Trayler, C.R., and Koczot, K.M., 1995, Regional Water Table (1994) and Water-Level Changes in the Morongo Basin, San Bernardino County, California

INTRODUCTION

The Morongo Basin is in the Mojave Desert region of southern California, about 100 mi east of Los Angeles. Ground water is virtually the sole source of water in the Morongo Basin. Increased pumping to meet the needs of an increasing resident population has resulted in ground-water overdraft in parts of the ground-water basin. Most of the water resources of the basin are managed by the Mojave Water Agency (MWA) and the U.S. Marine Corps Air/Ground Combat Center at Twentynine Palms (USMCAGCC). To help manage the ground-water resources, the MWA and the U.S. Marine Corps, Department of the Navy, requested the U.S. Geological Survey (USGS) to construct a regional water-table map of the Morongo ground-water basin.

The purposes of this study were to construct a regional water-table map and determine areas of water-level change in the Morongo Basin. Existing data were evaluated and water levels were measured in selected wells throughout the Morongo Basin. Water-level measurements were used to construct a regional water-table map for 1994 conditions (fig. 1), and available historical water levels were used to construct hydrographs (shown in fig. 1) and determine water-level change at selected wells.

Results of this study will aid the USGS in evaluating its current ground-water monitoring network in the Morongo Basin. In addition, information gained through this study will contribute to ongoing projects in the area, such as the Regional Aquifer-System Analysis (RASA) of Southern California.

Acknowledgments

Several local water agencies contributed water-level data used in this report. Those agencies include the Bighorn-Desert View Water Agency in Landers, the Hi-Desert Water District in Yucca Valley, the Joshua Basin Water District in Joshua Tree, and the Twentynine Palms Water District in Twentynine Palms. In addition, the results of studies at the USMCAGCC by Jacobs Engineering were very helpful to this study.

Description of Study Area

As defined for this study, the 1,000-square-mile Morongo ground-water basin consists of several alluvium-filled valleys and basins that are surrounded by the San Bernardino Mountains on the west, the Ord and Granite Mountains on the north, the Bullion Mountains on the east, and the Pinto and Little San Bernardino Mountains on the south. (Generally, the lightest and darkest gray areas of the shaded-relief map represent higher topography.) Previous investigators divided the Morongo Basin area into 17 or more separate ground-water basins or subbasins, including the Lucerne, Fry, Johnson, Upper Johnson, Means, Pipes, Reche, Warren, Copper Mountain, Joshua Tree, Giant Rock, Emerson, Surprise Spring, Mesquite, Deadman, Twentynine Palms, and Mainside Basins (fig. 2). The ground-water-basin boundaries shown in figure 2 are defined by faults, low-permeability rocks, and other ground-water barriers that generally restrict ground-water movement in the study area.

The climate of the Morongo Basin is typical of the Mojave Desert. The area receives little precipitation, and recharge to ground water is minimal. Average annual precipitation on the basin floor ranges from 4 to 6 in. (Rantz, 1969). Recently, MWA has begun an artificial-recharge project in Yucca Valley (Warren Basin) and is planning an artificial-recharge project near Lucerne Valley (Lucerne Basin). Local water districts, municipalities, the USMCAGCC, and private well owners rely on the local ground water for municipal, domestic, and agricultural needs.

The basin is largely undeveloped desert except for the towns of Lucerne Valley, Yucca Valley, Joshua Tree, Landers, and Twentynine Palms, and the main facility (Mainside) at the USMCAGCC. Agricultural development in the basin, with the exception of Lucerne Valley, is minimal.

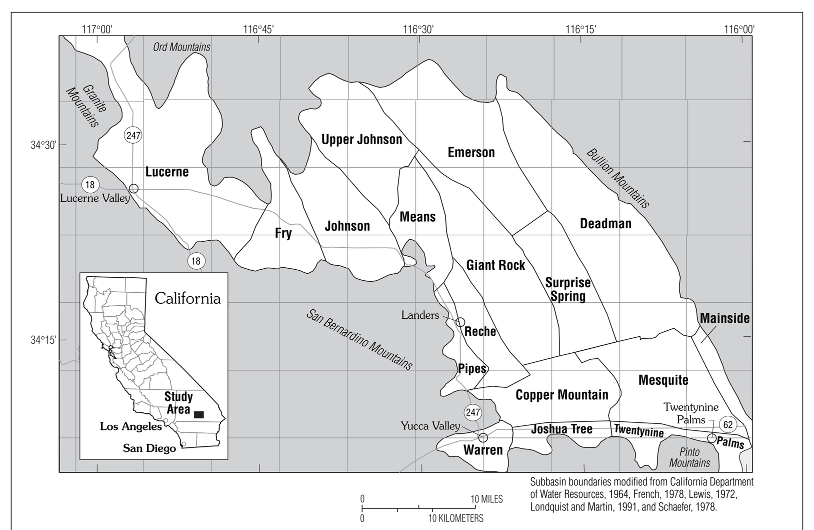


Figure 2. Location of study area and subbasins of Morongo Basin.

Geohydrology

Non-water-bearing igneous and metamorphic rocks underlie the ground-water basin and form the mountains and hills that surround the basin. These rocks contain virtually no water except where they are jointed or fractured.

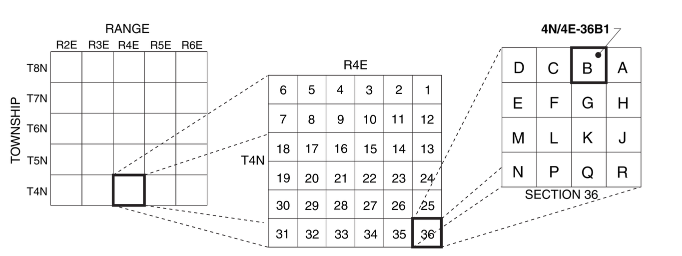
Alluvial deposits of Quaternary and Tertiary age fill the Morongo ground-water basin to a maximum depth of 10,000 ft near the eastern edge of the basin north of Deadman Lake (Moyle, 1984). In general, the deposits are unconsolidated at land surface and become partly consolidated with depth. The unconsolidated deposits, where saturated, are the only deposits from which significant quantities of ground water can be obtained.

The Morongo Basin is crossed by several northwest-trending faults that show evidence of both lateral and vertical movement (Bortugno, 1986). Large differences in water level across some of these faults suggest that they impede ground-water movement (F.S. Riley and G.F. Worts, Jr., USGS, written commun., 1953; Lewis, 1972; Schaefer, 1978; Londquist and Martin, 1991). The barrier effect of the faults is believed to be caused by compaction and deformation of the water-bearing deposits immediately adjacent to the faults and by cementation of the fault zone by mineral deposition (F.S. Riley and G.F. Worts, Jr., USGS, written commun., 1953; Schaefer, 1978; and Londquist and Martin, 1991). The Pinto Mountain Fault, its splays, and the mountain-front faults of the San Bernardino Mountains near Lucerne Basin are the only east-west-trending faults that have been identified in the study area. The Pinto Mountain Fault system also seems to be a barrier to ground-water movement. According to Bortugno (1986), most of the faults have been tectonically active within the Quaternary period.

Barriers to ground-water flow are also formed by the generally non-water-bearing consolidated rocks that compose the mountain ranges and the antiformal bedrock structure (transverse arch) located in the southern part of the Surprise Spring Basin.

Well-Numbering System

Wells are identified and numbered according to their location in the rectangular system for the subdivision of public lands. Identification consists of the township number, north or south; the range number, east or west; and the section number. Each section is divided into sixteen 40-acre tracts lettered consecutively (except I and 0), beginning with A in the northeast corner of the section and progressing in a sinusoidal manner to R in the southeast corner. Within the 40-acre tract, wells are sequentially numbered in the order they are inventoried. The final letter refers to the base line and meridian. In California, there are three base lines and meridians; Humboldt (H), Mount Diablo (M), and San Bernardino (S). All wells in the study area are referenced to the San Bernardino base line and meridian (S). Well numbers consist of 15 characters and follow the format 004N004E36B001S. In this report, well numbers are abbreviated and written 4N/4E-36B1. Wells in the same township and range are referred to by only their section designation, 36B1. The following diagram shows how the number for well 4N/4E-36B1 is derived.



Well-numbering diagram

Conversion Factors

Multiply	By	To obtain
foot (ft)	0.3048	meter
foot per year (ft/yr)	0.3048	meter per year
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

GROUND-WATER LEVELS AND MOVEMENT

Water-level Measurements

Water-level data for this study (table 1) were collected from 248 wells during the period January-October 1994 to define the water-table surface and the direction of ground-water movement. The water table is the surface in an unconfined aquifer at which the pressure is atmospheric, and it is defined by the levels at which water stands in wells that penetrate the water body (the zone of saturation) just far enough to hold water (Lohman and others, 1972). Additional water-level data (from 11 wells) collected prior to 1994 also were used to construct map contours where current data could not be obtained or in areas of sparse data and little water-level fluctuation. For 87 wells where static water-level measurements were difficult to obtain, water levels reported by other agencies were used. The remaining water levels were measured by USGS personnel using steel or calibrated electric tapes. Water-table altitude was calculated by subtracting the water-level measurement from the land-surface altitude (determined by leveling survey or from topographic maps). Ground-water flow is from high to low water-level altitude and is perpendicular to lines of equal water-table altitude on the map (fig. 1). Arrows shown on the map indicate the approximate direction of movement.

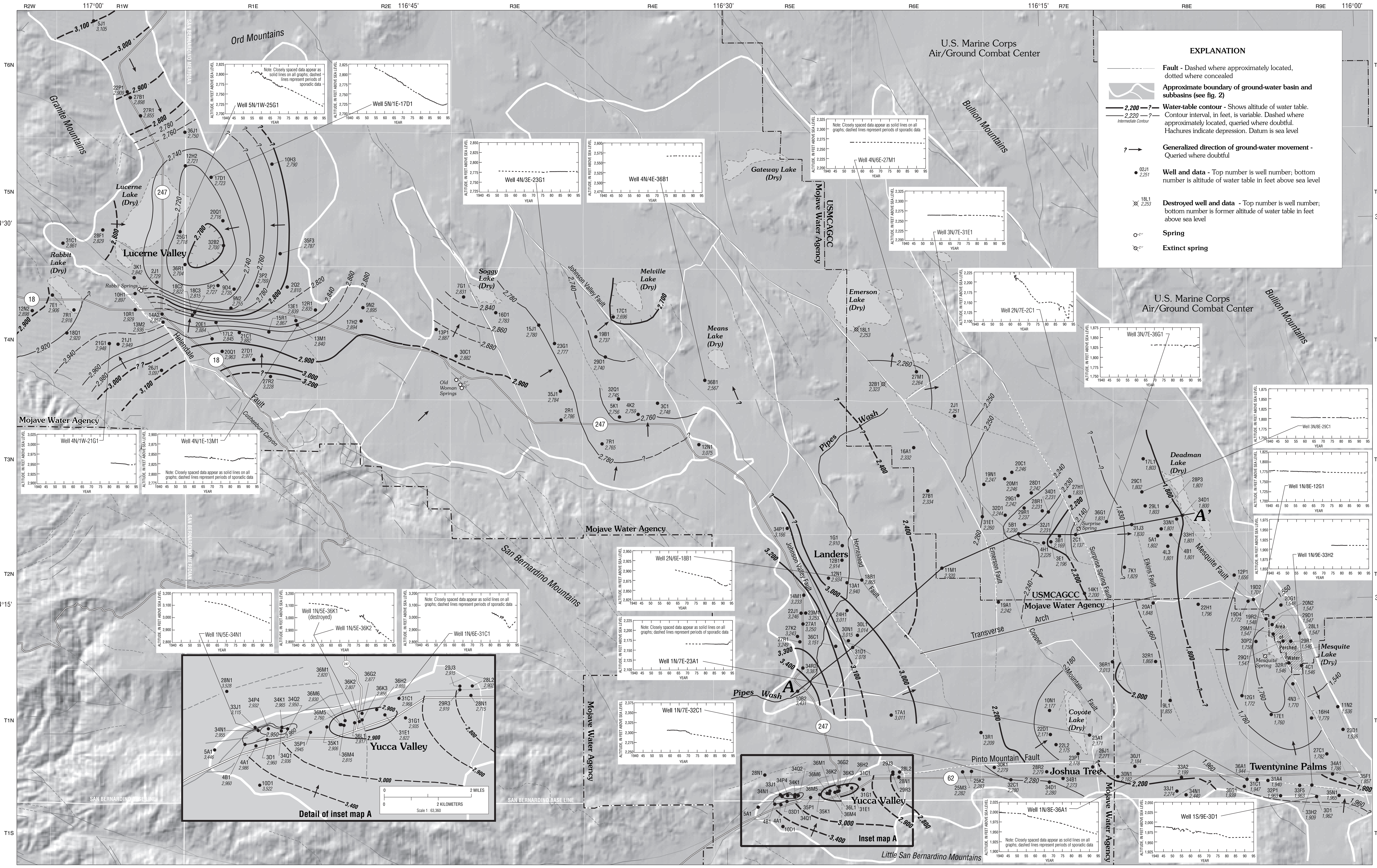


Figure 1. Altitude of the water table in 1994 and water-level changes at selected wells.

GROUND-WATER LEVELS AND MOVEMENT--Continued

Ground-Water Movement

In general, the water-table map indicates that ground water flows eastward and northward from the San Bernardino Mountains. From Pipes Wash, flow is eastward toward the localized sinks in the water table at Deadman and Mesquite dry lakes. Ground water pumping by the USMCAGCC in the Surprise Spring Basin has created a ground-water depression and has locally changed the direction of ground-water movement. From Cushenbury Canyon and other washes along the northern front of the San Bernardino Mountains, flow is northeastward to the pumping depression in the Lucerne Basin, and to the Soggy, Melville, and Means dry lakes. As ground water moves eastward through the Morongo Basin, subsurface flow across faults is impeded, resulting in a steplike decrease in water levels (fig. 3). For example, there is a water-level difference of more than 300 ft across the Surprise Spring Fault, near extinct Surprise Spring. Between the faults, the hydraulic gradient is approximately constant and generally very low. The past and present occurrence of springs at fault boundaries (Rabbit Springs, Old Woman Springs, Surprise Spring, and Mesquite Spring) indicates diversion of flow to the surface across faults at these locations, and emphasizes the importance of faults in controlling ground-water movement. Ground water leaves the basin across the Mesquite Fault in the southeastern part of the basin, and ultimately moves eastward toward Dale Dry Lake (not shown) (F.S. Riley and G.F. Worts, Jr., written commun., 1953).

Other patterns indicated by the contour lines and supported by previous findings are (1) northward flow from the Little San Bernardino Mountains to the Pinto Mountain Fault (Lewis, 1972), (2) minor flow southward from the San Bernardino Mountains into Warren Basin (Lewis, 1972), and (3) southward flow into Lucerne Basin from the Ord Mountains (Schaefer, 1979). Rates of ground-water movement in areas of the basin unaffected by pumping are low--generally a few feet per year (French, 1978).

Ground-water depressions are present in the areas of highest historical and current pumpage: Warren, Lucerne, and Surprise Spring Basins. Construction of water-table contours in Warren Basin was difficult because water levels vary considerably. To show small-scale variations, the Warren Basin area (inset map A) is enlarged to 1:63,360 scale. The variability might be due to (1) the presence of faults that separate the area into small isolated compartments, and (or) (2) incomplete recovery of the water table in the public-supply wells at the time of measurement--even though pumping had ceased 24 hours prior to measurement.

Perched water occurs in the Mainside Basin (under Mesquite Dry Lake) approximately 130 ft above the regional water table. Movement of this water seems to be southeastward, similar to that of the regional ground water below. The probable source of this perched water is spreading ponds that are used for sewage-water treatment.

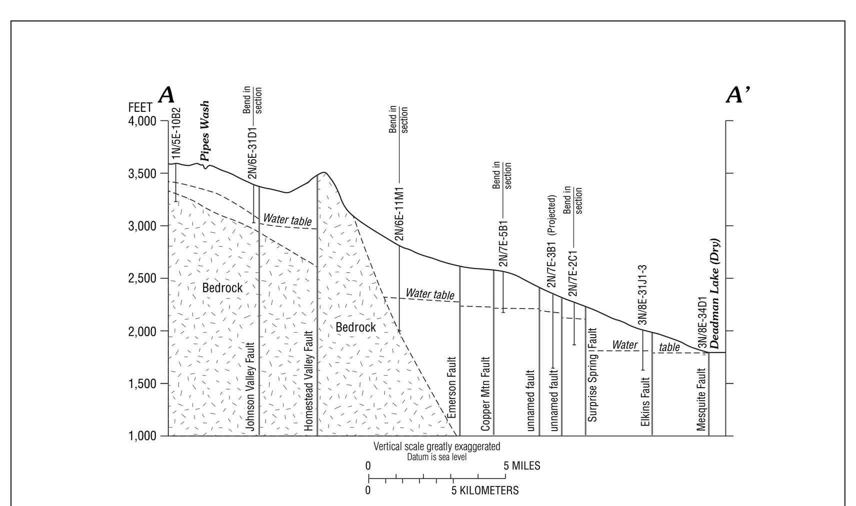


Figure 3. Hydrogeologic section A-A' showing steplike decrease in water levels across faults.

HISTORICAL WATER-LEVEL CHANGES

Available data for wells in the Morongo Basin were evaluated to determine water-level changes in different parts of the basin. Twenty-one long-term hydrographs for selected wells are shown on the large map. Water levels have remained relatively constant in the Deadman, Emerson, Mesquite, Mainside, Copper Mountain, Johnson, Upper Johnson, and Fry Basins, where the resident population is small and pumpage is minimal or nonexistent. Available data were insufficient to determine fluctuations of the water table in the Pipes, Emerson, or Giant Rock Basins. Water-table declines have occurred in parts of the Reche, Joshua Tree, Twenty-nine Palms, Surprise Spring, and Warren Basins. In the Reche Basin, the water level has declined about 36 ft since 1963 at well 2N/6E-18B1, probably the result of pumpage to supply the town of Landers; in the Joshua Tree and Twentynine Palms Basins, pumpage to supply the towns of Joshua Tree and Twentynine Palms has caused declines of about 25 ft since 1963 at well 1N/7E-32C1, and about 54 ft since 1940 at well 1N/8E-36A1; in the Surprise Spring Basin, the water level has declined 110 ft since 1960 at well 2N/7E-2C1 as a result of pumpage for the USMCAGCC; and in the Lucerne Basin, the water level has declined as much as 94 ft since 1954 at well 5N/1E-17D1, near the town of Lucerne Valley.

The largest observed water-level decline in the study area is in the Warren Basin, at Yucca Valley, where the combined decline since 1947 is 309 ft at well 1N/5E-36K1 (destroyed) and nearby well 1N/5E-36K2. The data for these two wells were combined to give a better indication of total decline in this area. In the western part of Warren Basin, the decline at well 1N/5E-34N1 is about 178 ft since 1958. These large declines probably result from increased pumpage to supply the growing population of Yucca Valley. The magnitude of those declines indicates small storage in compartments of the aquifer that are bounded by faults in combination with minimal natural recharge.

References Cited

Bortugno, E.J., 1986, Map showing recency of faulting, San Bernardino Quadrangle, California: California Division of Mines and Geology Regional Geologic Map Series, San Bernardino Quadrangle-map no. 3A, scale 1:250,000.

California Department of Water Resources, 1964, Names and areal code numbers of hydrologic areas in the Southern District: California Department of Water Resources Office Report, 57 p.

French, J.J., 1978, Ground-water storage in the Johnson Valley area, San Bernardino County, California: U.S. Geological Survey Water-Resources Investigations Report 77-130, 35 p.

Lewis, R.E., 1972, Ground-water resources of the Yucca Valley-Joshua Tree area, San Bernardino County, California: U.S. Geological Survey Open-File Report, 51 p.

References Cited--Continued

Lohman, S.W., and others, 1972, Definitions of selected ground-water terms--Revisions and conceptual refinements: U.S. Geological Survey Water-Supply Paper 1988, 21 p.

Londquist, C.J., and Martin, Peter, 1991, Geohydrology and ground-water-flow-simulation of the Surprise Spring Basin aquifer system, San Bernardino County, California: U.S. Geological Survey Water-Resources Investigations Report 89-4099, 41 p.

Moyle, W.R., Jr., 1984, Bouguer gravity anomaly map of the Twentynine Palms Marine Corps Base and vicinity, California: U.S. Geological Survey Water-Resources Investigations Report 84-4005, scale 1:62,500, 1 sheet.

Rantz, S.E., 1969 (1972), Mean annual precipitation in the California region: U.S. Geological Survey Open-File Report, 5 p., (includes two sheets, scale 1: 1,000,000).

Schaefer, D.H., 1978, Ground-water resources of the Marine Corps Base, Twentynine Palms, San Bernardino County, California: U.S. Geological Survey Water-Resources Investigations Report 77-37, 29 p.

---------1979, Ground-water conditions and potential for artificial recharge in Lucerne Valley, San Bernardino County, California: U.S. Geological Survey Water-Resources Investigations Report 78-118, 37 p.

Vertical Datum

Sea level: In this report, sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Table 1. Summary of well data, Morongo Basin

[State well No.: See "Well-Numbering System" section; some numbers subject to change upon verification. USGS identification No. consists of latitude, longitude, and sequence number. Altitude of land surface and altitude of water level in feet (rounded) above sea level. Casing depth, perforations, and obstruction in feet below land surface. Measurement method: **S**, steel tape; **R**, reported by other agencies; **V**, calibrated electric tape. Well notes: **M**, USGS multiple-depth piezometer; **O**, obstruction at specified depth; **P**, public-supply well; **PW**, perched water; **Z**, destroyed well; *, data not plotted on map because of overcrowding of similar information]

State well No.	USGS identification No.	Date of measurement	Altitude of land surface	Water level		Measurement method	Casing depth	Perforations		Well notes
				Depth	Altitude			Top	Bottom	
1N/5E-10B2	341139116263801	07-27-94	3,590	158.77	3,431	S	355	310	350	O at 192
1N/5E-28N1	340815116281301	05-06-94	3,635	107.45	3,528	S	155	--	--	
1N/5E-33J1	340729116272901	05-06-94	3,371	255.97	3,115	S	310	245	310	O at 280
1N/5E-34K1	340729116264701	01-05-94	3,380	415.20	2,965	R	640	340	640	P
1N/5E-34N1	340725116272401	01-04-94	3,340	385	2,955	R	548	200	545	P
1N/5E-34P4	340727116270801	01-06-94	3,360	428.5	2,932	R	1,020	398	1,010	P
1N/5E-34Q1	340724116264801	01-04-94	3,360	423.7	2,936	R	757	370	571	P
1N/5E-34Q2	340727116263801	01-05-94	3,360	409.6	2,950	R	990	360	900	P
1N/5E-35K1	340729116253701	01-06-94	3,260	354	2,906	R	860	300	850	P
1N/5E-35P1	340722116260301	01-05-94	3,280	335.2	2,945	R	504	194	494	P
1N/5E-36G1	340746116244201	01-05-94	3,225	346.51	2,878	V	570	550	570	*/M
1N/5E-36G2	340746116244202	01-05-94	3,225	348.04	2,877	S	400	380	400	M
1N/5E-36H2	340751116241901	01-05-94	3,210	322.3	2,888	R	1,000	400	1,000	P
1N/5E-36K2	340736116244601	01-05-94	3,230	423.20	2,807	R	--	--	--	P
1N/5E-36K3	340738116244301	01-04-94	3,230	374	2,856	R	1,115	550	1,115	P
1N/5E-36L1	340734116245401	01-04-94	3,230	413.1	2,817	R	735	275	725	P
1N/5E-36M1	340737116250801	01-02-94	3,250	429.90	2,820	V	570	550	570	M
1N/5E-36M4	340731116251001	01-04-94	3,245	430.4	2,815	R	800	400	800	P
1N/5E-36M5	340732116251701	01-04-94	3,245	485.1	2,760	R	1,450	920	1,450	P
1N/5E-36M6	340732116251601	01-04-94	3,245	414.7	2,830	R	800	450	800	P
1N/6E-13R1	340953116175801	05-03-94	2,650	440.52	2,209	V	715	455	710	
1N/6E-17A1	341036116221301	06-09-94	3,309	297.57	3,011	R	--	--	--	P
1N/6E-25K2	340822116182601	03-30-94	2,705	422.00	2,283	R	740	--	--	P
1N/6E-25M2	340817116185801	03-30-94	2,723	444.62	2,278	R	500	452	--	*/P
1N/6E-25M3	340821116185801	03-30-94	2,720	438.00	2,282	R	704	452	--	P
1N/6E-28L2	340821116215001	05-05-94	3,065	163.36	2,902	S	300	--	--	
1N/6E-28N1	340809116215201	05-05-94	3,107	392.31	2,715	S	500	--	--	
1N/6E-29J3	340821116220901	07-29-94	3,095	180	2,915	R	803	350	773	
1N/6E-29R3	340816116220901	07-29-94	3,105	186	2,919	R	680	360	660	
1N/6E-31C1	340750116234401	01-05-94	3,199	230.9	2,968	R	--	--	--	P
1N/6E-31E1	340744116240601	07-29-94	3,200	378	2,822	R	--	--	--	
1N/6E-31G1	340740116233401	07-29-94	3,250	315	2,935	R	--	--	--	
1N/7E-10N1	341044116144301	02-02-94	2,385	208.24	2,177	V	267	--	--	
1N/7E-22D1	340947116144101	02-28-94	2,405	233.94	2,171	V	506	464	506	
1N/7E-22L2	340923116142501	02-02-94	2,408	232.82	2,175	V	393	241	387	
1N/7E-23A1	340945116125001	05-02-94	2,376	205.15	2,171	S	370	360	370	
1N/7E-23P1	340901116132301	02-03-94	2,382	203.93	2,178	V	429	--	--	
1N/7E-26J1	340830116124201	03-30-94	2,510	239.41	2,271	R	401	277	401	P
1N/7E-28Q1	340819116145001	02-02-94	2,483	204.06	2,279	V	412	--	--	*
1N/7E-28R2	340819116145201	02-02-94	2,464	184.67	2,279	V	262	--	--	
1N/7E-30K1	340831116172201	03-30-94	2,625	346.21	2,279	R	740	--	--	P
1N/7E-32C1	340801116163401	05-03-94	2,610	329.56	2,280	V	--	--	--	
1N/7E-34B1	340803116140601	02-28-94	2,489	216.15	2,273	V	590	527	590	
1N/7E-34D1	340754116144501	02-02-94	2,543	262.59	2,280	V	396	261	391	
1N/8E-09L1	341106116090001	03-01-94	2,180	324.61	1,855	R	386	342	386	
1N/8E-12G1	341114116053301	03-02-94	1,973	200.78	1,772	V	--	--	--	
1N/8E-30J1	340831116104201	01-04-94	2,353	168.83	2,184	R	600	80	390	
1N/8E-30J2	340831116104301	09-28-93	2,353	164.50	2,188	R	400	145	312	*/P
1N/8E-30N1	340807116113101	02-17-94	2,490	307.67	2,182	R	400	200	400	P
1N/8E-33A2	340804116083001	02-01-94	2,510	311.33	2,199	R	350	195	345	P
1N/8E-33A3	340803116082901	02-22-94	2,510	312.84	2,197	R	408	258	403	*/P
1N/8E-33A4	340805116082901	02-27-94	2,510	307.58	2,202	R	530	318	510	*/P
1N/8E-33A5	340804116082901	02-22-94	2,510	309.75	2,200	R	410	310	410	*/P
1N/8E-33J1	340731116084301	03-04-94	2,700	425.96	2,274	V	553	310	330	
1N/8E-34M1	340731116082601	03-04-94	2,700	311.26	2,389	V	410	391	--	*
1N/8E-34N1	340722116081701	03-04-94	2,690	249.97	2,440	V	350	250	350	
1N/8E-36A1	340801116052401	01-18-94	2,130	185.66	1,944	R	292	--	--	P
1N/8E-36G1	340742116053201	01-04-94	2,158	218.58	1,939	R	430	220	420	P
1N/8E-36H2	340741116053201	08-31-93	2,160	217.08	1,943	R	337	52	337	*/P
1N/9E-04C1	341226116024601	10-11-93	1,769	223.21	1,546	R	244	218	243	
1N/9E-04N3	341141116030901	03-03-94	1,787	16.90	1,770	V	500	390	495	
1N/9E-11N2	341047116010501	05-27-94	1,790	253.58	1,536	S	--	--	--	
1N/9E-16H4	341020116021901	03-03-94	1,795	15.76	1,779	V	55	--	--	
1N/9E-17E1	341031116041401	03-02-94	1,870	109.88	1,760	V	--	--	--	
1N/9E-23D1	340953116005001	05-27-94	1,800	263.63	1,536	S	--	--	--	
1N/9E-27C1	340855116013601	03-03-94	1,867	84.63	1,782	V	--	--	--	
1N/9E-31A4	340755116042501	01-18-94	2,085	144.67	1,940	R	398	160	398	P
1N/9E-31C1	340757116045601	01-18-94	2,105	158.50	1,947	R	--	--	--	P
1N/9E-32P1	340719116034901	01-20-94	2,140	177.42	1,963	R	320	220	320	P
1N/9E-33F5	340743116025502	03-03-94	1,981	17.60	1,963	V	22	20	22	
1N/9E-33H2	340741116022002	03-03-94	1,961	51.69	1,909	V	57	55	57	
1N/9E-33J3	340739116021701	03-03-94	1,972	17.83	1,954	V	35	33	35	*
1N/9E-33K5	340739116023004	03-03-94	1,973	23.33	1,950	V	28	26	28	*
1N/9E-34A1	340808116012101	03-03-94	1,938	151.93	1,786	V	--	--	--	
1N/9E-35F1	340756116004601	03-03-94	1,972	115.40	1,857	V	--	--	--	
1N/9E-35N1	340718116010301	03-04-94	2,081	115.62	1,965	V	260	147	247	
1S/5E-03D1	340717116271001	01-06-94	3,340	380.52	2,960	R	940	400	940	P
1S/5E-04A1	340706116273001	04-26-94	3,331	345.10	2,986	R	535	200	525	
1S/5E-04B1	340706116274401	04-26-94	3,339	379.22	2,960	R	--	--	--	
1S/5E-05A1	340700116283201	05-04-94	3,554	107.94	3,446	S	390	145	340	
1S/5E-10D1	340614116272201	05-06-94	3,570	47.65	3,522	S	130	--	--	
1S/9E-03D1	340714116020701	03-04-94	2,075	113.32	1,962	S	275	--	--	
2N/5E-01G1	341716116242901	05-25-94	3,010	100.42	2,910	S	--	--	--	
2N/5E-12B1	341643116243101	06-09-94	3,059	145.17	2,914	R	--	--	--	P
2N/5E-12B2	341642116243001	06-09-94	3,055	138.92	2,916	R	--	--	--	*/P
2N/5E-12N1	341600116250801	05-25-94	3,217	283.33	2,934	V	358	337	358	
2N/5E-13A1	341549116241601	05-26-94	3,079	138.90	2,940	V	190	135	190	O at 155
2N/5E-14M1	341520116261901	05-26-94	3,423	190.03	3,233	R	305	170	300	
2N/5E-22J1	341438116262801	06-09-94	3,503	257	3,246	R	785	250	775	P
2N/5E-23M1	341438116261401	05-26-94	3,465	211.66	3,253	V	225	180	225	
2N/5E-24H1	341444116241701	06-09-94	3,282	270.99	3,011	R	604	220	580	P
2N/5E-27A1	341412116262201	05-05-94	3,470	219.76	3,250	S	485	443	485	O at 445
2N/5E-27K2	341343116263801	06-09-94	3,465	221.83	3,243	R	322	184	319	P
2N/5E-27K3	341343116263601	06-09-94	3,468	226.50	3,242	R	358	--	--	*/P
2N/5E-27R1	341331116263201	06-09-94	3,470	221.08	3,249	R	475	260	470	P
2N/5E-34R2	341228116262301	05-26-94	3,550	163.29	3,387	S	--	--	--	
2N/5E-36C1	341319116244901	06-09-94	3,433	282.33	3,151	R	--	--	--	
2N/6E-11M1	341622116194601	03-23-94	2,803	482.85	2,320	V	790	750	--	
2N/6E-18B1	341556116233401	05-26-94	3,087	221.90	2,865	V	310	187	305	P
2N/6E-30L1	341345116234701	05-05-94	3,330	316.41	3,014	S	377	123	375	O at 350
2N/6E-30N1	341332116241301	06-09-94	3,366	351.08	3,015	R	920	300	920	
2N/6E-31D1	341316116240101	05-05-94	3,395	316.69	3,078	S	358	337	358	
2N/7E-02C1	341741116132501	03-23-94	2,272	135.22	2,137	V	398	149	377	O at 325
2N/7E-02D1	341732116132701	03-23-94	2,290	150.79	2,139	S	532	250	532	*/P
2N/7E-03A1	341740116134201	03-23-94	2,301	160.54	2,140	S	560	210	550	*/P
2N/7E-03B1	341736116141201	03-23-94	2,355	186.02	2,169	S	700	260	690	P
2N/7E-03E1	341723116143601	03-23-94	2,385	188.83	2,196	S	510	250	510	P
2N/7E-04H1	341720116145601	03-23-94	2,442	216.02	2,226	V	481	300	420	
2N/7E-05B1	341742116160701	08-23-94	2,587	356.16	2,230	V	405	385	405	
2N/7E-14K1	341520116130101	03-22-94	2,538	337.82	2,200	V	644	450	558	O at 500
2N/7E-19A1	341501116170601	05-03-94	2,748	505.95	2,242	V	650	500	645	
2N/7E-36R1	341238116114301	03-01-94	2,305	291.85	2,013	V	462	305	462	
2N/8E-04B1	341737116085501	03-01-94	2,005	204.41	1,801	R	227	202	227	
2N/8E-04B2	341736116085401	12-29-93	2,008	208.16	1,800	R	226	202	226	*
2N/8E-04B3	341736116085901	03-05-94	2,010	209.28	1,801	R	230	204	229	*
2N/8E-04D1	341739116092801	03-04-94	2,027	226.14	1,801	R	246	222	246	*
2N/8E-04D2	341738116092601	03-06-94	2,025	224.01	1,801	R	246	221	246	*
2N/8E-04D3	341735116092601	12-22-93	2,030	229.10	1,801	R	248	223	248	*
2N/8E-04D4	341737116092801	03-05-94	2,028	227.39	1,801	R	248	222	248	*
2N/8E-04F1	341725116090401	07-20-94	2,022	221.07	1,801	R	240	215	240	*
2N/8E-04L1	341709116090401	01-26-94	2,042	240.66	1,801	V	591	571	591	*/M
2N/8E-04L2	341709116090402	01-26-94	2,042	240.65	1,801	V	380	360	380	*/M
2N/8E-04L3	341709116090403	01-26-94	2,042	240.61	1,801	V	285	245	285	M
2N/8E-05A1	341735116093101	03-02-94	2,039	237.65	1,802	R	259	234	259	
2N/8E-05A2	341738116093401	03-02-94	2,036	235.42	1,801	R	254	228	253	*
2N/8E-07K1	341621116110601	03-22-94	2,270	441.34	1,829	V	525	125	505	
2N/8E-12P1	341600116055501	02-22-94	1,848	192.3	1,656	R	212	186	211	
2N/8E-20A1	341454116094601	03-01-94	2,270	422.04	1,848	R	559	509	554	
2N/8E-22H1	341451116073901	03-01-94	2,125	328.82	1,796	R	390	340	390	
2N/8E-32R1	341238116094101	05-30-92	2,210	342.00	1,868	R	489	--	--	
2N/9E-19D2	341502116050101	03-22-94	1,840	139.45	1,701	V	--	--	--	
2N/9E-19D4	341458116051601	03-22-94	1,860	88.21	1,772	V	519	259	519	
2N/9E-19R1	341416116042501	01-26-94	1,768	220.77	1,548	V	460	440	460	*/M
2N/9E-19R2	341416116042502	01-26-94	1,768	220.36	1,548	V	310	290	310	M
2N/9E-20G1	341449116034201	01-26-94	1,921	373.00	1,548	V	440	400	440	
2N/9E-20N1	341419116040401	01-26-94	1,771	223.44	1,548	V	450	430	450	*/M
2N/9E-20N2	341419116040402	01-26-94	1,771	224.34	1,547	V	270	250	270	M
2N/9E-28L1	341341116024901	01-26-94	1,891	343.96	1,547	V	397	367	387	
2N/9E-29D1	341402116040801	02-09-94	1,767	219.92	1,547	R	238	213	238	
2N/9E-29M1	341340116040501	01-26-94	1,760	213.26	1,547	V	410	390	410	M
2N/9E-29M2	341340116040502	01-25-94	1,760	185.62	1,575	V	250	220	250	*/PW/M
2N/9E-29M3	341340116040503	01-26-94	1,760	75.13	1,685	V	90	70	90	*/PW/M
2N/9E-29Q1	341323116033801	02-09-94	1,765	218.12	1,547	R	238	213	238	
2N/9E-29R1	341323116031601	02-23-94	1,767	220.67	1,546	R	256	236	256	
2N/9E-29R2	341322116031501	02-05-94	1,769	221.91	1,546	R	254	234	254	*
2N/9E-29R3	341323116031501	01-10-94	1,769	222.32	1,546	R	254	218	254	*
2N/9E-30P2	341323116045501	03-02-94	1,790	31.99	1,758	V	--	--	--	
2N/9E-31C2	341321116050001	03-02-94	1,795	33.00	1,762	V	--	--	--	*
2N/9E-32J1	341247116032601	03-22-94	1,758	72.90	1,685	R	86	65	85	*/PW
2N/9E-32J2	341245116032501	03-23-94	1,758	73.20	1,685	R	86	66	86	*/PW
2N/9E-32J4	341246116032301	03-23-94	1,758	72.77	1,685	R	89	64	89	*/PW
2N/9E-32J5	341244116032601	01-19-94	1,758	72.82	1,685	R	90	64	89	*/PW
2N/9E-32J6	341245116032301	03-24-94	1,758	72.92	1,546	R	80	60	80	*/PW
2N/9E-32R1	341232116032201	02-27-94	1,759	212.58	1,546	V	470	450	470	PW/M
2N/9E-32R2	341232116032202	02-27-94	1,759	189.11	1,570	V	255	235	255	*/PW/M
2N/9E-32R3	341232116032203	02-27-94	1,759	65.27	1,694	V	80	60	80	*/PW/M
3N/3E-02R1	342216116374801	06-29-94	2,990	203.65	2,786	V	--	240	242	O at 240
3N/4E-03C1	342304116334401	05-24-94	2,840	92.10	2,748	S	137	107	137	
3N/4E-04K2	342229116341001	05-16-94	2,915	155.78	2,759	S	510	360	510	
3N/4E-05K1	342224116350101	05-25-94	2,930	173.90	2,756	V	211	166	206	O at 186
3N/4E-07R1	342120116355101	05-25-94	3,120	355	2,765	R	406	366	406	
3N/4E-12N1	342117116311501	05-25-94	3,255	180.15	3,075	S	203	--	--	
3N/5E-34P1	341758116270501	05-25-94	3,309	143.47	3,166	S	--	--	--	
3N/6E-02J1	342221116190801	03-29-94	2,413	161.63	2,251	S	--	--	--	
3N/6E-16A1	342107116210401	03-28-94	2,507	174.56	2,332	S	295	275	295	
3N/6E-27B1	341925116202501	03-28-94	2,643	309.20	2,334	S	415	395	415	
3N/7E-19N1	341939116174501	03-29-94	2,488	241.74	2,247	S	295	275	295	
3N/7E-20C1	342111116174801	03-29-94	2,445	198.55	2,246	S	605	228	605	O at 212
3N/7E-20M1	341952116164601	03-29-94	2,458	211.54	2,246	S	295	275	295	
3N/7E-27H1	341909116134101	03-29-94	2,240	407.05	1,833	V	587	472	572	
3N/7E-28D1	341918116153001	03-24-94	2,473	230.57	2,242	V	618	418	598	
3N/7E-28D2	341923116153201	05-24-94	2,473	233.20	2,238	V	600	390	580	*P
3N/7E-28R1	341836116150501	03-22-94	2,521	290.21	2,231	V	600	390	580	P
3N/7E-29F1	341905116163401	05-24-94	2,510	277.80	2,232	V	600	390	580	*P
3N/7E-29G1	341912116160801	03-24-94	2,501	258.17	2,242	V	351	312	348	O at 342
3N/7E-29R1	341843116155201	03-24-94	2,520	283.55	2,236	V	600	390	580	P
3N/7E-31E1	341823116175001	03-24-94	2,514	254.32	2,260	V	--	--	--	
3N/7E-32D1	341826116164501	03-24-94	2,544	299.99	2,244	V	618	418	598	
3N/7E-32J1	341804116155101	03-24-94	2,548	316.61	2,232	S	600	390	580	P
3N/7E-34D1	341833116144201	08-22-94	2,501	270.32	2,231	V	--	270	--	
3N/7E-36G1	341809116115801	08-23-94	2,111	279.72	1,831	V	--	384	--	
3N/8E-17L1	342037116101101	03-29-94	1,850	47.81	1,803	S	--	248	--	
3N/8E-28P1	341843116090401	01-26-94	1,832	30.90	1,801	V	395	375	395	*/M
3N/8E-28P2	341843116090402	01-26-94	1,832	30.85	1,801	V	180	160	180	*/M
3N/8E-28P3	341843116090403	01-26-94	1,832	30.81	1,801	V	85	45	85	M
3N/8E-29C1	341918116101501	03-29-94	1,891	88.43	1,802	S	--	500	684	O at 201
3N/8E-29L1	341845116100701	03-29-94	1,906	102.95	1,803	S	600	270	590	
3N/8E-31J1	341801116104601	01-26-94	2,036	206.68	1,830	V	390	370	390	*/M
3N/8E-31J2	341801116104602	01-26-94	2,036	206.63	1,830	V	320	300	320	*/M
3N/8E-31J3	341801116104603	01-26-94	2,036	206.59	1,830	V	250	210	250	M
3N/8E-32J1	341757116094701	04-07-94	2,000	203.43	1,797	S	--	--	--	*
3N/8E-33H1	341814116083801	01-07-94	1,865	63.97	1,801	R	82	56	82	
3N/8E-33H2	341822116083301	01-08-94	1,837	36.25	1,801	R	56	30	56	*
3N/8E-33H3	341819116083101	01-09-94	1,845	43.76	1,801	R	63	37	63	*
3N/8E-33N1	341751116092201	01-05-94	1,993	191.85	1,801	R	208	183	208	
3N/8E-34D1	341823116082201	04-07-94	1,824	24.16	1,800	V	--	180	--	
3N/8E-33N2	341752116092501	01-04-94	1,992	190.66	1,801	R	210	185	210	*
4N/1E-02Q2	342732116504701	06-30-94	2,926	116.07	2,810	S	--	--	--	
4N/1E-03P2	342735116521701	06-30-94	2,930	161.30	2,769	S	--	--	--	
4N/1E-05P2	342736116540401	05-16-94	2,910	183.40	2,727	V	--	--	--	
4N/1E-09D4	342728116531901	10-07-94	2,925	190.28	2,735	S	300	180	300	
4N/1E-09N2	342642116532701	04-01-92	2,965	210	2,755	R	298	--	--	
4N/1E-12R1	342638116492601	06-30-94	2,975	140.27	2,835	S	330	--	--	
4N/1E-13E1	342613116502201	07-22-94	3,000	161.04	2,839	S	505	220	488	
4N/1E-13M1	342603116501801	05-16-94	3,014	174.42	2,840	S	270	--	--	
4N/1E-15R1	342546116513901	08-29-94	3,062	195.03	2,867	S	405	240	340	
4N/1E-17L2	342601116540701	10-07-94	2,990	144.51	2,845	S	250	--	--	
4N/1E-18C2	342627116551801	08-03-94	2,980	158.40	2,822	S	194	--	--	
4N/1E-18C3	342633116551001	08-03-94	2,965	150	2,815	R	155	--	--	
4N/1E-20E1	342530116542101	10-07-94	3,020	136.10	2,884	S	280	--	--	
4N/1E-20Q1	342501116535201	10-07-94	3,090	126.73	2,963	S	260	120	260	
4N/1E-21C1	342545116530301	07-26-94	3,063	181.37	2,882	V	--	--	--	
4N/1E-27D1	342441116522201	10-07-94	3,225	248.15	2,977	S	425	240	418	
4N/1E-27R2	342401116513401	07-01-94	3,381	153.33	3,228	S	200	--	--	
4N/1W-02J1	342744116565801	10-05-94	2,866	136.10	2,729	V	--	--	--	
4N/1W-03K1	342755116580301	07-22-94	2,860	17.53	2,842	S	404	--	--	
4N/1W-07E1	342714117015601	07-26-94	2,950	44.52	2,906	S	--	--	--	
4N/1W-07R1	342639117005501	07-26-94	2,936	18.29	2,918	S	130	--	--	
4N/1W-10H1	342717116580001	10-06-93	2,910	12.69	2,897	S	--	--	--	
4N/1W-10R1	342639116580001	05-16-94	2,946	17.53	2,929	S	--	--	--	
4N/1W-13M2	342610116564101	05-17-94	2,934	56.22	2,936	V	--	--	--	
4N/1W-13M3	342610116564102	11-18-93	2,990	55.15	2,935	S	--	--	--	*
4N/1W-14A2	342629116564401	08-03-94	2,962	105.34	2,857	S	--	--	--	
4N/1W-18Q1	342544117011501	05-16-94	3,000	79.54	2,920	S	--	--	--	
4N/1W-21G1	342519116591401	05-17-94	3,121	173.07	2,948	S	--	--	--	
4N/1W-21J1	342518116584901	03-21-94	3,138	189.00	2,949	R	330	--	--	
4N/1W-26J1	342416116564501	03-21-94	3,422	325.53	3,097	R	515	415	470	
4N/2E-09N2	342643116471101	06-30-94	3,035	139.54	2,895	S	--	--	--	
4N/2E-13P1	342551116434301	06-29-94	2,995	108.10	2,887	S	--	--	--	
4N/2E-17H2	342612116471601	06-30-94	3,030	135.95	2,894	S	200	--	--	
4N/2W-12N2	342637117025401	07-26-94	3,003	104.75	2,898	S	192	60	192	
4N/3E-07G1	342708116422401	06-29-94	2,895	64.30	2,831	V	97	95	97	
4N/3E-15J1	342600116385101	06-29-94	2,863	82.64	2,780	V	89	87	89	
4N/3E-16D1	342631116405301	06-29-94	2,885	101.56	2,783	S	200	--	--	
4N/3E-23G1	342517116380601	06-29-94	2,850	72.72	2,777	V	154	76	150	O at 107
4N/3E-30C1	342448116424601	06-29-94	3,080	198.18	2,882	V	--	--	--	
4N/3E-35J1	342324116374901	01-02-94	2,920	136.05	2,784	S	512	200	512	
4N/4E-17C1	342620116351701	05-25-94	2,735	38.95	2,696	V	61	59	61	O at 54
4N/4E-19B1	342533116360801	05-25-94	2,775	38.05	2,737	V	120	--	--	
4N/4E-29D1	342446116354101	05-24-94	2,770	29.96	2,740	V	47	45	47	
4N/4E-32Q1	342306116350301	05-24-94	2,825	80.02	2,745	V	490	119	120	O at 118
4N/4E-36B1	342350116305801	05-24-94	2,630	63.22	2,567	V	72	70	72	
4N/6E-18L1	342547116234501	06-09-82	2,293	39.66	2,253	S	92	90	92	Z
4N/6E-27M1	342406116205501	03-28-94	2,350	86.18	2,264	S	--	--	--	
4N/6E-32B1	342337116223001	03-02-76	2,400	77.00	2,323	S	102	100	102	Z
5N/1E-10H3	343222116513001	07-21-94	3,030	239.65	2,790	S	260	--	--	
5N/1E-17D1	343153116542301	01-13-94	2,880	157.24	2,723	S	--	--	--	
5N/1E-20Q1	343009116535001	07-21-94	2,863	147.30	2,716	S	--	--	--	
5N/1E-32B2	342910116534801	07-22-94	2,870	169.84	2,700	S	465	240	400	
5N/1E-35F3	342851116510701	06-30-94	2,942	154.85	2,787	S	250	--	--	
5N/1W-12H2	343219116553701	07-21-94	2,872	151.16	2,721	S	230	80	230	
5N/1W-25G1	342943116555201	07-22-94	2,850	132.08	2,718	S	--	--	--	
5N/1W-28F1	342948116593301	07-22-94	2,865	35.77	2,829	S	--	--	--	
5N/1W-31C1	342916117012601	07-26-94	3,080	218.70	2,861	S	252	--	--	
5N/1W-36R1	342826116553901	07-22-94	2,861	156.98	2,704	S	468	148	468	O at 345
6N/1W-05J1	343802116595901	07-21-94	3,220	115.35	3,105	S	--	--	--	
6N/1W-22P1	343513116582201	07-21-94	3,059	150.46	2,909	S	350	--	--	
6N/1W-27B1	343500116581401	07-21-94	3,040	141.56	2,898	S	--	--	--	
6N/1W-27R1	343417116574501	07-21-94	3,038	182.72	2,855	S	354	168	288	
6N/1W-36J1	343338116553801	07-21-94	2,948	197.53	2,750	S	266	226	266	

Regional Water Table (1994) and Water-Level Changes in the Morongo Basin, San Bernardino County, California

By Carolyn R. Trayler and Kathryn M. Koczot, 1995

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