield of the test wells ranged from 4 to 10 gpm. Data from these wells show that the alluvium in Bear Canyou and Canada Honda is neither thick enough nor permeable enough to yield large quantities of water to wells.

DUNE SAND (RECENT)

Deposits of wind-blown sand mantle a narrow strip along the coast from Surf, Calif., to Canada Honda. Most of the sand, which is reworked from the Orcutt, was deposited by the strong sea breezes. The dune sand is probably above the zone of ground-water saturation and therefore is not favorable as an aquifer.

GEOLOGIC STRUCTURE

The rocks in the western part of the Santa Ynez Mountains have been folded into a broad, eastward-trending anticline bounded on the north by the Canada Honda fault of Dibblee (1950, p. 56). North of this fault the rocks are sharply folded into a series of smaller eastward-trending anticlines and synclines that have one or more faulted zones parallel to their axes. Many structures are obscured by the relatively thin, undisturbed sediments comprising the Orcutt sand, dune sand, and younger alluvium of Pleistocene and Recent age.

The trace of the Canada Honda fault of Dibblee (1950) follows the north side of Canada Honda from the La Salle (Rodeo) Canyon road to near Point Pedernales. According to Dibblee (1950, p. 56), the fault dips steeply to the south and has a maximum displacement of about 3,000 feet; the north side has been downdropped. In many places the rocks adjacent to the fault are crumpled and fractured over a narrow zone. Several small seeps issue from this fractured zone and from landslide debris downslope south of the trace of the fault.

Almost 2 miles north of and parallel to the Canada Honda fault is an unnamed fault that was not mapped by Dibblee (1950), but which has been inferred from test wells 2, 4, 5, and 10 and from oil test wells 7/35–33M1 (Lagomarsino No. 1) and Keystone Petroleum Co. True No. 1 (Dibblee, 1950, p. 70, pl. 3). Evidence of the fault was found by the authors in several places along its trace during the investigation. The fault is exposed in Bear Canyon along the road west of test well 5. Here the Monterey shale and the Sisquoc formation are brecciated across a wide zone, and semi-indurated strata of the Careaga sand along the downthrown side of the fault have been tilted steeply to the north by drag. About 500 feet to the northeast, at a small exposure in the floor of Bear Canyon, a probably smaller fault that cuts the Careaga sand trends slightly north of east along the north side of a small tributary of Bear Creek and is marked by small seeps and phreatophyte growth.

Information from the exploratory oil-test wells mentioned previously indicates that the larger fault dips steeply to the south and that the north side has dropped about 1,000 feet. This downfaulting has preserved from erosion a sizable basin filled with permeable sediments north of the fault, which is herein referred to as the Lompoc Terrace ground-water basin. The nature of the northern boundary of this basin is not completely understood but it may be bounded by a fault or sharp fold. A fault is inferred on the basis of the amount of structural relief between test well 3 and outcrops of the Monterey shale and Sisquoc formation along State Highway 150 west of Lompoc Canyon (section *A–A′*, pl. 2). The ground-water discharge in Lompoc Canyon between test well 3 and the inferred fault (pl. 1) may be due to a ground-water barrier formed by the uplift of the relatively impermeable Monterey shale and Sisquoc formation on the north.

GEOLOGIC HISTORY

Details of the geologic history of the general area are discussed by Dibblee (1950), Woodring and Bramlette (1950), and Upson and Thomasson (1951). Therefore, only those events pertaining to the ground-water supply are discussed here.

The Jurassic, Cretaceous, and most of the Tertiary periods are represented by rocks in the Santa Ynez Mountains. These consolidated rocks record at least eight sequences of deposition and later deformation. The last major deformation occurred during the Pleistocene epoch.

During late Pliocene time, western Santa Barbara County was covered by a relatively shallow arm of the ocean in which was deposited the fine sand and silt of the Careaga sand. These sediments covered most of what is now the missile facility to a depth of several hundred feet.

Near the end of the Pliocene epoch this arm of the sea had become more or less filled with sediment and formed a broad plain at or near sea level. Movement along the Canada Honda and related faults occurred sometime after the deposition of the Careaga sand but before the Orcutt sand was laid down and accompanied the rise of the Santa Ynez Mountains. This orogeny was followed by a period of intensive erosion during which the larger canyons in the area were cut.

Following the period of crustal activity in the Pleistocene epoch, the Orcutt sand was deposited. The veneer of marine sand and gravel of the Orcutt sand covered most of the area north of the Santa Ynez Mountains and smoothed the topography by partly filling the canyons. During the late part of the Pleistocene epoch, the Orcutt sand and older formations were tilted a few degrees toward the Santa Ynez Valley as the area underwent a slight deformation which resulted in the present general topography. The younger alluvium was deposited in Recent time.

WATER RESOURCES

SURFACE WATER

The area of the missile facility is drained mainly by five watersheds; one major, the Santa Ynez Valley; and four minor, Lompoc Canyon, Canada Honda, and Bear and Spring Canyons. These watersheds are discussed briefly below, and chemical analyses of water from the seeps and streams in the watersheds are given in table 7.

The amount of surface water contributed to the Santa Ynez Valley from the missile facility property is small. Lompoc Canyon, probably the largest contributor, drains about 5.3 square miles, but the rainfall is small and the stream bed is moderately permeable. Little runoff occurs during the summer months, but during the wet winter months, the ground water rises at the canyon mouth and some streamflow occurs.

Upstream from the unnamed fault that marks the southern limit of the Lompoc Terrace ground-water basin, the stream in Lompoc Canyon has a small flow most of the year. Because the alluvial fill here is fairly thin and rests on the relatively impermeable Sisquoc formation and Monterey shale, the water table is shallow and the valley floor is covered by dense vegetation. Most of these plants, called phreatophytes, extract water directly from the zone of ground-water saturation. On September 3, 1958, the stream in Lompoc Canyon was flowing at a rate of 21 gpm at a point 4,500 feet south of test well 2. A few hundred yards downstream the flow decreased because of infiltration into the permeable stream bed and finally ceased in a dense growth of willows because of evapotranspiration.

Canada Honda, which discharges to the Pacific, drains about 12 square miles in the southern part of the area and contains a perennial stream within 3 to 4 miles of its mouth. Most of the streamflow during the summer months is derived from the several springs along both sides of the canyon.

Bear Creek is an intermittent stream draining about 3 square miles in the west-central part of the missile facility. In July 1958 the creek was flowing at about 10 gpm near the main road crossing and probably is perennial throughout most of its lower reach. The valley has been dammed by a railroad fill so that storm runoff from the drainage area is ponded between the main road and the railroad fill. The ponded water drains through the material used in the fill and discharges to the ocean.

Spring Canyon and an unnamed canyon about half a mile to the south of Spring Canyon drain much of the southwestern part of the missile facility. Several small seeps occur in Spring Canyon, but streamflow between seeps was not continuous during the summer of 1958.

GROUND WATER

Water that fills the openings in rocks and deposits within the earth is termed "ground water." The geologic units in which the water is contained consist of unconsolidated deposits, particularly beds of sand and (or) gravel, in which openings occur between sand grains or or gravel particles, and of consolidated rocks in which the openings are generally restricted to fractures or joints which are not as continuous or uniform as the openings in unconsolidated deposits. The primary source of recharge to ground water is precipitation.

Within the boundaries of the missile facility ground water may be obtained chiefly from the Santa Ynez Valley, the Lompoc Terrace ground-water basin, and the valley of Canada Honda. Small supplies of ground water may be obtained locally from the consolidated rocks. The water-bearing character of the several geologic units in these areas was discussed in the "Section on geology."

SANTA YNEZ VALLEY

The most productive source of ground water in the area is the younger alluvium in the Santa Ynez Valley. Considerable ground-water data are available for this hydrologic unit and comprehensive reports by Upson and Thomasson (1951) and Wilson (1959) describe the geology and hydrology of the valley.

Properly constructed wells perforated in the lower part of the younger alluvium of the Santa Ynez Valley (approximately the 100- to 190-ft-depth interval) may be expected to produce about 1,000 gpm with a drawdown of about 20 feet. However, two questions should be considered if large withdrawls of ground water are to be made by the missile facility from the main water-bearing zone of the valley.

The first question is, what effect, if any, will the operation of Cachuma Dam, on the Santa Ynez River about 48 miles upstream from its mouth, have on the ground-water supply of the valley downstream? Wilson (1959, p. 93) estimated that 22,000 acre-feet of water per year could be pumped perennially from the Santa Ynez Valley. His estimate was based on extrapolated estimates for 11 dry years and 14 wet years. From 1946 through 1955 the actual pumpage ranged from 16,000 to 26,000 acre-foot per year and averaged about 19,000 acre-feet per year; water levels remained relatively constant. Cachuma Dam has been in operation only since January 7, 1953, and it is not known at this time whether regulated releases from the dam and operation of the 210,000 acre-feet reservoir will increase or decrease the recharge to ground water in the downstream valley area. The Geological Survey is making a continuing study, in cooperation with the Santa Barbara County Water Agency, to determine the effect of the operation of Cachuma Dam and reservoir on the downstream ground-water supply.

The second question concerns the quality of water in the younger alluvium. The chloride concentration in the water from test well 11 was 290 ppm and in well 7/35–21L4 was 470 ppm. These chloride concentrations are borderline or unusable for domestic and public supply according to standards recommended by the U.S. Public Health Service for drinking water on interstate carriers (250 ppm of chloride is the recommended upper limit). Because no sea-water encroachment is known to have occurred in historic time, the high chloride concentration, which has been increasing in the central part of the coastal valley, is probably due to the leaching and concentration of salts resulting from irrigation and (or) the mixing of ground water from the older marine sediments underlying the alluvium. An additional problem concerning the quality of the ground water of the coastal area is the threat of sea-water encroachment. Should extensive pumping draw down the water level and cause an inland hydraulic gradient to develop, a landward advance of sea water would result.

LOMPOC TERRACE GROUND-WATER BASIN

The Lompoc Terrace ground-water basin is a structural and hydrologic feature formed by downfaulting along the south and possibly the north sides of the basin (p. 12, pl. 1). However, it is not a completely separate basin because the east end probably is in hydraulic continuity with ground water beneath the alluvial plain of the Santa Ynez Valley and the west end may be in hydraulic continuity with the Pacific Ocean. The areal extent of this ground-water reserve is from the ocean on the west nearly to La Salle Canyon on on the east, and between the two eastward-trending faults described on pages 12–13. The Lompoc Terrace ground-water basin has not been developed; it has been tapped only by test wells 2, 3, 4, 6, and 10 and by supply well 7/35–33J2.

Geologic section *A–A′* (pl. 2), which extends north-northeast through the Lompoc Terrace ground-water basin, shows diagrammatically the lithologic and subsurface structural features within the basin. It also shows the water-level profile as of September 1958. The ground-water supply is contained in three lithologic units as follows: (1) the basal unit, a fossiliferous gravel of the Cebada member of the Careaga sand; (2) the middle unit, fine-grained sand and silt of the Cebada, and (3) the upper unit, coarse-grained pebbly sand in the Orcutt sand and in the Graciosa member of the Careaga sand, part of which may be equivalent to the Paso Robles formation. Test wells 3, 4, and 6 which tapped the upper unit had specific capacities that ranged from less than 0.1 (test well 3) to about 1.8 gpm per foot of drawdown (test well 6). Supply well 7/35–33J2 in Lompoc Canyon, gravel packed throughout the saturated interval, had a specific capacity of about 5 gpm per foot of drawdown. Because the basal gravel has been identified in only three wells (7/35–33M1, 7/35–33J2, and 7/35–33R1), its western, northern, and eastern extent is uncertain. However, the dip of the basal gravel, about 5° W., computed from logs of wells 33M1, 33J2, and 33R1, indicates that at test well 4 the gravel, if present, would be about 900 feet below sea level.

MOVEMENT, RECHARGE, AND DISCHARGE

The direction of movement of ground water in the Lompoc Terrace basin is indicated by the water-level contours on figure 2. Ground

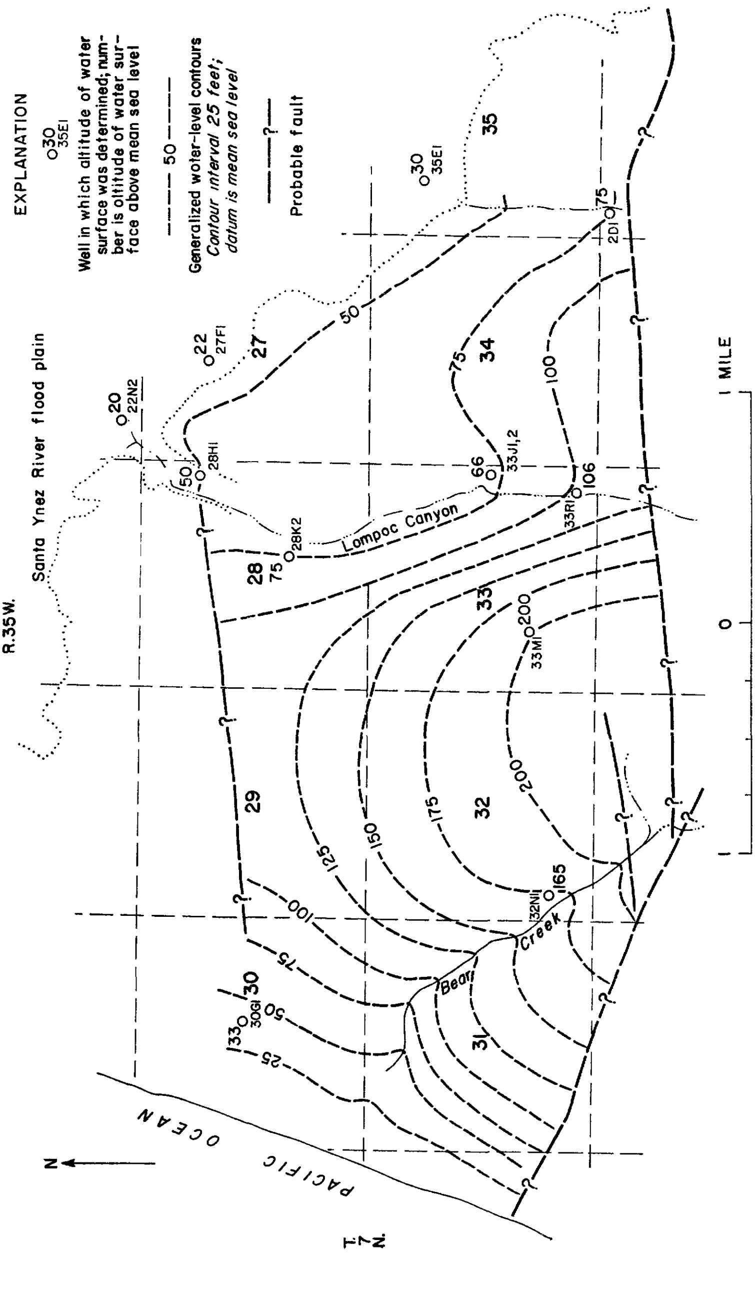

FIGURE 2.—Water-level contour map of the Lompoc Terrace ground-water basin, September 1958.

water moves downgradient perpendicular to the contour lines from higher to lower altitudes. Figure 2 shows that ground water is moving northwestward toward the sea and northeastward toward the Santa Ynez Valley. The water-level contours are based on the altitude of the water surface at the indicated control points. The altitudes of the water surface were measured in September 1958 in all wells except the oil-test well 7/35–33M1. The altitude of the water surface at this point was inferred to be higher than about 200 feet above sea level because the electric log made in September 1954 indicated saturated material as high as 190 feet above sea level.

Recharge to the basin is from infiltration of precipitation that falls directly on the loose, permeable dune sand and Orcutt sand, from percolation of surface runoff in Lompoc Canyon, from minor streams, and from movement of perched ground water in the tributary to Lompoc Canyon that borders the basin on the south. Because of the low average annual precipitation, the total recharge may be small.

Ground water from the basin is discharged by subsurface movement into the alluvial plain of the Santa Ynez Valley on the north and east and into the ocean on the west. Ground water is discharged by evaporation and by transpiration by phreatophytes in Bear Creek canyon and near the inferred fault at the mouth of Lompoc Canyon. More than 80 acres of dense phreatophyte growth in Bear Creek canyon consume about 300 acre-feet of water per year, on the basis of an estimated average use of 3.5 acre-feet per acre (Upson, 1951, p. 134). In addition, ground-water discharge sustains a perennial flow into Bear Creek.

GROUND-WATER STORAGE CAPACITY

The quantity of fresh water in storage that theoretically is available to wells in the Lompoc Terrace basin is equal to the volume of the deposits saturated with fresh water multiplied by the specific yield of those deposits. The specific yield of a saturated deposit is the ratio of its own volume to the volume of water it will yield by gravity, expressed as a percentage; the specific yield may range from less than 1 percent for clay to more than 35 percent for sand and gravel.

The Lompoc Terrace basin is probably in hydraulic continuity with the ocean; therefore, for practical purposes, ground water in storage available for use will be considered as that which is contained only in the saturated deposits above sea level. The average thickness of these saturated deposits (110 feet) may be estimated from the water-level contours on figure 2. The ground-water basin (4,800 acres) is fairly well defined by faults on the north and south, by the ocean on the west, and by the younger alluvium of the Santa Ynez Valley on the east. Thus, the volume of saturated deposits above sea level is estimated to be about 500,000 acre-feet.

In this report, the specific yield was estimated in a manner similar to that used by Wilson (1959, p. 59, 60, 86) for calculation of the specific yield of the unconsolidated deposits in the Lompoc subarea of the Santa Ynez River valley. Values of specific yield assigned by Wilson (1959, p. 60) to various classes of material are given below:

Material	*Specific yield (percent)*
Gravel	20
Sand	20
Fine sand	15
Cemented gravel	5
Silt and clay	1

On the assumption that these values are applicable to the materials of the Lompoc Terrace basin, similar values were assigned to each of several classes of materials described in the logs of test wells 1, 3, 4, 6, and 10, and oil-test well 7/35–33M1. An average specific yield for the storage unit was then derived by weighting the assigned specific yield for each class of material in proportion to the relative amount of each type in the total volume. The average specific yield calculated by this method, and considered to be a conservative estimate, is about 12 percent.

Ground water in storage available to wells in the Lompoc Terrace basin is the product of the volume of saturated deposits that are above sea level (500,000 acre-feet), and the estimated specific yield (12 percent). Usable ground water in storage therefore is estimated to be about 60,000 acre-feet.

Wilson (1959, p. 60) estimated that 7,400 acre-feet of ground water is in storage in an area that includes about half of the Lompoc Terrace ground-water basin of this report; however, Wilson's estimate was comparably lower than 60,000 acre-feet because at the time of his estimate the areal extent of the Lompoc Terrace basin had not been recognized to be as large as shown herein; no water-level data were available from which to estimate the saturated thickness; and no well logs were available on which to base estimates of specific yield. Wilson's estimate was meant to serve as a conservative approximation of a minimum quantity of ground water in the general area of Lompoc Canyon.

UTILIZATION OF GROUND-WATER IN STORAGE

The one supply well in Lompoc Canyon (7/35–33J2) is perforated opposite two water-yielding zones. The lower zone, a fossiliferous gravel of the Cebada member of the Careaga sand, is below sea level and, therefore, was not considered in the computation of ground-water storage described above, but it is probably the most productive water-bearing zone in the basin. The upper zone, which is within the zone considered in the storage unit, is a coarse pebbly sand, probably of the Graciosa member of the Careaga sand. These two zones apparently are separated by fine-grained deposits throughout much of the basin, but they are connected hydraulically at places where the gravel of the Cebada member of the Careaga sand is in contact with the coarse sand of Graciosa member of the Careaga sand and by the gravel pack that surrounds supply well 7/35–33J2. Thus, the total quantity of water that can be produced from supply well 7/35–33J2 depends on the effective permeability and the degree of connection between the gravel of the Cebada member and the coarse sand of the Graciosa member of the Careaga sand.

Ideally, to meet the requirements of the missile facility, ground water should be withdrawn uniformly from the storage unit through several wells spaced so as to avoid mutual interference of the cones of depression. To achieve this result, it may be necessary to construct a well field of several gravel-packed wells. Either Lompoc Canyon or Bear Canyon would be a suitable location for this well field. The optimum yield of 500 gpm obtained in supply well 7/35–33J2 attests to the productivity of the deposits of the Lompoc Canyon area. Test well 4, which yielded about 20 gpm on test, suggests that a gravel-packed and properly developed well in Bear Canyon might be capable of yielding as much as 100 gpm. Drilling and devloping one gravel-packed well in Bear Canyon would confirm or deny this. Moreover, a well in Bear Canyon, if drilled to a depth of 900 to 1,000 feet below land surface, might tap the fossiliferous gravel of the Careaga sand that was identified in wells 7/35–33J2, 33M1, and 33R1. Because the fossiliferous gravel zone is the most productive water-bearing zone in the basin, yeilds greater than the 100 gpm estimated could be expected if this unit were tapped. Development of a well field in Bear Canyon would have an additional advantage in that lowering the water level in this area would conserve water that is now being wasted by a dense growth of phreatophytes.

CHEMICAL QUALITY

The chloride concentration of the ground water in the Lompoc Terrace ground-water basin ranges from about 180 ppm at test well 6 to 300 ppm at test well 4 (table 7). The dissolved solids range from 550 to 1,150 ppm, and total hardness ranges from about 225 to 700 ppm. Water in the Lompoc Terrace ground-water basin is generally slightly better in quality than elsewhere within the boundaries of the missile facility.

The water of supply well 7/35–33J2, in Lompoc Canyon, is relatively poor in quality. On October 11, 1958, the chloride content was 270 ppm, the dissolved-solids content 950 ppm, the hardness 480 ppm, the fluoride content 0.1 ppm, and the boron content 0.04 ppm (table 7).

CANADA HONDA

The third and least favorable basin from which ground-water supplies might be obtained is Canada Honda, where consolidated rocks are overlain by a thin deposit of younger alluvium. This younger alluvium is discontinuous along the course of the stream and, as determined by test drilling, is only 50 to 70 feet thick. It covers an area of about 200 acres beginning at a point about 3 miles upstream from the coast (pl. 1). Test wells 7, 8, and 9 were drilled in this area to determine the water-bearing character of the alluvium. The static water level in the vicinity of these wells during the summer of 1958 was about 20 feet below the flood plain, but the alluvium was found to be poorly permeable and the wells yielded only 5 to 10 gpm.

If an area of about 200 acres had average thickness of 50 feet and a specific yield of 10 percent, the amount of water stored in the alluvium in this upstream part of Canada Honda is about 1,000 acre-feet. The quality of water is relatively poor; a sample from test well 7 contained 275 ppm of choride and 1,120 ppm of dissolved solids (table 7).

SUMMARY AND CONCLUSIONS

A study of the geology and hydrology of the area within the boundaries of the Point Arguello Naval Missile Facility indicates that the anticipated water demand by the Navy of 0.6 to 1.6 mgd (a continuous flow of 400 to 1,100 gpm) can be supplied by water from wells drilled within the missile facility. Two nearly separate ground-water basins can provide the supply—the Santa Ynez Valley proper and the Lompoc Terrace. In the Santa Ynez Valley, wells less than 200 feet deep tap the younger alluvium and yield about 1,000 gpm at moderate drawdown. In the Lompoc Terrace ground-water basin the water is of slightly better quality, but the wells will probably each yield only about 500 gpm at moderate to large drawdown. The development and utilization of these two basins are summarized in the following paragraphs:

In relatively wet years the ground-water recharge to the coastal area of the Santa Ynez Valley probably would be adequate to meet the estimated requirements of the missile facility. Should a series of dry years occur, pumping from wells at the seaward end of the valley on the missile facility, and the large amount of pumping for irrigation farther inland, might cause a lowering of water levels to a point where salt-water encroachment would begin. If salt water were drawn inland to the well field, the ground-water supply would become unfit for domestic and irrigation uses. The chloride concentration of the water in the vicinity of test well 11, probably would be about 300 ppm and the water would be considered of marginal quality for domestic use.

Supply well 1 (7/35–33J2) in the Lompoc Terrace basin is designed to produce 500 gpm, which is insufficient to meet the anticipated total requirements of the missile facility. The basin heretofore has not been utilized as a source of ground-water supply. However, considering the meager rainfall and runoff, the average annual recharge may be small. The estimated usable ground water in storage is about 60,000 acre-feet which is sufficient to supply the anticipated requirements (about 1,000 acre-ft per year) of the missile facility for 60 years. However, it may be necessary to construct and use additional supply wells to extract a significant part of the usable ground water in storage. Records should be kept of measurements of water levels and of the quantity of water pumped to determine the rate of depletion of storage, and samples of water should be analyzed periodically from supply and test wells to detect any deterioration in the quality of the supply due to salt-water encroachment or other causes.

Development of ground-water supplies from the younger alluvium of the Santa Ynez Valley would place an additional burden upon the resources of the coastal basin, which has supplied an average of nearly 20,000 acre-feet per year for irrigation, for water supplies for Army and Air Force installations and the city of Lompoc (not shown on pl. 1), and for other uses. The extent to which the Lompoc Terrace basin could meet the total requirements of the missile facility for several tens of years cannot be predicted accurately until pumping and water-level data have been collected for several years. However, it is suggested that the potable water supply be obtained from the basin. Water of marginal or poor quality can be used for fire protection, cooling, or special test purposes. It is suggested that wells be drilled in the younger alluvium of the Santa Ynez Valley near the coast so that any salt-water encroachment would occur only at the seaward end of the coastal basin where it would least affect the large pumped part of the basin east of the missile facility.

The Geological Survey logged the 11 test wells and the 1 supply well as they were being drilled between March 3 and October 8, 1958 (table 5).

The 11 test wells were drilled by Floyd V. Wells, Santa Maria, Calif., by the cable-tool method, using solid tools (any or all rock bits as opposed to various bailers). The logs of wells were compiled on the basis of drill cuttings brought up in the bailer, and the changes in drilling characteristics.

The one supply well 7/35–33J2 was drilled by Evans Bros., Lancaster, Calif., by the rotary method. The log of this well was compiled from an examination of ditch samples of cuttings.

TABLE 5.—*Well logs*

Material	Thickness (ft)	Depth (ft)
Test well 1 (7/35-30G1) [Approximately 1.4 miles south of Surf, Calif., 400 ft west of State Highway 150. Land-surface altitude about 130 ft. Drilled Mar. 3–Apr. 14, 1958]		
Sand, brown	64	64
Sand and gravel	34	98
Clay, green, and some brown sand, small pebbles of chert, and diatomaceous mudstone; contains water at 117 ft	52	150
Clay, green; subrounded to subangular pieces of diatomaceous mudstone	80	230
Clay, green; streaks of sand and pebbles	10	240
Mudstone, green; and angular fragments of diatomaceous mudstone	37	277

Perforations: 115 to 270 ft.
Water level after perforation: 97 ft below land surface.
Yield: Well bailed dry in about 10 min, recovery less than 1 gpm.

Material	Thickness (ft)	Depth (ft)
Test well 2 (7/35-33R1) [In Lompoc Canyon, approx. 2.2 miles south of State Highway 150. Land-surface altitude about 216 ft. Drilled Apr. 16–28, 1958]		
Sand, light-brown, very fine to coarse; and shale fragments	33	33
Sand, very fine to medium, and silty clay	52	85
Sand, with some clay, orange-brown	10	95
Clay, sandy, very fine, and silt; gray wood fragments at 139 ft	64	159
Sand, clayey, yellow-brown, fine	11	170
Clay, olive-brown, contains fine sand	5	175
Sand, clayey, gray-brown, very fine, carbonized wood	7	182
Clay, very sandy, dark-gray; very fine sand	27	209
Sand, clayey, very fine to coarse; contains carbonized wood and sparse shells	16	225
Sand, clayey, and some gravel; contains wood and some tar-cemented sand	18	243
Clay, contains very fine sand	34	277
Clay, sandy and pebbly; contains carbonized wood and tar-cemented sand	3	280
Clay; contains very fine sand; alternates with very fine sand and silty clay	120	400
Gravel, sandy, fossiliferous	19	419
Sand, clayey, very fine; a few granules	6	425
Sand, very coarse; granules and silty clay	5	430
Clay, sandy, olive-gray	2	432

Perforations: 12 cuts per ft, 402 to 420 ft; cement plug at about 425 ft.
Water level after perforation: 110 ft below land surface.
Yield: Bailed at 43 gpm with 50-ft drawdown; test pumped June 5, 1958, 180 gpm with 280-ft drawdown.

TABLE 5.—*Well logs*—Continued

Material	Thickness (ft)	Depth (ft)
Test well 3 (7/35-28K2) [In Lompoc Canyon about 0.9 mile south of State Highway 150. Land-surface altitude approx. 89 ft. Drilled Apr. 30–May 15, 1958]		
Sand, pebbly and clayey, dark-yellowish-brown, medium to coarse; rounded pebbles to 30 mm	21	21
Sand, pebbly and silty, coarse to very coarse	2	23
Sand, clayey, moderate yellowish-brown, very fine to coarse; some granules and small pebbles	27	50
Sand, moderate yellowish-brown, slightly clayey; scattered pebbles and granules	13	63
Sand, clayey and silty, olive-gray, fine to very fine; flows into hole readily	252	315

Perforations: 4 cuts per ft at 22–23, 46–48, and 60–63 ft. Backfilled with gravel and cement plug set at 235 ft.
Water level after perforation: 15 ft below land surface.
Yield: 5 gpm by bail test.

Material	Thickness (ft)	Depth (ft)
Test well 4 (7/35-32N1) [Bear Canyon, about 0.75 mile southeast of State Highway 150. Land-surface altitude approximately 175 ft. Drilled May 16–27, 1958]		
Sand, silty and gravelly, yellow-brown; sand is very fine to very coarse; gravel is angular chert, pebbles average 5–8 mm, some as much as 20 mm; gravel makes up about 5 percent total sediment	25	25
Sand, olive, fine; contains sparse coarse sand and granules and some angular chert pebbles as much as 10 mm	30	55
Sand, clayey and silty, olive-gray, very fine to coarse; coarse grains are angular chert	30	85
Sand, olive-gray, very fine to coarse, and sparse pebbles of angular chert	10	95
Sand, clayey and silty, olive-gray, very fine to medium; contains some coarse sand, granules of angular chert and sparse shell fragments	30	125
Sand, very silty, clayey, pale-olive to grayish-olive; very fine, sparse medium sand; angular granules of chert	23	148
Sand, clayey, olive-gray, fine to coarse, and sparse very coarse sand; one limonite cemented sandstone block in sample	3	151
Sand, silty and clayey, olive-gray, very fine, some medium and coarse sand scattered throughout	34	185
Sand, silty, dark-yellowish-brown, very fine to coarse, and very sparse granules and very small pebbles of angular chert. When penetrated with drill, water in casing rose from about 20 ft below top of casing and flowed for approximately 5 min; total flow less than 50 gal	3	188

TABLE 5.—*Well logs*—Continued

Material	Thickness (ft)	Depth (ft)
Test well 4 (7/35–32N1)—Continued		
Sand, silty and clayey, olive-gray, very fine to medium, and sparse angular pebbles and granules of chert; pebbles about 20 by 5 mm maximum	7	195
Sand, silty and clayey, olive-gray, very fine to coarse	20	215
Sand, olive-gray, mostly very fine grained to silt size; shell fragments	85	300

Perforations:

Feet	*Cuts per foot*	*Fee*	*Cuts per foot*
10–35	4	101–112	4
35–85	2	112–184	2
85–95	4	184–190	4
95–101	2	190–210	2

Water level after perforation: 10 ft below land surface.
Yield: 21 gpm by bail test; well further developed and test pumped on June 25, 1958, and no increase in yield resulted.

Test well 5 (6/35–5F1)

[Bear Canyon, about 1.3 miles southeast of State Highway 150. Land-surface altitude about 220 ft. Drilled May 28–29, 1958]

Material	Thickness (ft)	Depth (ft)
Sand, pebbly, dark-brown, medium to coarse; pebbles average about one-half in., make up about 20 percent of the sediment; upper part high in organic material or soil(?)	29	29
Sand, pebbly, light-olive-gray, medium to coarse; pebbles average about one-third in. to 1 in.; coarse sand and pebbles are angular chert	8	37
Sand, pebbly and clayey, light-olive-gray, medium to very coarse; pebbles average about one-half in.; grades downward into underlying unit	5	42
Sand, clayey and pebbly, olive-gray, fine to very fine; pebbles about one-fifth in.; material is compact and firm	13	55
Sand, olive-gray, very fine, silty, semi-indurated (Careaga sand); small pebbles recovered to 60 ft, but probably dropped into hole from above 55 ft	22	77

Perforations; 4 cuts per ft, from 5 to 57 ft; cement plug at 70 ft.
Water level after perforation: 25 ft below land surface.
Yield: 4 gpm by bail test.

TABLE 5.—*Well logs*—Continued

Material	Thickness (ft)	Depth (ft)
Test well 6 (7/35-33J1) [Lompoc Canyon, about 1.75 miles south of State Highway 150. Land-surface altitude approximately 177 ft. Drilled June 2-17, 1958]		
Sand, slightly clayey and silty, yellowish-orange to grayish-orange, fine to coarse; averages about medium to coarse; grains generally subrounded; sparse very coarse sand	98	98
Sand, yellowish-orange to grayish-orange, fine to very fine; sparse coarse sand	15	113
Sand, dusky-yellow to dark-yellowish-orange, fine to very coarse; sparse granules and very small pebbles	35	148
Sand, yellowish-gray to pale-olive, fine to very fine	25	173
Sand, pale-olive to olive-gray, fine to medium; sparse granules and very small pebbles; pebbles rounded as much as three-eighths in	5	178
Sand, pebbly, moderate-yellow, very fine to coarse; pebbles as much as three-eighths in	9	187
Sand, grayish-yellow, medium fine to coarse; sparse angular pebbles as much as one-fourth in	18	205
Sand, grayish-yellow to dusky-yellow, very fine to coarse; sparse granules	23	228
Sand, silty, olive-gray, very fine; very sparse medium sand; sparse to abundant shell fragments; semiconsolidated	107	335
Sand, olive-gray, very fine to silty; sparse granules and very small rounded pebbles as much as one-fourth in.; abundant shell fragments	5	340
Sand, olive-gray, very fine to silty; sparse fine to medium sand; sparse shell fragments	40	380

Perforations:

Feet	*Cuts per feet*	*Feet*	*Cuts per foot*
113–118	4	178–187	8
118–125	6	187–205	4
125–155	2	205–225	2
173–178	4		

Water level after perforation: 112 ft below land surface.
Yield: Bail tested at 50 gpm with 18-ft drawdown, test pumped at 125 gpm with 65-ft drawdown.

Material	Thickness (ft)	Depth (ft)
Test well 7 (6/35-15J1) [Canada Honda, 200 ft north of Canada Honda Road and 500 ft east of junction with road from La Salle (Rodeo) Canyon. Land-surface altitude approximately 585 ft. Drilled June 2-6, 1958]		
Clay, gray-brown, friable adobe; some small streaks of yellow sandy clay and some pebbles; water at 18 ft	33	33
Clay, sandy, gray, soft, sticky; and some gravel and sand streaks	12	45

TABLE 5.—*Well logs*—Continued

Material	Thickness (ft)	Depth (ft)
Test well 7 (6/35-15J1)—Continued		
Clay, yellow-brown, plastic, tough; and well-rounded pebbles	13	58
Shale, dark-brown, friable, fairly soft	18	76
Serpentine bedrock and large resistant boulders	2	78

Perforations: 20 to 75 ft, 6 cuts per ft.
Water level after perforation: 21 ft below land surface.
Yield: Bail tested at 7 gpm.

Test well 8 (6/35-16P1)
[Canada Honda, 7,300 ft NW of Tranquillon Mountain. Land-surface altitude about 400 ft. Drilled June 9-12, 1958]

Material	Thickness (ft)	Depth (ft)
Clay, light-olive-gray, slightly sandy and gravelly; sand fine to very fine; pebbles very sparse, angular, as much as one-half in	16	16
Sand, very clayey, slightly pebbly, light-olive-gray, fine to very fine; sparse granules and pebbles as much as one-half in	29	45
Gravel, olive-gray, angular to subrounded, as much as 1 by 2 in., average about five-eighths in.; very fine to coarse sand	3	48
Sand, clayey and gravelly, olive-gray, very fine to coarse; pebbles angular, as much as five-eighths in	7	55
Sand, silty and clayey, olive-gray, very fine to coarse; sparse very coarse sand and granules	8	63
Sand, very clayey, pebbly, olive-gray to grayish-olive, fine to very fine; sparse pebbles are green metamorphic rock fragments as much as one-half in; similar composition; and increasing hardness downward	7	70
Sand, clayey, very pebbly and tightly cemented (Honda formation of Dibblee, 1950)	6	76

Perforations:

Feet	*Cuts per foot*
20-48	4
48-60	6
60-68	4

Water level after perforation: 18 ft below land surface.
Yield: Bail tested at 10 gpm.

Test well 9 (6/35-21D1).
[Canada Honda, 7,200 ft northwest of Tranquillon Mountain, 1,000 ft southwest of test well 8. Land-surface altitude about 380 ft. Drilled June 12-16, 1958.]

Material	Thickness (ft)	Depth (ft)
Sand, very clayey (or clay, very sandy), light-olive-gray to light-yellowish-brown, fine to very coarse; sparse rounded pebbles as much as three-eighths in	14	14

TABLE 5.—*Well logs*—Continued

Material	Thickness (ft)	Depth (ft)
Test well 9 (6/35-21D1)—Continued		
Sand, dark-yellowish-brown, very clayey and pebbly, very fine to very coarse; pebbles as much as 2 in are mostly rounded metamorphic rock, chert, and sandstone fragments, and make up about 20 percent of sediment	3	17
Sand, yellowish-brown, clayey, very fine to medium; very sparse coarse sand and very small pebbles	13	30
Sand, olive-gray, very clayey, very fine to medium; about 10 percent very small rounded pebbles and granules of quartz, chert, and metamorphic rocks	15	45
Gravel, light-olive-gray, very clayey and sandy; pebbles as much as seven-eighths in; average about three-eighths in, composed of metamorphic rocks, sandstone, siltstone; a few are chert and quartz similar to that in Monterey shale (probably at base of alluvium)	5	50
Sand, pale-olive to grayish-olive, clayey, gravelly, very fine to very coarse; pebbles rounded to angular metamorphic rock fragments, and light-gray quartz and chert resembling that in Monterey shale; pebbles average about one-fifth in; abundant granules; similar composition, increasing hardness, and gradational downward	6	56
Sand, clayey; more pebbly than above unit; pebbles are dark-gray metamorphic rock fragments (95 percent) as in Honda or Espada formations of Dibblee (1950) along sides of valley	3	59

Perforations:

Feet	*Cuts per foot*
14–17	4
30–44	4
44–50	6
50–55	4

Water level after perforation: 17 ft below land surface.
Yield: Bail tested at 5 gpm.

Test well 10(6/35-2D1).

[South of Cagianut Ranch, 1.2 miles south of State Highway 150 in unnamed canyon 1 mile west of La Salle (Rodeo) Canyon. Land-surface altitude about 289 ft. Drilled June 18–July 7, 1958]

Material	Thickness (ft)	Depth (ft)
Sand, dusky-brown to grayish-black, silty, medium to fine; high in organic matter	30	30
Sand, yellowish-brown to light-olive-gray, clayey, very fine to very coarse; contains fragments of semiconsolidated clay or silt	15	45
Similar to above unit; no clay fragments	15	60
Sand, light-olive-gray, clayey, medium; sparse rounded granules and pebbles (⅜ in diameter) of chert and quartzite	15	75
Sand, very clayey, light-olive-gray; contains pebbles of homogenous clayey material; otherwise similar to above unit	10	87

TABLE 5.—*Well logs*—Continued

Material	Thickness (ft)	Depth (ft)
Test well 10 (6/35-2D1).—Continued		
Sand, yellowish-brown to yellowish-gray, clayey, very fine to coarse	40	125
Sand, yellowish-brown, slightly clayey, very fine to coarse; sparse reddish iron oxide stains	10	135
Sand, moderate-yellowish-brown, clayey, fine to very fine; contains sparse pieces of wood (possible contamination from surface during drilling) and iron oxide streaks	8	143
Sand, olive-gray to grayish-olive, silty and clayey, mostly very fine and some medium to fine; sparse flakes of carbonaceous material; locally sparse to abundant shell fragments	332	475

Perforations: 250 to 470 ft, 4 cuts every 2 ft.
Water level after perforation: 215 ft below land surface.
Yield: Bail tested at 20 gpm with 107-ft drawdown; unable to clear of fine sand.

Material	Thickness (ft)	Depth (ft)
Test well 11 (7/35-22N2) [Santa Ynez Valley; about 300 ft northeast of State Highway 150 at mouth of Lompoc Canyon, on east side of road. Land-surface altitude about 24 ft. Drilled July 8-18, 1958]		
Sand, dark yellowish-brown to light olive-gray, clayey and silty, fine to coarse; sparse small angular pebbles as much as 1 in, average about one-fourth in	15	15
Sandy clay; clayey sand; silty, dark-yellowish-brown; very fine to coarse sand; scattered chunks of silty gray clay	11	26
Clay, sandy and slightly pebbly, light-olive-gray to dusky-yellow; pebbles ¼ to ½ in	6	32
Interbedded sand and clay; clay is greenish-gray to pale-olive; sand is greenish-gray to olive-gray, fine to medium; sparse granules and very sparse pebbles as much as three-fourths in	13	45
Sand, silty and slightly clayey, greenish-gray to light-olive-gray, medium to coarse; sparse very coarse sand and granules	11	56
Interbedded clay and sand; clay is greenish-gray, and contains a few plant roots but little or no silt or sand; sand is silty, pale olive, fine to medium, and contains sparse subrounded pebbles ½ to 1 in	4	60
Clay, silty and sandy, greenish-gray; sand is fine to very fine	5	65
Sand, greenish-gray, very silty and clayey, fine to medium; sparse small to large rounded pebbles ¼ to 2½ in	10	75
Clay, greenish-gray, slightly sandy; sparse subrounded pebbles ¼ to 1½ in	21	96
Sand, clayey and pebbly, greenish-gray to yellowish-brown, fine to coarse grained; pebbles about ⅜ in., subrounded to angular	21	117

TABLE 5.—*Well logs*—Continued

Material	Thickness (ft)	Depth (ft)
Test well 11 (7/35-22N2)—Continued		
Gravel, light-olive-gray, sandy and clayey; rounded pebbles average about one-half in., few as much as 1¾ in.; sand very fine to very coarse	8	125
Sand, silty and clayey, slightly pebbly, light-olive-gray to pale-olive, fine to very coarse; pebbles average ⅜ to ⅝ in.	54	179
Clay, pale-olive to grayish-olive, sandy and pebbly; pebbles about one-fourth in.	4	183
Clay, grayish-olive-green; sparse pebbles one-fourth in.; contact with overlying unit gradational	7	190
Clay, grayish-olive-green (Foxen mudstone)	4	194

Perforations: 96 to 181 ft, 6 cuts per ft.
Water level after perforation: 7 ft below land surface.
Yield: Bail tested at 75 gpm; test pumped July 22, 1958, at 380 gpm with about 30-ft drawdown.

Supply well 1 (7/35-33J2)

[Lompoc Canyon, about 1.7 miles south of State Highway 150. Land-surface altitude approx. 177 ft. Drilled Sept. 29–Oct. 8, 1958]

Material	Thickness (ft)	Depth (ft)
Sand, buff, very fine to coarse; thin streaks of gray clay and white to light-buff silt; sparse well-rounded pebble fragments	105	105
Sand, pebbly, light-gray, medium to very coarse; some thin streaks of white to buff silt	127	232
Sand, olive-gray, very fine; streaks of small well-rounded pebbles (¼ in.)	138	370
Sand, pebbly, olive-gray	25	395
Gravel, sandy, fossiliferous, olive-gray; well-rounded pebbles as much as five-eights in.	70	465
Sand and clay, olive-gray; sparse one-fourth in. pebbles	55	520
Sand and clay, olive-gray	10	530

Perforations: Precut Roscoe Moss horizontal louvers, 2½ by ⅛ in cut, 8 cuts around, 2¾ in between rounds, at 170–210 and 375–465 ft; bull-nose plug at bottom. Gravel pack between 28-in hole and 14-in casing; 465 ft completed depth.
Water level after cleaning with surge block: 114 ft below land surface.
Yield: Test pumped Oct. 14–17, 1958, 900 gpm with 148-ft drawdown.

Lagomarsino No. 1 (7/35-33M1)

[Oil-test well on topographic divide between Lompoc and Bear Canyons, about 2.0 miles south of State Highway 150. Land-surface altitude about 491 ft. Drilled and abandoned September 1954 by Intex Oil Co. Logged by Intex Oil Co.]

Material	Thickness (ft)	Depth (ft)
Not logged	60	60
Sand and gravel, buff; fine to coarse sand, and angular and well-rounded pebbles	180	240
Sand, whitish-buff, pebbly; well-rounded pebbles	190	430
Sand, pebbly and silty; rare angular pebbles	30	460
Sand, buff-gray, pebbly, fine to very coarse grained; common well-rounded pebbles	120	580
Sand, dark-gray, fine-grained	455	1,035
Shale, green-brown, firm	765	1,800

TABLE 6.—*Chemical analyses of water from*

[Constituents in

Well	Location	Date sampled	Laboratory [1]	Sampled depth (feet)	Temperature °F	Specific conductance (micromhos at 25° C)
Test 1, 7/35-30G1	South of Surf	4-14-58	QW	260		2,620
2, 7/35-33R1	Lompoc Canyon	4-23-58	11ND, SEL			
Do	do	5-5-58	QW	250	64	1,600
Do	do	6-5-58	QW	391	64	1,450
3, 7/35-28K2	do	5-13-58	QW	30	66	1,210
4, 7/35-32N1	Bear Canyon	7-25-58	11ND, SEL	300		1,600
6, 7/35-33J1	Lompoc Canyon	6-24-58	QW	153	64	890
Do	do	9-3-58	11ND, SEL			980
7, 6/35-15J1	Canada Honda, La Salle-Honda Roads.	6-6-58	QW	30	64	1,920
10, 6/35-2D1	South of Cagianut Ranch	7-7-58	QW	213	65	2,700
11, 7/35-22N2	Mouth of Lompoc Canyon	7-22-58	11ND, SEL			1,720
7/35-20J1	0.7 mile south of Baroda	12-19-58	QW	10		3,480
Do	do	5-15-58	QW	7		10,000
21D1	0.7 mile southeast of Baroda near railroad.	8-22-58	11ND, SEL	6		1,450
21L4	West of Lompoc Canyon	9-27-57	State Calif	±160		2,360
28H1	Lompoc Canyon, near mouth	3-10-58	QW	20		1,160
33J2	Lompoc Canyon supply well	10-11-58	11ND, SEL	465	67	1,360

[1] QW: Quality of Water Branch, U.S. Geological Survey.
11ND, SEL: Sanitary Engineering Laboratory, 11th Naval District Public Works Office.

wells, Point Arguello Naval Missile Facility

parts per million]

Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$		Percent Sodium	pH
													Total	Noncarbonate		
-----	-----	24	22	487	46	586	-----	460	-----	-----	-----	[2] 1,800	150	0	84	7.9
14	9.5	-----	-----	-----	-----	-----	120	200	0.6	-----	-----	1,100	480	225	-----	7.6
-----	-----	168	66	92	7.3	372	-----	215	-----	-----	-----	[2] 1,100	690	385	22	7.4
58	0	123	59	92	7.0	244	246	215	0	0.7	0.1	1,010	548	348	26	8.0
-----	-----	60	21	154	5.4	164	-----	272	-----	-----	-----	[2] 850	235	101	58	7.4
20	-----	-----	-----	-----	-----	-----	140	300	.3	-----	1.5	1,150	470	278	-----	7.7
34	0	47	26	90	5.0	150	55	175	.3	1.7	.1	544	225	102	46	7.6
21	13	-----	-----	-----	-----	-----	45	188	.4	-----	0	770	228	88	-----	7.3
24	0	75	60	246	3.6	487	171	275	1.0	2.3	.8	1,120	434	35	55	8.0
50	0	162	74	320	10	226	490	502	.7	1.3	.3	1,840	707	522	49	7.0
44	.25	-----	-----	-----	-----	-----	106	296	0	-----	-----	1,120	418	206	-----	7.4
-----	-----	-----	9	-----	-----	-----	-----	940	-----	-----	-----	[2] 2,400	438	-----	-----	-----
-----	-----	-----	24	-----	-----	-----	-----	2,820	-----	-----	-----	[2] 7,000	1,220	-----	-----	-----
14	.5	-----	-----	-----	-----	-----	18	300	.1	-----	.09	1,050	322	20	-----	8.3
42	.3	88	98	266	5.6	180	409	470	.3	10	.2	1,650	-----	-----	48	7.3
-----	-----	-----	5	-----	-----	-----	-----	260	-----	-----	-----	[2] 800	240	-----	-----	-----
37	2.6	-----	-----	-----	-----	-----	136	270	.1	-----	.04	950	480	-----	-----	7.5

[2] Estimated by Ground Water Branch as specific conductance times 0.7.

TABLE 7.—*Partial chemical analyses of surface waters, springs, and seeps, Point Arguello Naval Missile Facility*

[Analyses by Quality of Water Branch, U.S. Geological Survey]

Name or description	Location	Locality	Date sampled	Temperature °F	Specific conductance (micromhos at 25° C)	Parts per million: Magnesium (Mg)	Parts per million: Chloride (Cl)	Parts per million: Dissolved solids [1]	Parts per million: Total hardness as $CaCO_3$
Bear Creek.	North fork, altitude 375 ft ±.	6/35-5H	4-24-58	71	493	2	102	340	75
Bear Canyon, spring.	South fork, stock tank inlet.	5Q	...do....	62	582	2	112	400	125
Bear Canyon tributary.	South side of Bear Canyon, south of test well 5.	5F	...do....	57	614	2	126	430	115
Surface seep.	South of Baroda.......	7/35-20B	4-26-58	62	3,060	13	740	2,140	630
Swamp....	4,000 ft south of Baroda.	20K	...do....	61	13,000	70	3,880	9,100	3,520
Spring.....	Spring in Canada Honda.	6/35-16K	...do....	59	896	6	78	630	320
Seep.......	West side of Lompoc Canyon, north of test well 3.	7/35-28G	4-28-58	63	749	3	178	520	130
Do.......	Fault zone southeast of test well 2 in fire break.	6/35-3G	4-29-58	58	211	1	69	150	29
Do.......	Gully above swamp, southeast of Baroda.	7/35-20Q	5-2-58	68	735	2	175	510	115
Bear Creek.	600 ft southeast of main road crossing.	31H	...do....	59	2,050	12	365	1,440	610
Spring Canyon.	Stock tank in Spring Canyon.	6/35-6Q	...do....	58	337	1	46	240	25
Honda Creek.	....	15J	3-10-58	......	1,820	13	188	1,270	650

[1] Dissolved solids approximate: estimated by multiplying specific conductance times 0.7.

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