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REGIONAL SYSTEMS DEVELOPMENT FOR GEOTHERMAL ENERGY RESOURCES
PACIFIC REGION (CALIFORNIA AND HAWAII)

TASK 3 - WATER RESOURCES EVALUATION

TOPICAL REPORT
APPENDICES

19 MARCH 1979

Prepared for
Department of Energy
Division of Geothermal Energy
Washington, D.C.

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BIBLIOGRAPHY LISTING

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APPENDIX B

LITERATURE CROSS REFERENCE

TOPICS	KEY WORDS	AUTHOR McDONALD & LOELTZ TITLE Water Resources of Lower Colorado River - Salton Sea Area or 1971 Summary Report REFERENCE NO.	AUTHOR HELY, HUGHES, IRELAN TITLE Hydrologic Regimen of Salton Sea, California REFERENCE NO.	AUTHOR HELY & PECK TITLE Precipitation, Runoff & Water Loss in the Lower Colorado River - Salton Sea Area REFERENCE NO.
GROUNDWATER	AQUICLUDE			
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KEY WORD LITERATURE REVIEW

APPENDIX C

SUMMARY OF VISITS

APPENDIX C

SUMMARY OF VISITS

The following is a list of people, agency, address and date of visits and telephone contacts.

	Date of Contact
Robert T. Littleton (Chief Geologist) U.S. Bureau of Reclamation Box 427 Boulder City, Nevada 89005 Telephone: (702) 293-8553	6/5/78
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Bruce Massey (Hydrologist) U.S. Geological Survey Sacramento, California Telephone: (916) 784-4258	Telephone
Wilfred Elder (Geologist) University of California Institute of Geophysics and Planetary Physics Riverside, California Telephone: (714) 787-3439	Telephone
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Walter Randall (Geologist) Geothermal Resource International 4677 Admiralty Way Marina del Rey, California 90291 Telephone: (213) 821-8802	Telephone
William Smith (Geologist) Republic Geothermal P.O. Box 3388 Santa Fe Springs, California 90670 Telephone: (213) 945-3661	Telephone
Richard Swanson (Geothermal Program Manager) San Diego Gas & Electric San Diego, California Telephone: (714) 232-4252	5/17/78
Alfredo Manon Mercado (General Superintendent) Comision Federal de Electricidad P.O. Box 248 Calexico, California 92231 Telephone: 2-20-12, ext. 121	5/16/78

APPENDIX D

SURFACE WATER DATA

TABLE ID-1

PRECIPITATION DATA, IMPERIAL, CALIFORNIA FROM JANUARY 1914 – DECEMBER 1977

	64 Year Average		Maximum		Minimum		1977	
	Inches	Centimeters	Inches	Centimeters	Inches	Centimeters	Inches	Centimeters
January	0.36	0.91	2.30	5.84	0.00	0.00	0.05	0.13
February	0.32	0.81	1.90	4.83	0.00	0.00	0.02	0.05
March	0.19	0.48	1.41	3.58	0.00	0.00	0.04	0.10
April	0.12	0.30	1.11	2.82	0.00	0.00	0.00	0.00
May	0.02	0.05	0.41	1.04	0.00	0.00	0.00	0.00
June	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July	0.08	0.20	1.31	3.33	0.00	0.00	0.01	0.02
August	0.38	0.96	3.87	9.83	0.00	0.00	3.87	9.83
September	0.41	1.04	2.84	7.21	0.00	0.00	0.00	0.00
October	0.23	0.58	2.86	7.26	0.00	0.00	0.29	0.74
November	0.19	0.48	1.51	3.83	0.00	0.00	0.00	0.00
December	0.51	1.29	1.89	4.80	0.00	0.00	0.93	2.36
Total	2.81	7.14					5.21	13.23

COEFFICIENT OF VARIATION %

January	1.33	July	2.56
February	1.52	August	1.88
March	1.47	September	2.41
April	2.04	October	2.31
May	2.79	November	1.86
June	0	December	1.52

Source: IID, 1978.

TABLE ID-2

MONTHLY MAXIMUM PRECIPITATION
IMPERIAL VALLEY
1914 - 1977

Order	Year	Inches	Month	Probability of Exceedence
1	1926	3.87	December	0.016
1	1977	3.87	August	0.016
3	1927	2.92	December	0.047
4	1921	2.84	August	0.062
4	1976	2.84	September	0.062
6	1947	2.46	December	0.094
7	1940	2.38	December	0.109
8	1946	2.16	August	0.125

Source: VTN, 1978.

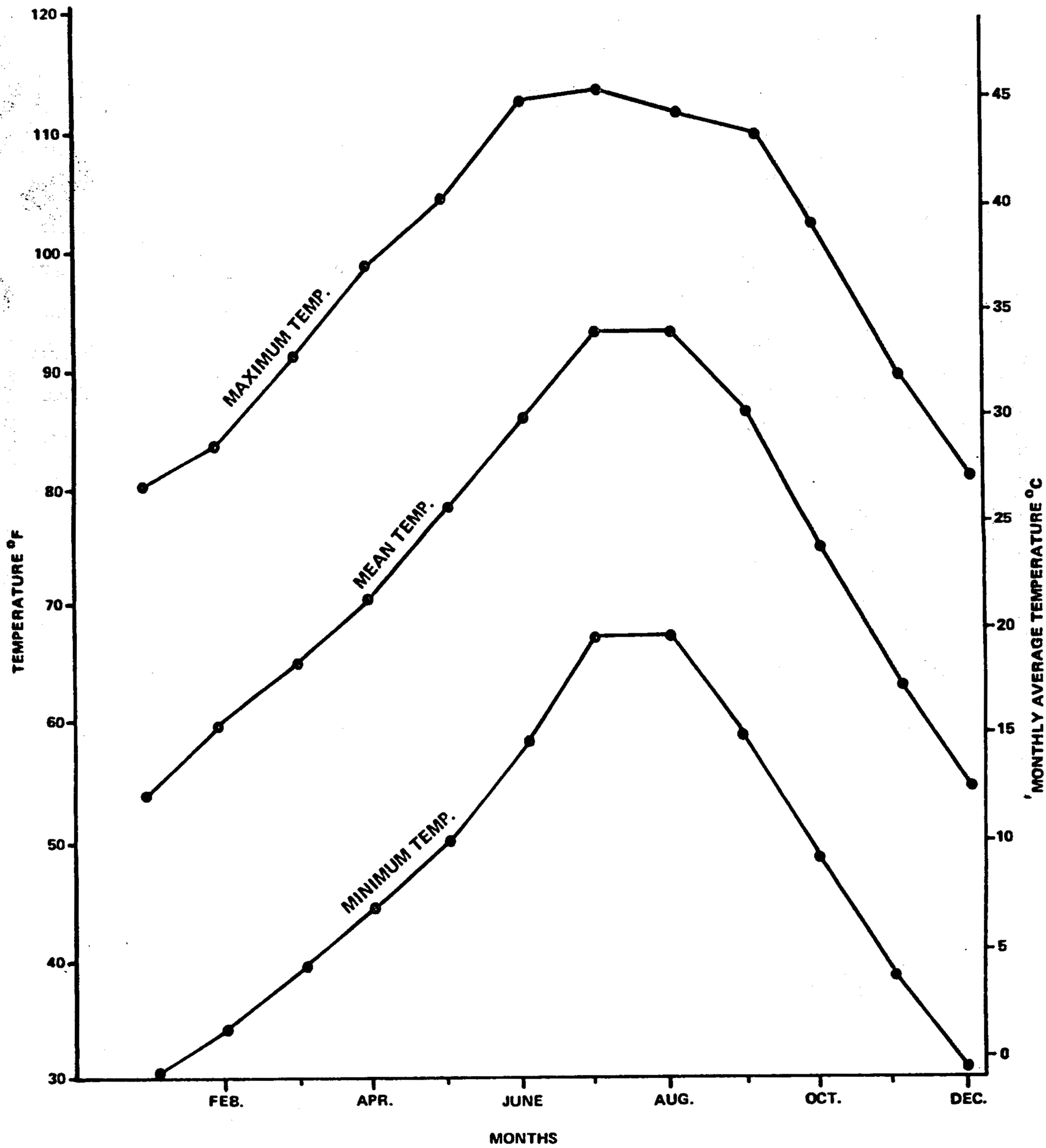
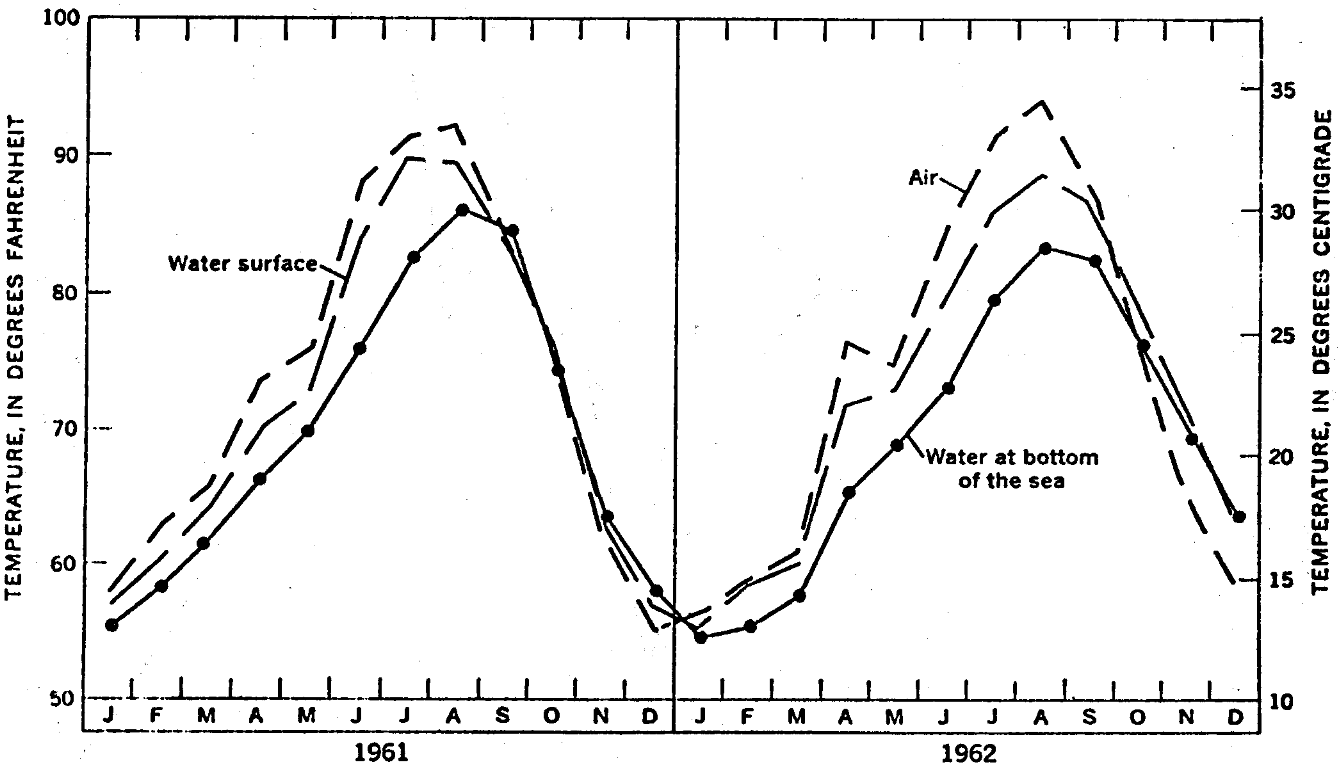


FIGURE ID-1

TEMPERATURE PROFILE, IMPERIAL WEATHER STATION
1914 – 1977 INCLUSIVE

Source: IID 1978



Source: Hely, Hughes, and Irelan, 1966

FIGURE ID-2

MONTHLY TEMPERATURE OF AIR AND WATER AT SALTON SEA AREA

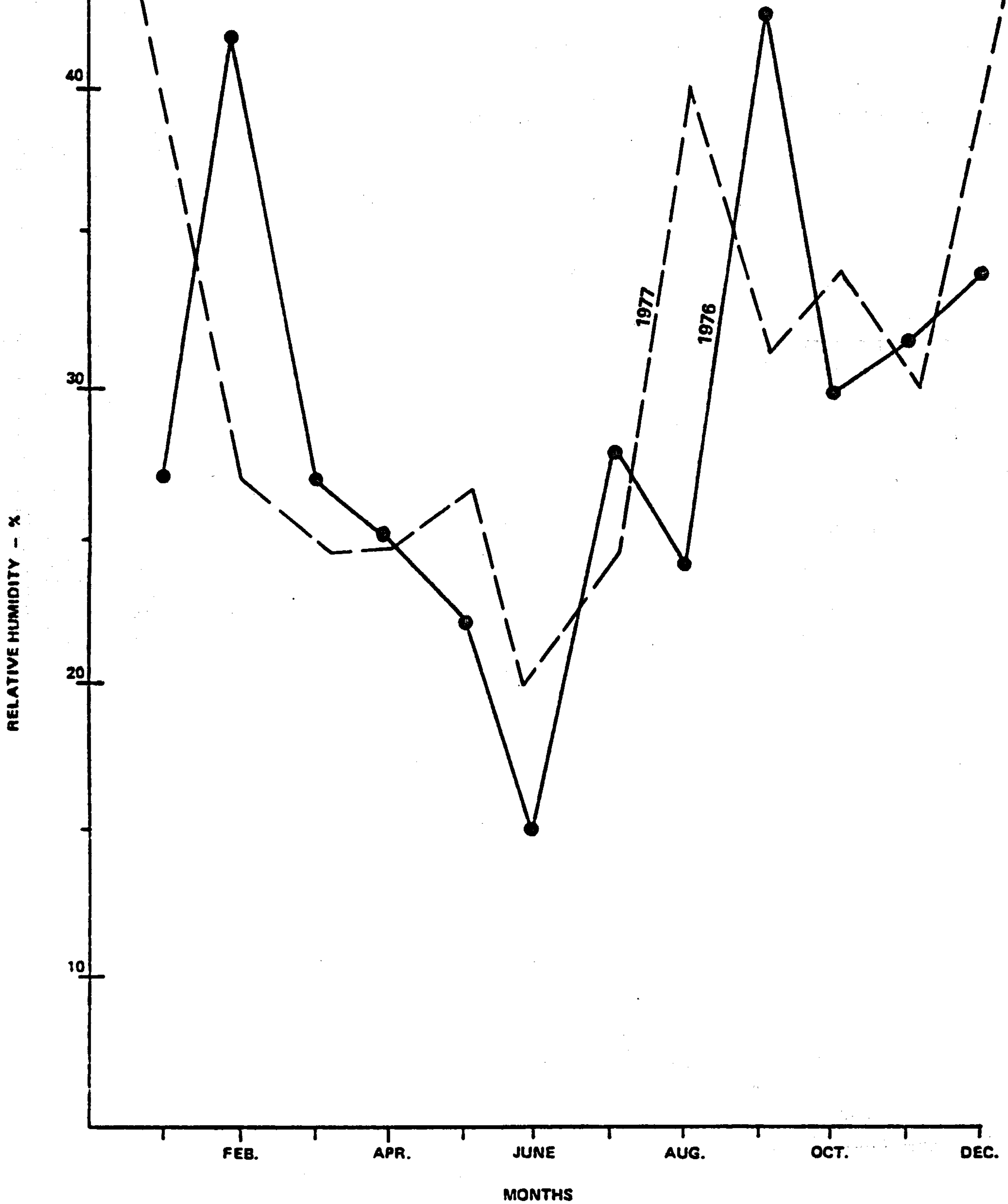
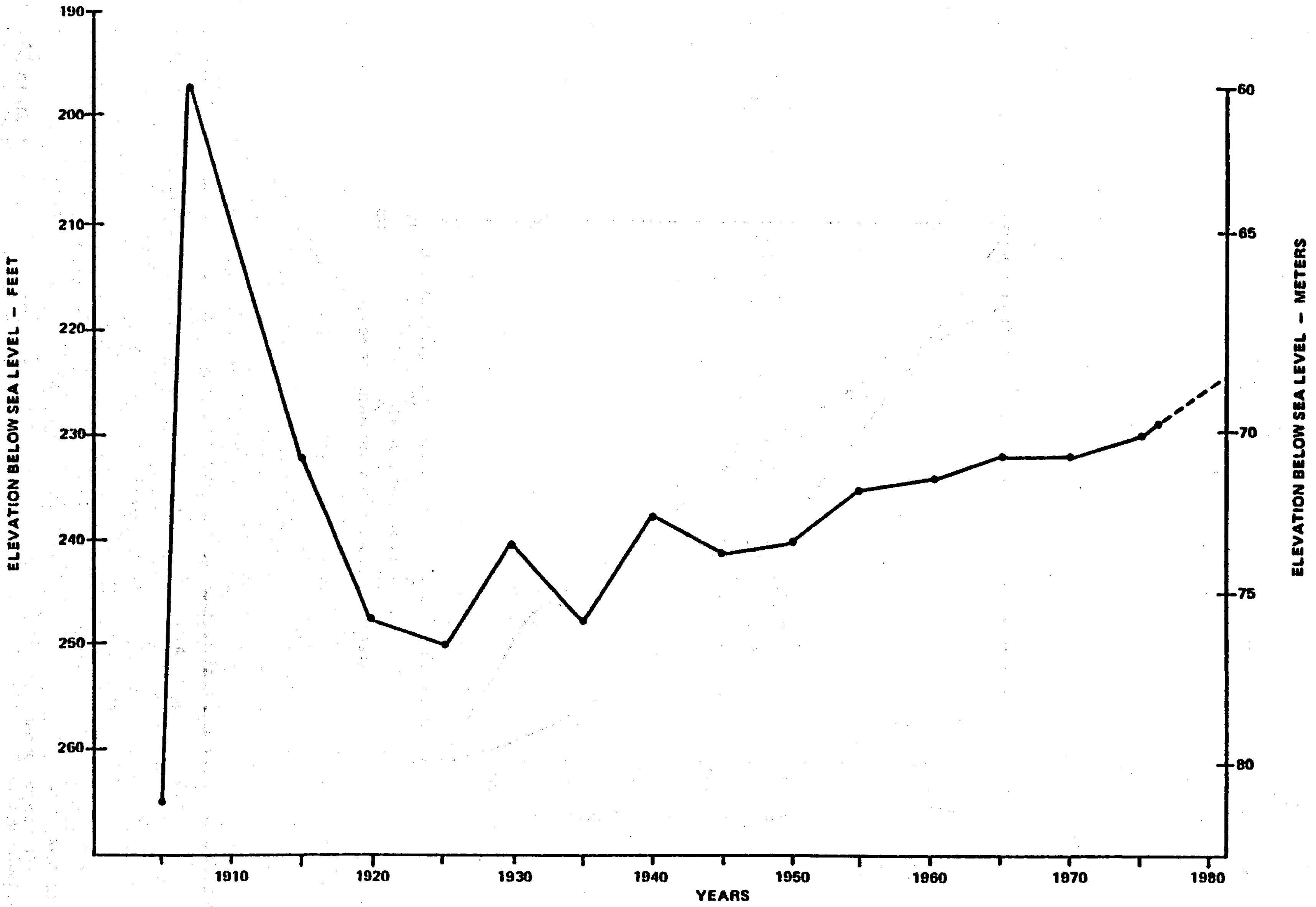


FIGURE ID-3

Source: IID 1978

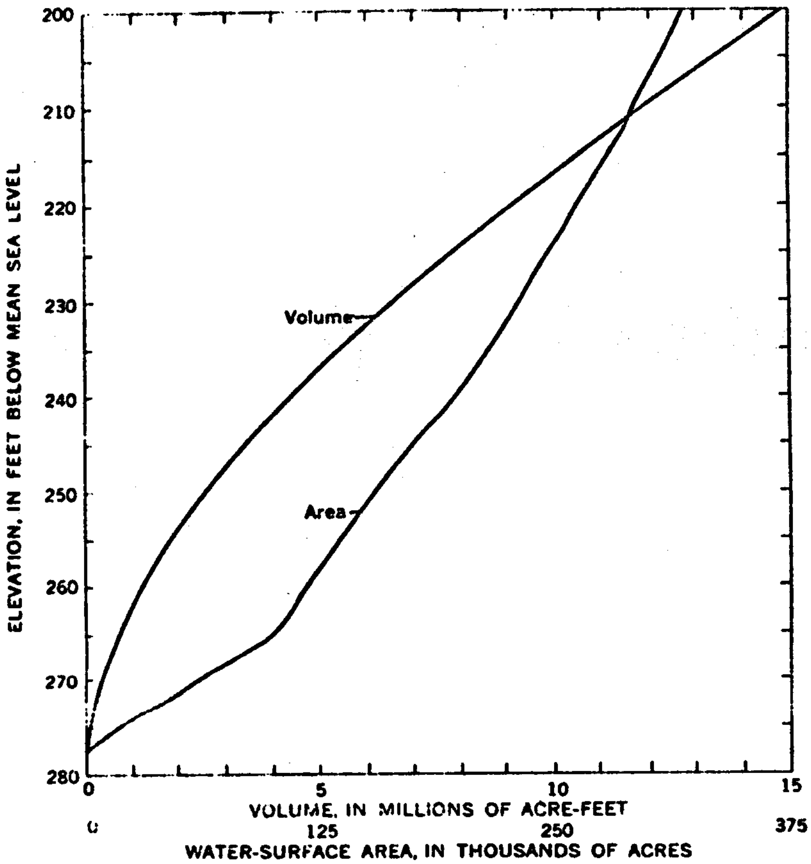
HUMIDITY PROFILE, IMPERIAL WEATHER STATION, 1976 & 1977



Source: IID 1978

FIGURE ID-4

ELEVATION OF THE SALTON SEA 1905-1977



Source: Littlefield, W. M., 1966
Hydrology and Physiography of the Salton Sea, California, U.S.G.S Hydrologic Investigations Atlas HA-222

FIGURE ID-5

AREA AND VOLUME CURVES FOR THE SALTON SEA

TABLE ID-3

PAN-EVAPORATION RATES, UNIVERSITY OF CALIFORNIA FIELD STATION HOLTVILLE SEPTEMBER 1965 - SEPTEMBER 1975

Month	Inches	Centimeters
JANUARY	3.33	8.46
FEBRUARY	4.41	11.20
MARCH	7.38	18.75
APRIL	9.94	25.25
MAY	13.40	34.04
JUNE	15.12	38.40
JULY	15.41	39.14
AUGUST	14.14	35.92
SEPTEMBER	11.57	29.39
OCTOBER	7.86	19.96
NOVEMBER	4.76	12.09
DECEMBER	3.21	8.15
TOTAL	110.53	280.75

Source: VTN: Heber Geothermal Demonstration Project, 1977

TABLE ID-4

EXISTING WASTE WATER DISCHARGE, IMPERIAL VALLEY, CALIFORNIA

City of District and Designator	Population Served	Flow (MGD)	Type or Degree of Treatment	Effluent Discharge
City of Calexico	10,200	0.65	Activated Sludge	New River
Heber Public Utilities District	500	0.085	Raw Sewage Lagoons	Central Drain No. 3
City of Imperial	3,500	0.45	Primary Sedimentation	Private Drain Dolson Drain
City of Brawley	15,750	1.38	Primary Sedimentation	New River
Seeley County Water District	926	0.121	Raw Sewage Lagoon	New River
Pioneer Memorial Hospital District	275	0.04	Activated Sludge	New River
City of Westmorland	1,600	0.21	Inhoff Tank	Trifolium Drain Ditch No. 6
City of Holtville	3,700	0.30	Inhoff Tank, Trickling Filter	Alamo River
City of Calipatria	2,500	0.25	Raw Sewage Lagoon	Alamo River
Niland Sanitary District	1,200	0.19	Inhoff Tank	R Drain
County of Imperial Country Club	100	0.03	Biofiltration	Barbara Worth Drain
Meadows Union School District	380	0.006	Septic Tank	Sub surface
City of El Centro	20,000	2.7	Primary Sedimentation	Central Drain
Imperial Junior College District	2,700	0.038	Package Plant	Central Drain Alamo River
McCabe Union School District	325	0.006	Package Plant	Wildcat Drain New River
County of Imperial Red Hill Marina	95	0.001	Raw Sewage Lagoon	Evaporation & Infiltration
County of Imperial Bomby Beach	60	0.0007	Septic Tank	Evaporation
California Department of Fish and Game Wister Unit	30	0.005	Septic Tank	Evaporation & Infiltration
Imperial Irrigation District Steam Power Plant	–	0.1	None	Central Drain Alamo River

EXISTING WASTE WATER DISCHARGE, IMPERIAL VALLEY, CALIFORNIA

City of District and Designator	Population Served	Flow (MGD)	Type or Degree of Treatment	Effluent Discharge
U.S. Gypsium	–	0.06	Lagoons	Evaporation
Agriform Company	–	0.0007	Lagoons	Evaporation
Southwest Marketing Corporation	–	0.06	Ponds	Evaporation
Anza Meat Packing Co.	–	0.0002 0.005	Burial in trenches Lagoons	Evaporation Pasture irrigation & evaporation
Sinclair Geothermal Wells	–	0.00	Temporary storage only	Evaporation
Union Oil Company	–	0.20	Temporary storage	Evaporation
Imperial Thermal Products	–	–	Temporary storage	Evaporation
Valley Nitrogen Producer, Inc.	–	1.40	pH control and chromate reduction	Date Drain Alamo River
C & D Truck Service	–	0.005	Raw Sewage Lagoons	Alamo River
Walker Livestock Transportation	–	0.001	Sedimentation Tanks	Trifolium Drain No. 6, New River
Rockwood Chemical Company	–	0.0005	Impervious Basin	Evaporation
Holly Sugar Corporation	–	1.11	Clarifier, Stabilization Lagoons	New Side Drain Alamo River
USN – Naval Air Facility El Centro	2,600	0.30	Raw Sewage Lagoon	New River

	Flow (MGD)
Sum	
Drainage	9.366 (10,490 Acre-feet/yr)
Evaporation, irrigation and infiltration	0.299 (335 Acre-feet/yr)
Total	9.665 (10,814 Acre-feet/yr)

TABLE ID-5

WATER QUALITY DATA, NEW RIVER AT INTERNATIONAL BOUNDARY CALEXICO, CALIFORNIA FEBRUARY 1973 to SEPTEMBER 1976

Parameters*	No. of Samples	Average	Standard Deviation	Coefficient of Variation %
Instantaneous Discharge (CFS)	48	146.73	28.66	19.53
Ca	47	251.23	18.21	7.25
Mg	46	128.69	13.83	10.75
Na	47	1,090.85	115.66	10.60
K	46	57.62	21.77	37.77
HCO_3	47	294.96	30.28	10.26
Aklalinity as $CaCO_3$	47	242.00	24.88	10.28
SO_4	47	807.02	62.92	7.80
Cl	47	1,813.83	191.99	10.58
F	47	.74	.18	24.70
Kjeldahl - N	39	5.95	2.76	46.31
Total - P	39	1.39	.38	27.49
Dissolved Residue at 180°C	47	4,533.40	416.80	9.19
Conductance (Micromhos)	48	6,987.18	784.20	11.22
Ph (Scale)	47	7.63	.29	3.79
Temperature (°C)	48	24.19	6.30	26.04
Turbidity (NTU)	38	23.05	31.00	134.50
Phytoplankton (Cells/ml)	37	5.21×10^4	5.237×10^4	100.52
Fecal Coliform (Colonies/100 ml)	42	25.66×10^5	24.454×10^5	95.30
Streptococci (Colonies/100 ml)	45	3.835×10^5	5.722×10^5	149.22
Total Organic Carbon	11	24.91	9.03	36.24
Suspended Solids	31	126.10	74.91	59.41

*Dimension in mg/l except where specified.

Source: USGS Water Resources Data for California, 1973 - 1976.

TABLE ID-6

MEASURED PAN-EVAPORATION
SALTON SEA, 1977

Month	Sandy Beach		Devil's Hole		Salt Farm	
	Inches	Centimeters	Inches	Centimeters	Inches	Centimeters
January	3.46	8.79	2.85	7.24	2.98	7.57
February	5.61	14.25	5.10	12.95	5.09	12.93
March	9.49	24.10	7.57	19.23	8.08	20.52
April	9.53	24.21	8.47	21.51	8.92	22.66
May	12.75	32.38	10.55	26.80	11.32	28.75
June	14.89	37.82	12.97	32.94	13.47	34.21
July	15.04	32.20	12.62	32.05	13.80	35.05
August	15.62	39.67	12.37	31.42	13.64	34.64
September	12.56	31.90	10.36	26.31	11.06	28.09
October	8.68	22.05	7.19	18.26	7.57	19.23
November	7.38	18.74	5.79	14.71	6.32	16.05
December	4.68	11.89	4.52	11.48	4.38	11.12
Total	119.69	304.01	100.36	254.91	106.63	270.84

Source: IID, 1978

APPENDIX E

GROUND WATER QUALITY DATA

TABLE IE-1

GROUNDWATER QUALITY DATA

WESTERN IMPERIAL VALLEY

Well location	Interval sampled (ft below land surface)	Analysis No.	Date of sample	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Total dissolved solids	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Specific conductance (micromhos at 25°C)	pH
Lower Borrego Valley																				
12S/6E-15H		185	8 1 60	24	61	10	402		116	650	305	2.5	----	----	1,070	244	149	81	2,040	7.6
27K		186a	1 8 64		16	1.0	177	3.4	[illegible]	145	147	----	.3	----	638	48	0	88	896	7.7
		186b	6 2 63	30	16	.7	171		[illegible]	125	146	4.8	----	----	620	42	0	88	911	7.5
23J		187	6 2-63	24	76	7.4	280		[illegible]	285	326	3.6	----	----	1,130	220	148	75	1,870	7.6
23H		188	8 1-60	20	82	15	400		[illegible]	375	380	4.0	----	----	1,510	268	180	77	2,410	7.6
13S/6E-22A1	312 417	199	7 29 63	19	450	144	1,360		95	1,050	2,600	1.3	----	----	5,910	1,880	1,800	61	8,600	7.2
22A2	265 607	200a	9 26 62	20	157	23	373		92	388	578		----	----	1,580	486	410	62	2,770	7.3
		200b	7 29 63	19	130	29	363		100	400	860	8	----	----	1,360	442	360	65	2,630	7.4
23B1	250 500	201a	9 25 62	19	162	31	381		84	398	828		----	----	1,650	510	461	61	2,920	7.3
		201b	7 29 63	20	163	31	409		84	425	845	1.3	----	----	1,740	534	465	62	2,900	7.6
San Felipe Creek-Superstition Hills Area																				
12S/10E-20A1		202a	1 6 18	15	56	1.1	270		85	216	330	----	----	----	865	193	112	75	----	----
		202b	1 9 60		67	34	222		97	284	365	----	----	----	1,030	286	277	58	1,770	----
		202c	9 25 62	15	61	14	292		95	233	370	0.8	----	----	1,030	210	132	75	1,930	7.2
26		203	1 4 60		170	38	465		281	396	660	----	----	----	1,720	497	176	71	2,820	----
30		204a	1 4 60		170	87	1,320		104	26	2,310	----	----	----	3,920	465	410	85	----	----
		204b	9 25 62	0	140	66	1,860		66	5	2,740	----	----	----	4,630	482	466	88	8,430	6.8
12S/11E-16H1	310 600	205a	5 20 64	18	38	8.4	470	9.4	200	296	495	1.8	0.1	2.0	1,440	132	0	88	2,470	8.2
		205b	7 2 64	18	30	9.0	472	9.4	191	295	498	1.3	5.2	2.6	1,420	112	0	88	2,460	8.4
16H2	[illegible] 56	206	5 20 64	15	348	197	2,380		348	2,400	2,950	----	----	----	8,420	1,680	1,460	76	12,600	7.2
21		207a	11 20 17	26	30	22	705		207	451	748	----	1.4	----	2,080	165	0	90	----	----
		207b	9 25 62		28	32	1,830		867	800	2,300	----	----	----	5,270	202	0	95	9,180	7.8
Coyote Valley																				
9S/9E-25K	60 247	208a	6 15-60		19	67	70	4.3	107	87	61	.6	3.8	----	278	75	0	68	----	8.3
		208b	3 6-62	18	20	3.2	73		102	25	40	1.0	----	----	282	65	0	----	800	7.3
25M		209	3 6 62	17	20	4.6	82		102	22	67	1.1	----	----	286	75	0	78	832	7.3
26H		210	3 5 62	28	18	3.0	91		100	30	68	1.1	3.9	----	286	61	0	77	540	7.6
35M	415 495	211a	7 3-62		1.4	.3	104	6.0	120	14	88	3.6	.1	----	230	4.6	0	84	----	9.2
		211b	1 9-62	46	1.6	.1	106		128	10	88	2.0	----	----	311	4	0	98	800	8.8
3AN		212	1 9 62	36	6.1	2.2	114		102	14	84	2.0			328	24	0	91	577	7.8
36C1		213a	10 27 62	22	20	0	78		143	24	89	.9	2.5		292	78	0	76	490	8.2
		213b	2 10 60		14	5	102	0	140	30	78		3		316	86	0	77	562	8.1
		213c	3 6 62	10	14	3.2	108		130	35	94	2.2	0		326	48	0	83	663	8.0
[illegible]	180 [illegible]	214a	2 8 61		16	4.0	93	43	184	27	80	1.6	4.8		290	60	0	78	----	8.3
		214b	3 5 62	14	19	2.8	101		108	28	75	1.8			325	58	0	79	584	7.3
[illegible]	190 214	215a	5 27 67	25	5	4	124		178	30	71	.1		.46	357	30	0	90	606	----
		215b	2 10 56		5	1	126	0	177	35	78				341	17	0	92	622	8.4
		215c	3 5 62	11	8.8	1.6	133		196	32	75	3.5			356	20	0	94	628	7.7
[illegible]		216	1 5 62	9	5.8	1.8	141		188	30	87	4.0			381	21	0	94	670	7.7
[illegible]		217a	9 15 60	21	7.2	7.8	141		224	40	72				431	50	0	86	----	7.8
		217b	1953		12	3	144		207	63	84				410	42	0	88	----	----
		217c	1950		10	3	100	10	207	65	65				456	38	0	87	761	8.6
10S/10E-[illegible]		218	2 19 50		13	12	500	0	308	370	376		0		1,430	83	0	92	2,300	8.0
[illegible]		219	12 16 60		3	14	3,140		1,620	520	2,510				8,000	0	0	99	----	----
[illegible]		220a	6 27 50	40	32	12	129	5.3	106	95	128		2.5		527	130	0	67	910	7.8
		220b	1 5 62	20	25	7.4	108		156	43	100	1.0			391	93	0	72	711	7.9
West Mesa																				
14S/11E-13K	115 500	221a	4 3 62	16	111	36	445		82	827	365	1.4	2	1.6	1,870	480	413	67	2,800	7.5
		221b	5 11 62	16	152	33	510		84	1,000	318				2,110	515	463	68	2,920	7.7
15S/11E-14K	94 95	222	4 15 64	15	308	112	1,260		112	1,650	1,700				5,210	1,500	1,390	64	7,970	7.7
15S/11E-12H	138 160	223	3 19 64	7	28	10	1,500		366	2,240	635				4,690	150	0	96	6,500	9.2
16S/12E-6P	92 261	224	8 19 58		131	57	726		146	700	808	6	1.1	0.74	2,620	564	444	74	4,030	8.2
Yuha Desert																				
16S/11E-24H	141 151	225	3 19 64	1	110	96	4,150		194	3,330	1,300				12,200	765	614	97	17,800	8.2
16.5S/10E-34H		226	4 23 63	12	8.4	7	280		272	160	141	2.2			742	24	0	96	1,220	8.2
34P2		227	7 17 62	11	8	2.0	155		220	58	88	2.8			454	33	0	91	750	8.1
6		228a	5 8 52		7.0	1.6	183		270	55	95	12.0	4.3	.4	403	24	0	94	878	8.2
		228b	1 4 56		4	.5	315	6	265	100	110			.25	508	11	0	96	900	8.8
16.5S/11E-6M1		229	8 21 62		0	2.4	5,010		5,940	2,700	2,200				13,600	10	0	100	17,600	9.4
6M2		230	8 21 62		11	2.6	1,000		1,500	800	420				2,630	38	0	98	4,150	8.5
17S/9E-10G		231	7 17 62	34	1	.4	124		112	22	108	3.5			347	4	0	98	590	9.1
17S/10E-3P		232	4 22 64	11	20	.3	238		137	159	219	8			721	78	0	86	1,250	7.4
17S/12E-1A		233	3 19 64	15	188	71	600		298	825	805				2,770	770	678	46	4,090	8.0

Results in milligrams per liter, except as indicated.

Adapted from: Geohydrologic Reconnaissance of the Imperial Valley, California, U.S.G.S. Professional Paper 486-K, O.J. Loeltz, et al, 1975.

TABLE IE-2

GROUNDWATER QUALITY DATA

EASTERN IMPERIAL VALLEY
Chocolate Mountains Piedmont Slope

[illegible]

Pilot Knob Mesa-Sand Hills Area

[illegible]

East Mesa

[illegible]

Results in milligrams per liter, except as indicated.

Adapted from: Geohydrologic Reconnaissance of the Imperial Valley, California, U.S.G.S. Professional Paper 486-K, O.J. Loeltz, et al, 1975.

TABLE IE-3

GROUNDWATER QUALITY DATA

CENTRAL IMPERIAL VALLEY
[illegible]

Results in milligrams per liter, except as indicated.

Adapted from: Geohydrologic Reconnaissance of the Imperial Valley, California,
U.S.G.S. Professional Paper 486-K, O.J. Loeltz, et al, 1975.

APPENDIX F

GEOPHYSICAL WELL LOGS

AREA 1

Well Name: R. G. WINDER
Well Location: 16S 21E 16B1S
Elevation of Land Surface (MSL): 320 FT.
Depth of Well: 847 FT.
Sampling Depth Interval: 598 – 806 FT.
Date of Sample: 7-19-61
Sampled By:
Analyzed By:

Dissolved SiO_2	23
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	82
Dissolved Mg (mg/l)	24
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	235
Dissolved K (mg/l)	
HCO_3 (mg/l)	191
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	157
Dissolved SO_4 (mg/l)	157
Dissolved Cl (mg/l)	358
Dissolved F (mg/l)	0.5
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	2.6
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	977
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	304
Non-CO_3 hardness (mg/l)	148
Percent Na	
SAR	
Specific conductance (µmhos)	1700
pH	8.0
Temperature °C	
CO_2 (mg/l)	3.1
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	450
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: R. G. WINDER

Well Location: 16S21E16B1S

Elevation of Land Surface (MSL): 320 FT.

Depth of Well: 847 FT.

Sampling Depth Interval: 598 - 806 FT.

Date of Sample: 10-27-62

Sampled By:

Analyzed By:

Dissolved SiO_2	19
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	74
Dissolved Mg (mg/l)	25
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	225
Dissolved K (mg/l)	
HCO_3 (mg/l)	192
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	157
Dissolved SO_4 (mg/l)	140
Dissolved Cl (mg/l)	335
Dissolved F (mg/l)	0.7
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	915
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	288
Non-CO_3 hardness (mg/l)	130
Percent Na	
SAR	
Specific conductance (μmhos)	1700
pH	7.3
Temperature °C	
CO_2 (mg/l)	3.1
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 6
Well Location: 16S 20E 31K1S
Elevation of Land Surface (MSL): 155 FT.
Depth of Well: 1000 FT.
Sampling Depth Interval: 340 — 520 FT.
Date of Sample: 5-2-62
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	21
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	78
Dissolved Mg (mg/l)	16
Dissolved Na (mg/l)	138
Dissolved Na+K (mg/l)	
Dissolved K (mg/l)	5.9
HCO_3 (mg/l)	149
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	122
Dissolved SO_4 (mg/l)	293
Dissolved Cl (mg/l)	103
Dissolved F (mg/l)	0.1
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	0.8
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	729
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	259
Non-CO_3 hardness (mg/l)	137
Percent Na	53
SAR	3.7
Specific conductance (µmhos)	1130
pH	8.0
Temperature °C	
CO_2 (mg/l)	2.4
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	140
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 6
Well Location: 16S 20E 31K1S
Elevation of Land Surface (MSL): 155 FT.
Depth of Well: 1000 FT.
Sampling Depth Interval: 340 - 520 FT.
Date of Sample: 6-26-63
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	21
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	81
Dissolved Mg (mg/l)	18
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	142
Dissolved K (mg/l)	
HCO_3 (mg/l)	152
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	125
Dissolved SO_4 (mg/l)	300
Dissolved Cl (mg/l)	104
Dissolved F (mg/l)	0.3
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	1.2
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	743
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	276
Non-CO_3 hardness (mg/l)	152
Percent Na	
SAR	
Specific conductance (µmhos)	1140
pH	7.4
Temperature °C	
CO_2 (mg/l)	9.7
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	140
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 6
Well Location: 16S 20E 31K1S
Elevation of Land Surface (MSL): 155 FT.
Depth of Well: 1000 FT.
Sampling Depth Interval: 340 - 520 FT.
Date of Sample: 1-13-64
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	17
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	80
Dissolved Mg (mg/l)	20
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	146
Dissolved K (mg/l)	
HCO_3 (mg/l)	150
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	123
Dissolved SO_4 (mg/l)	312
Dissolved Cl (mg/l)	106
Dissolved F (mg/l)	0.3
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	756
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	280
Non-CO_3 hardness (mg/l)	157
Percent Na	
SAR	
Specific conductance (μmhos)	1150
pH	7.4
Temperature °C	
CO_2 (mg/l)	9.6
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 11
Well Location: 15S18E15M1S
Elevation of Land Surface (MSL): 120 FT.
Depth of Well: 1140 FT.
Sampling Depth Interval: 309 — 894 FT.
Date of Sample: 4-4-63
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	30
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	159
Dissolved Mg (mg/l)	27
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	554
Dissolved K (mg/l)	
HCO_3 (mg/l)	72
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	59
Dissolved SO_4 (mg/l)	167
Dissolved Cl (mg/l)	1050
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	2020
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	508
Non-CO_3 hardness (mg/l)	449
Percent Na	
SAR	
Specific conductance (μmhos)	3800
pH	7.2
Temperature °C	32.2
CO_2 (mg/l)	7.3
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 11
Well Location: 15S 18E 15M1S
Elevation of Land Surface (MSL): 120 FT.
Depth of Well: 1140 FT.
Sampling Depth Interval: 309 – 894 FT.
Date of Sample: 5-10-63
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	35
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	165
Dissolved Mg (mg/l)	28
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	543
Dissolved K (mg/l)	
HCO_3 (mg/l)	70
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	57
Dissolved SO_4 (mg/l)	170
Dissolved Cl (mg/l)	1040
Dissolved F (mg/l)	0.6
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	3.8
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	2020
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	525
Non-CO_3 hardness (mg/l)	470
Percent Na	
SAR	
Specific conductance (μmhos)	3790
pH	7.3
Temperature °C	
CO_2 (mg/l)	5.6
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	680
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 11
Well Location: 15S 18E 15M1S
Elevation of Land Surface (MSL): 120 FT.
Depth of Well: 1140 FT.
Sampling Depth Interval: 309 – 894 FT.
Date of Sample: 1-14-64
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	23
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	158
Dissolved Mg (mg/l)	43
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	504
Dissolved K (mg/l)	
HCO_3 (mg/l)	50
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	41
Dissolved SO_4 (mg/l)	200
Dissolved Cl (mg/l)	1000
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1960
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	570
Non-CO_3 hardness (mg/l)	522
Percent Na	
SAR	
Specific conductance (µmhos)	3790
pH	7.3
Temperature °C	
CO_2 (mg/l)	4.0
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 12
Well Location: 16S 19E 11 D 1 S
Elevation of Land Surface (MSL): 155 FT.
Depth of Well: 1000 FT.
Sampling Depth Interval: 300 – 610 FT.
Date of Sample: 5-2-63
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	26
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	52
Dissolved Mg (mg/l)	7.4
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	253
Dissolved K (mg/l)	
HCO_3 (mg/l)	131
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	107
Dissolved SO_4 (mg/l)	285
Dissolved Cl (mg/l)	216
Dissolved F (mg/l)	0.6
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	1.1
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	905
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	160
Non-CO_3 hardness (mg/l)	52
Percent Na	
SAR	
Specific conductance (µmhos)	1490
pH	7.7
Temperature °C	29.4
CO_2 (mg/l)	4.2
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	240
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 12
Well Location: 16S 19E 11D1S
Elevation of Land Surface (MSL): 155 FT.
Depth of Well: 1000 FT.
Sampling Depth Interval: 300 – 610 FT.
Date of Sample: 1-14-64
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	25
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	76
Dissolved Mg (mg/l)	8.6
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	196
Dissolved K (mg/l)	
HCO_3 (mg/l)	145
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	119
Dissolved SO_4 (mg/l)	357
Dissolved Cl (mg/l)	118
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	1.2
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	854
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	232
Non-CO_3 hardness (mg/l)	113
Percent Na	
SAR	
Specific conductance (μmhos)	1300
pH	7.3
Temperature °C	
CO_2 (mg/l)	12
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	140
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 1

Well Name: LCRP 18
Well Location: 16S 18E 32R1S
Elevation of Land Surface (MSL): 118 FT.
Depth of Well: 815 FT.
Sampling Depth Interval: 140 — 630 FT.
Date of Sample: 6-30-64
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	27
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	23
Dissolved Mg (mg/l)	8.6
Dissolved Na (mg/l)	272
Dissolved Na+K (mg/l)	
Dissolved K (mg/l)	4
HCO_3 (mg/l)	208
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	171
Dissolved SO_4 (mg/l)	235
Dissolved Cl (mg/l)	200
Dissolved F (mg/l)	1.7
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	0.5
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	874
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	93
Non-CO_3 hardness (mg/l)	
Percent Na	86
SAR	12
Specific conductance (µmhos)	1460
pH	8.0
Temperature °C	
CO_2 (mg/l)	3.3
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	640
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 2

Well Name: SPC
Well Location: 12S/16E 9A 1S
Elevation of Land Surface (MSL): 220 FT.
Depth of Well: 1005 FT.
Sampling Depth Interval: 150 — 1000 FT.
Date of Sample: 7-8-63
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	28
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	63
Dissolved Mg (mg/l)	22
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	566
Dissolved K (mg/l)	
HCO_3 (mg/l)	420
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	344
Dissolved SO_4 (mg/l)	217
Dissolved Cl (mg/l)	645
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1750
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	248
Non-CO_3 hardness (mg/l)	
Percent Na	
SAR	
Specific conductance (µmhos)	3150
pH	7.6
Temperature °C	33.3
CO_2 (mg/l)	17
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 2

Well Name: SPC
Well Location: 12S 16E 9A1S
Elevation of Land Surface (MSL): 220 FT.
Depth of Well: 1005 FT.
Sampling Depth Interval: 150 – 1000 FT.
Date of Sample: 7-9-63
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	34
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	83
Dissolved Mg (mg/l)	29
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	663
Dissolved K (mg/l)	
HCO_3 (mg/l)	520
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	427
Dissolved SO_4 (mg/l)	243
Dissolved Cl (mg/l)	765
Dissolved F (mg/l)	2.3
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	3.9
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	2080
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	326
Non-CO_3 hardness (mg/l)	
Percent Na	
SAR	
Specific conductance (μmhos)	3660
pH	7.4
Temperature °C	34.4
CO_2 (mg/l)	33
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	1800
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: T. M. JACOBS
Well Location: 12S 9E 22A2S
Elevation of Land Surface (MSL): —12 FT.
Depth of Well: 667 FT.
Sampling Depth Interval: 380 TO 667 FT.
Date of Sample: 9-25-62
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	20
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	157
Dissolved Mg (mg/l)	23
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	372
Dissolved K (mg/l)	
HCO_3 (mg/l)	92
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	75
Dissolved SO_4 (mg/l)	388
Dissolved Cl (mg/l)	578
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1580
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	486
Non-CO_3 hardness (mg/l)	410
Percent Na	
SAR	
Specific conductance (µmhos)	2770
pH	7.3
Temperature °C	29.3
CO_2 (mg/l)	7.4
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: T. M. JACOBS

Well Location: 12S 9E 22A2S

Elevation of Land Surface (MSL): -12 FT.

Depth of Well: 667 FT.

Sampling Depth Interval: 380 - 667 FT.

Date of Sample: 7-29-63

Sampled By: USGS

Analyzed By: USGS

Dissolved SiO_2	19
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	130
Dissolved Mg (mg/l)	29
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	383
Dissolved K (mg/l)	
HCO_3 (mg/l)	100
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	82
Dissolved SO_4 (mg/l)	400
Dissolved Cl (mg/l)	550
Dissolved F (mg/l)	0.8
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1560
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	442
Non-CO_3 hardness (mg/l)	360
Percent Na	
SAR	
Specific conductance (μmhos)	2630
pH	7.4
Temperature °C	30.0
CO_2 (mg/l)	6.4
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: T.M. JACOBS
Well Location: 12S9E 22A2S
Elevation of Land Surface (MSL): – 12 FT.
Depth of Well: 667 FT.
Sampling Depth Interval: 380 – 667 FT.
Date of Sample: 8-24-73
Sampled By: EDUCATIONAL
Analyzed By: EDUCATIONAL

Dissolved SiO_2	
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	55
Dissolved Mg (mg/l)	
Dissolved Na (mg/l)	400
Dissolved Na+K (mg/l)	
Dissolved K (mg/l)	9.8
HCO_3 (mg/l)	
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	
Dissolved SO_4 (mg/l)	
Dissolved Cl (mg/l)	
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	
Non-CO_3 hardness (mg/l)	
Percent Na	18
SAR	
Specific conductance (μmhos)	
pH	8.5
Temperature °C	30.0
CO_2 (mg/l)	
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: HARPERS WELL
Well Location: 12S 10E 26M1S
Elevation of Land Surface (MSL): -115 FT.
Depth of Well: 320 FT.
Sampling Depth Interval: N.A.
Date of Sample: 1-8-1918
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	15
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	100
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	56
Dissolved Mg (mg/l)	13
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	270
Dissolved K (mg/l)	
HCO_3 (mg/l)	98
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	80
Dissolved SO_4 (mg/l)	216
Dissolved Cl (mg/l)	336
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	955
TDS (mg/l)	
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	193
Non-CO_3 hardness (mg/l)	112
Percent Na	
SAR	
Specific conductance (μmhos)	
pH	
Temperature °C	
CO_2 (mg/l)	
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: HARPERS WELL

Well Location: 12S 10E 26M1S

Elevation of Land Surface (MSL): - 115 FT.

Depth of Well: 320 FT.

Sampling Depth Interval: N. A.

Date of Sample: 1-9-49

Sampled By: SCS

Analyzed By: OTHER

Dissolved SiO_2	
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	87
Dissolved Mg (mg/l)	34
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	222
Dissolved K (mg/l)	
HCO_3 (mg/l)	97
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	80
Dissolved SO_4 (mg/l)	284
Dissolved Cl (mg/l)	355
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1030
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	356
Non-CO_3 hardness (mg/l)	277
Percent Na	
SAR	
Specific conductance (μmhos)	1770
pH	
Temperature °C	
CO_2 (mg/l)	
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	220
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: HARPERS WELL
Well Location: 12S 10E 26M1S
Elevation of Land Surface (MSL): - 115 FT.
Depth of Well: 320 FT.
Sampling Depth Interval: N.A.
Date of Sample: 9-25-62
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	15
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	61
Dissolved Mg (mg/l)	14
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	292
Dissolved K (mg/l)	
HCO_3 (mg/l)	96
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	79
Dissolved SO_4 (mg/l)	233
Dissolved Cl (mg/l)	370
Dissolved F (mg/l)	0.8
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1030
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	210
Non-CO_3 hardness (mg/l)	132
Percent Na	
SAR	
Specific conductance (μmhos)	1920
pH	7.2
Temperature °C	28.3
CO_2 (mg/l)	9.7
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: HARPERS WELL
Well Location: 12S 10E 26M1S
Elevation of Land Surface (MSL): -115 FT.
Depth of Well: 320 FT.
Sampling Depth Interval: N.A.
Date of Sample: 5-12-67
Sampled By: OTHER
Analyzed By: OTHER

Dissolved SiO_2	
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	62
Dissolved Mg (mg/l)	12
Dissolved Na (mg/l)	280
Dissolved Na+K (mg/l)	
Dissolved K (mg/l)	5
HCO_3 (mg/l)	105
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	86
Dissolved SO_4 (mg/l)	221
Dissolved Cl (mg/l)	352
Dissolved F (mg/l)	0.8
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	1.3
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1024
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	200
Non-CO_3 hardness (mg/l)	120
Percent Na	74
SAR	8.5
Specific conductance (μmhos)	1754
pH	7.7
Temperature °C	23.9
CO_2 (mg/l)	3.4
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	700
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: LCRP 19
Well Location: 12S 11E 18J 1S
Elevation of Land Surface (MSL): -175 FT.
Depth of Well: 959 FT.
Sampling Depth Interval: 310 — 650 FT.
Date of Sample: 5-20-64
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	18
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	20
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	39
Dissolved Mg (mg/l)	8.4
Dissolved Na (mg/l)	470
Dissolved Na+K (mg/l)	
Dissolved K (mg/l)	9.4
HCO_3 (mg/l)	200
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	164
Dissolved SO_4 (mg/l)	296
Dissolved Cl (mg/l)	495
Dissolved F (mg/l)	1.8
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	0.1
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1440
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	132
Non-CO_3 hardness (mg/l)	
Percent Na	88
SAR	18
Specific conductance (µmhos)	2470
pH	8.2
Temperature °C	32.8
CO_2 (mg/l)	2.0
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	2000
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 3

Well Name: LCRP 19
Well Location: 12S/11E/18J/S
Elevation of Land Surface (MSL): -175 FT.
Depth of Well: 959 FT.
Sampling Depth Interval: 310 - 650 FT.
Date of Sample: 7-2-64
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	18
Dissolved Al (µg/l)	
Total Fe (µg/l)	
Dissolved Fe (µg/l)	
Ferrous Fe (µg/l)	
Total Mn (µg/l)	
Dissolved Mn (µg/l)	
Dissolved Ca (mg/l)	30
Dissolved Mg (mg/l)	9.0
Dissolved Na (mg/l)	472
Dissolved Na+K (mg/l)	
Dissolved K (mg/l)	9.4
HCO_3 (mg/l)	191
CO_3 (mg/l)	6
Alkalinity as $CaCO_3$ (mg/l)	157
Dissolved SO_4 (mg/l)	285
Dissolved Cl (mg/l)	498
Dissolved F (mg/l)	1.2
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	5.2
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1420
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	112
Non-CO_3 hardness (mg/l)	
Percent Na	89
SAR	19
Specific conductance (µmhos)	2460
pH	8.4
Temperature °C	32.8
CO_2 (mg/l)	1.2
Total As (µg/l)	
Dissolved As (µg/l)	
Dissolved Ba (µg/l)	
Dissolved B (µg/l)	2606
Dissolved Li (µg/l)	
Dissolved Sr (µg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 4

Well Name: LCRP 8
Well Location: 14S 11E 32R1S
Elevation of Land Surface (MSL): 88 FT.
Depth of Well: 985 FT.
Sampling Depth Interval: 135 - 560 FT.
Date of Sample: 4-3-62
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	16
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	133
Dissolved Mg (mg/l)	36
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	445
Dissolved K (mg/l)	
HCO_3 (mg/l)	82
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	67
Dissolved SO_4 (mg/l)	827
Dissolved Cl (mg/l)	365
Dissolved F (mg/l)	1.4
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

Total NO_3 (mg/l)	0.2
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	1870
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	480
Non-CO_3 hardness (mg/l)	413
Percent Na	
SAR	
Specific conductance (μmhos)	2800
pH	7.5
Temperature °C	
CO_2 (mg/l)	4.1
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	1600
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

AREA 4

Well Name: LCRP 8
Well Location: 14S 11E 32R1S
Elevation of Land Surface (MSL): 88 FT.
Depth of Well: 985 FT.
Sampling Depth Interval: 135 - 560 FT.
Date of Sample: 5-11-62
Sampled By: USGS
Analyzed By: USGS

Dissolved SiO_2	15
Dissolved Al (μg/l)	
Total Fe (μg/l)	
Dissolved Fe (μg/l)	
Ferrous Fe (μg/l)	
Total Mn (μg/l)	
Dissolved Mn (μg/l)	
Dissolved Ca (mg/l)	152
Dissolved Mg (mg/l)	33
Dissolved Na (mg/l)	
Dissolved Na+K (mg/l)	510
Dissolved K (mg/l)	
HCO_3 (mg/l)	84
CO_3 (mg/l)	
Alkalinity as $CaCO_3$ (mg/l)	69
Dissolved SO_4 (mg/l)	1080
Dissolved Cl (mg/l)	318
Dissolved F (mg/l)	
Br (mg/l)	
I (mg/l)	
Dissolved NO_3 as N (mg/l)	

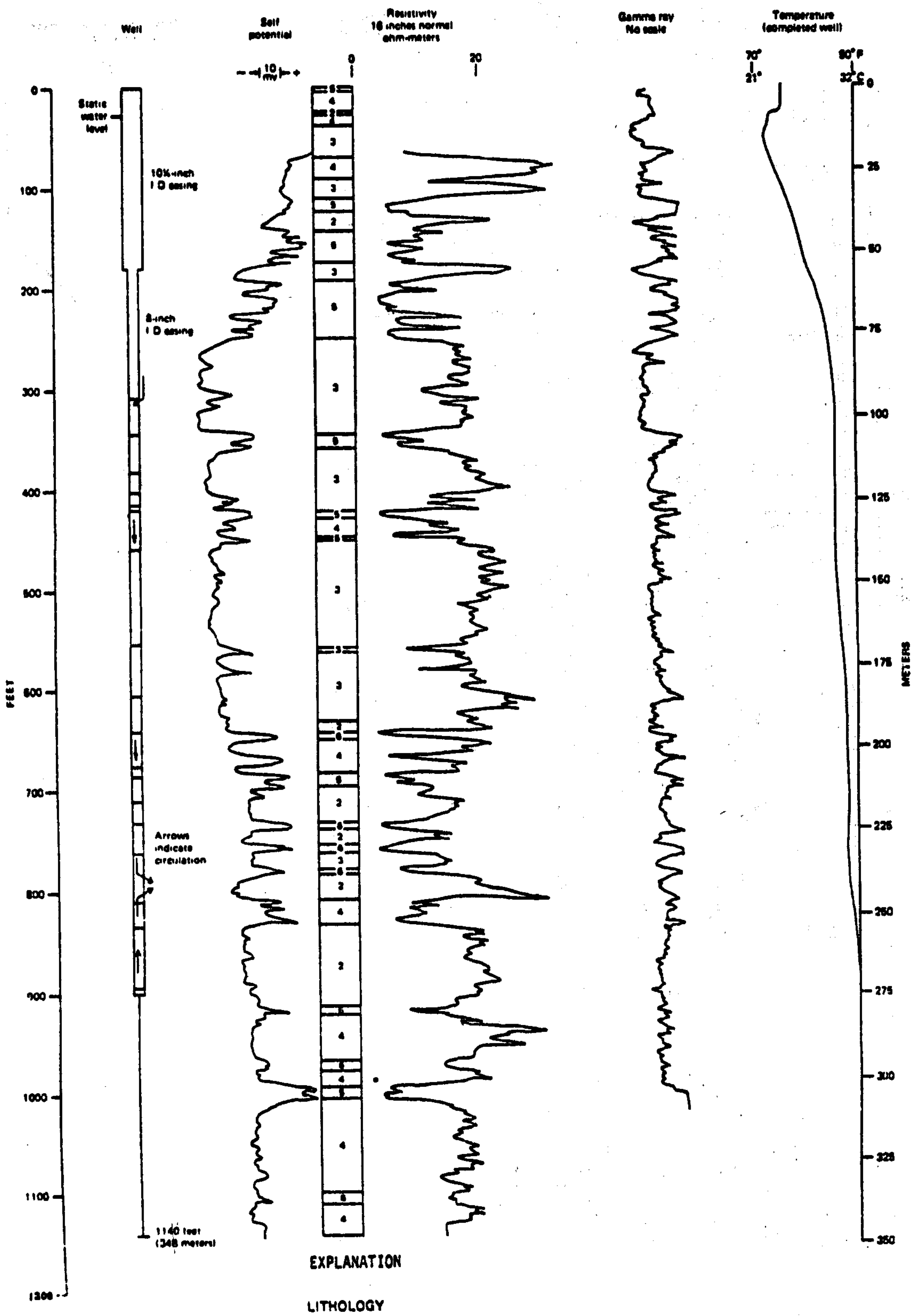
Total NO_3 (mg/l)	
Dissolved NO_3 (mg/l)	
Dissolved NO_2+NO_3 as N (mg/l)	
Dissolved NH_3 as N (mg/l)	
Dissolved NH_3 as NH_4 (mg/l)	
TDS residue at 180°C (mg/l)	
TDS (mg/l)	2140
TDS (tons/acre-ft.)	
Hardness (Ca, Mg) (mg/l)	515
Non-CO_3 hardness (mg/l)	463
Percent Na	
SAR	
Specific conductance (μmhos)	2920
pH	7.7
Temperature °C	
CO_2 (mg/l)	2.7
Total As (μg/l)	
Dissolved As (μg/l)	
Dissolved Ba (μg/l)	
Dissolved B (μg/l)	
Dissolved Li (μg/l)	
Dissolved Sr (μg/l)	

NOTE: Data adapted from Selected Data on Water Wells, Geothermal Wells and Oil Tests in Imperial Valley California, U.S.G.S. Open File Report, July, 1976, by B.F. Hardt and J. J. French.

APPENDIX G

GEOPHYSICAL WELL LOGS

LCRP 11 16S/18E-15M1
Altitude +120 feet (+38 meters)

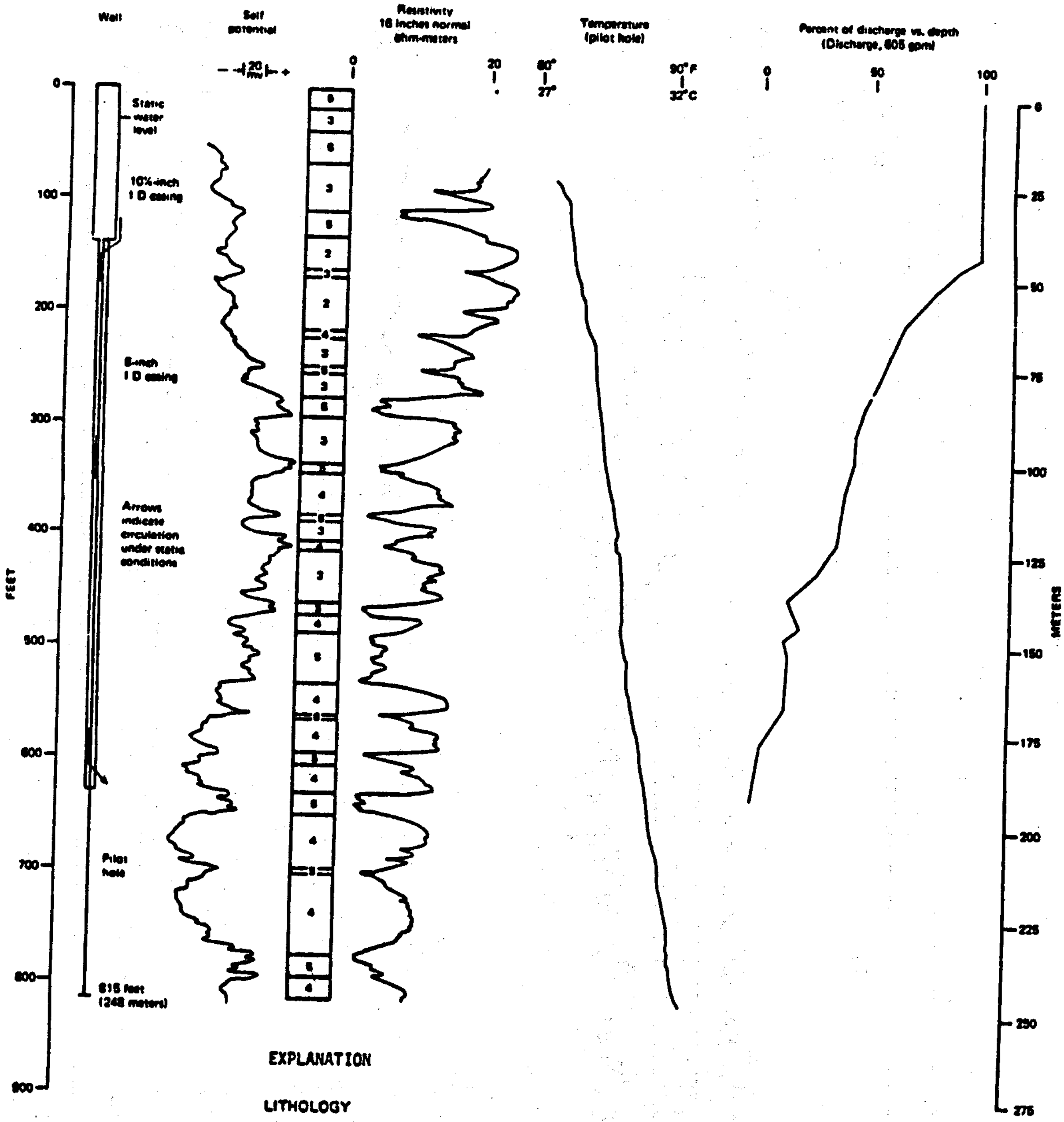


EXPLANATION

LITHOLOGY

1	Gravel
2	Sand and gravel
3	Sand
4	Silty sand, very fine sand, or silty clay with sand
5	Silty clay, clay silt, or silty clay with fine sand
6	Clay

LCRP 18 16S/18E-32R
Altitude +118 feet (+36 meters)

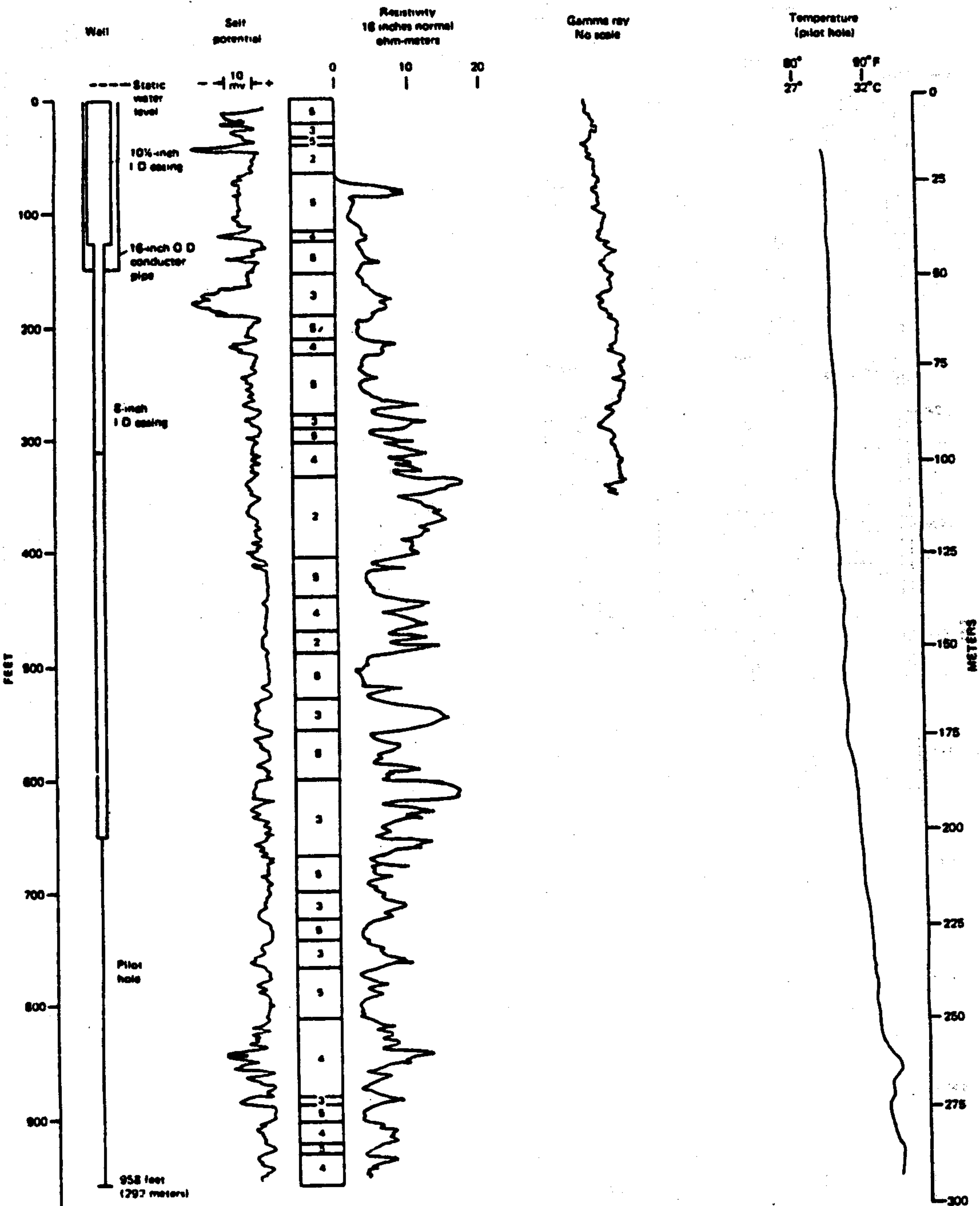


EXPLANATION

LITHOLOGY

1	Gravel
2	Sand and gravel
3	Sand
4	Silty sand, very fine sand, or silty clay with sand
5	Silty clay, clay silt, or silty clay with fine sand
6	Clay

LCRP 19 12S/11E-18J
Altitude -175 feet (-53 meters)



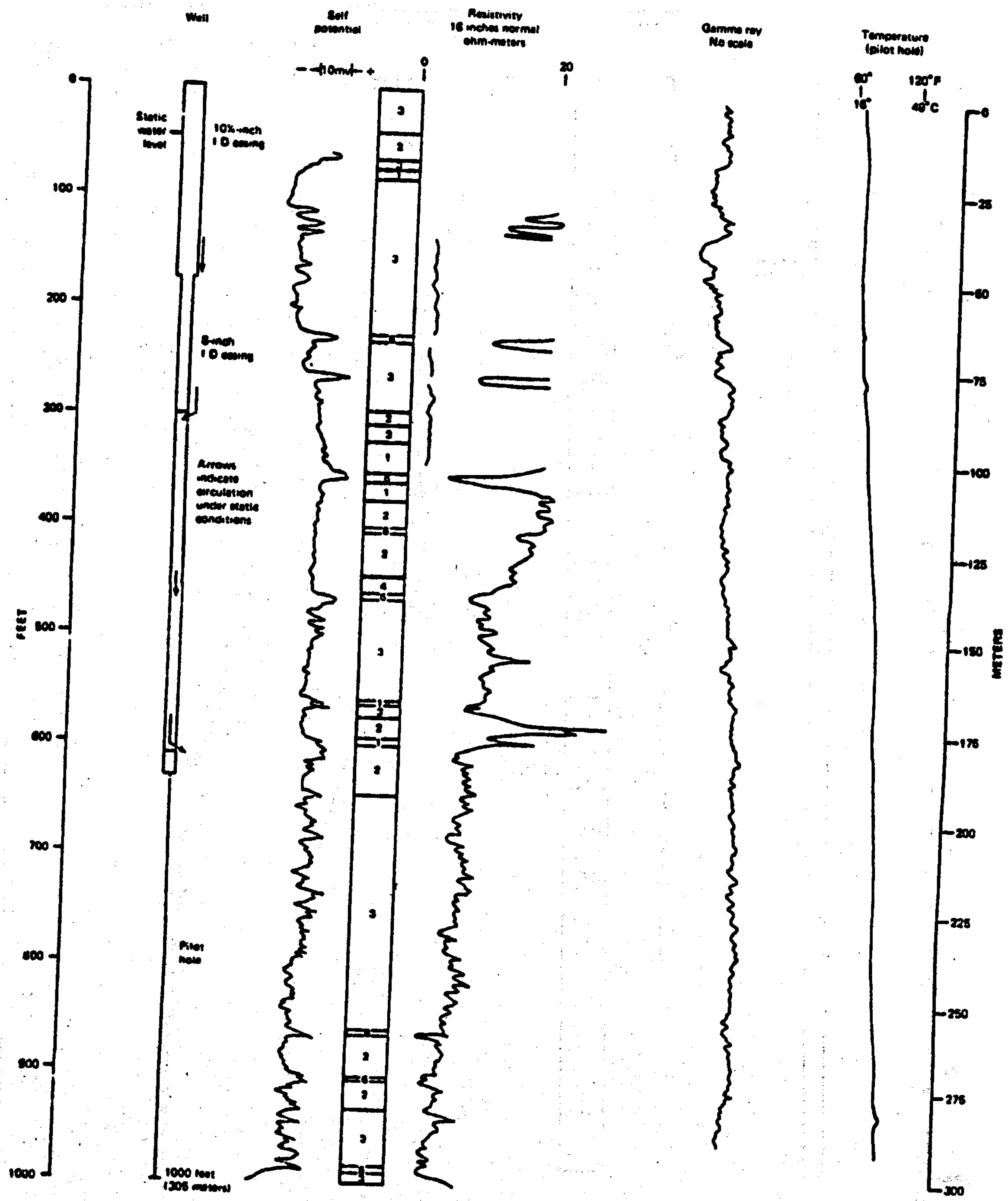
LEAD EDGE

EXPLANATION

LITHOLOGY

1	Gravel
2	Sand and gravel
3	Sand
4	Silty sand, very fine sand, or silty clay with sand
5	Silty clay, clay silt, or silty clay with fine sand
6	Clay

LCRP 12 16S/19E-11D1
Altitude +155 feet (+47 meters)



EXPLANATION

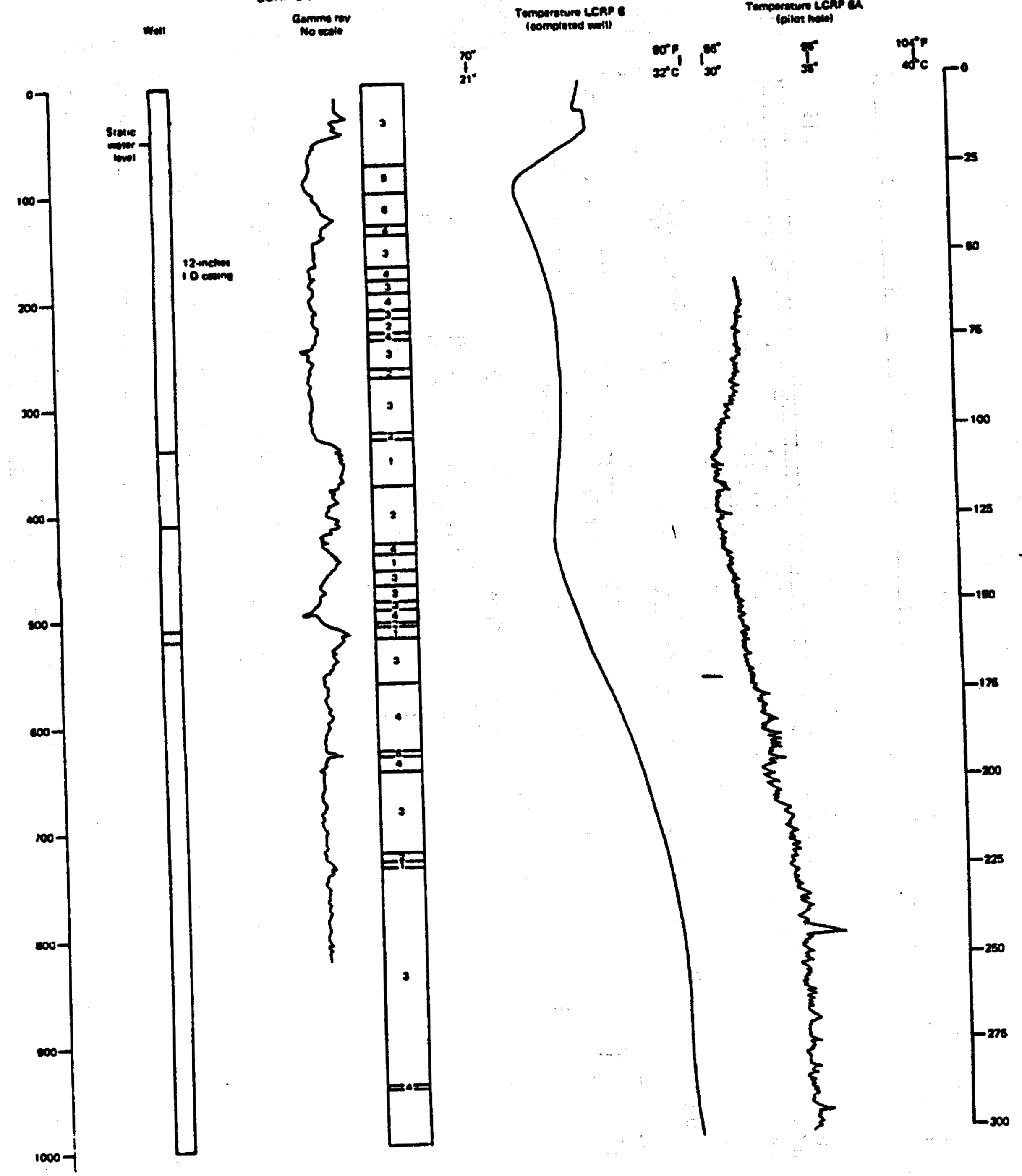
LITHOLOGY

1	Gravel
2	Sand and gravel
3	Sand
4	Silty sand, very fine sand, or silty clay with sand
5	Silty clay, clay silt, or silty clay with fine sand
6	Clay

LCRP 6 16S/20E-31R

Altitude +155 feet (+47 meters)

LCRP 6 drilled by cable tool; LCRP 6A consisted of deepening by rotary method

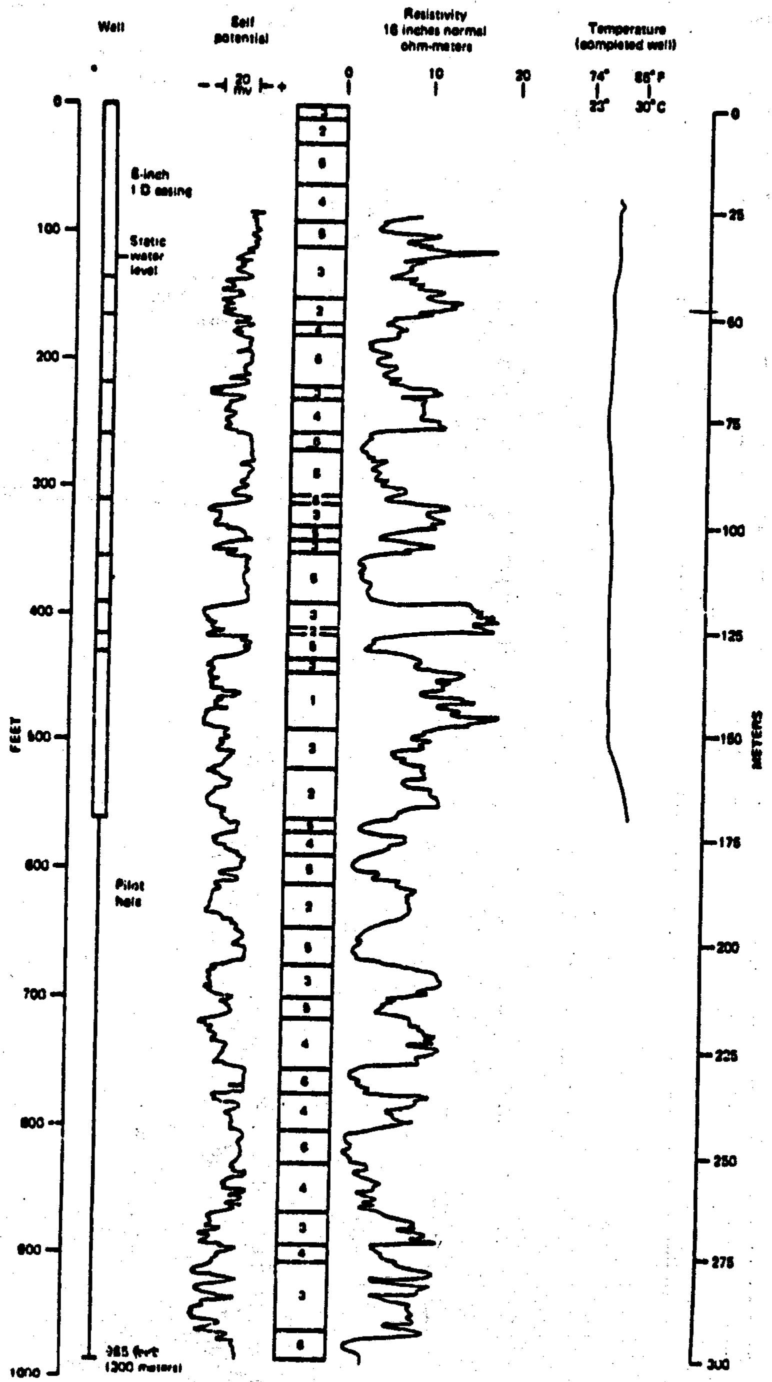


EXPLANATION

LITHOLOGY

1	Gravel
2	Sand and gravel
3	Sand
4	Silty sand, very fine sand, or silty clay with sand
5	Silty clay, clay silt, or silty clay with fine sand
6	Clay

LCRP 6 14S/11E-32R1
Altitude +88 feet (+27 meters)

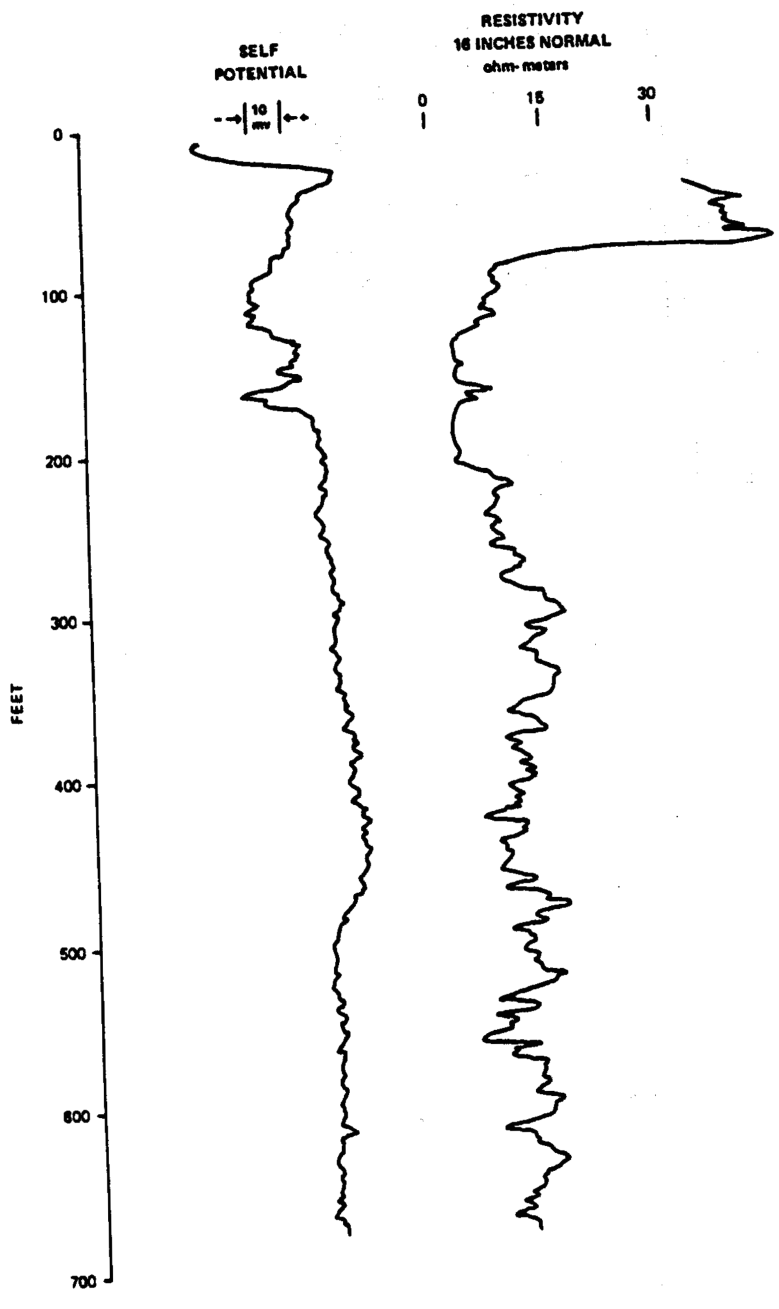


EXPLANATION

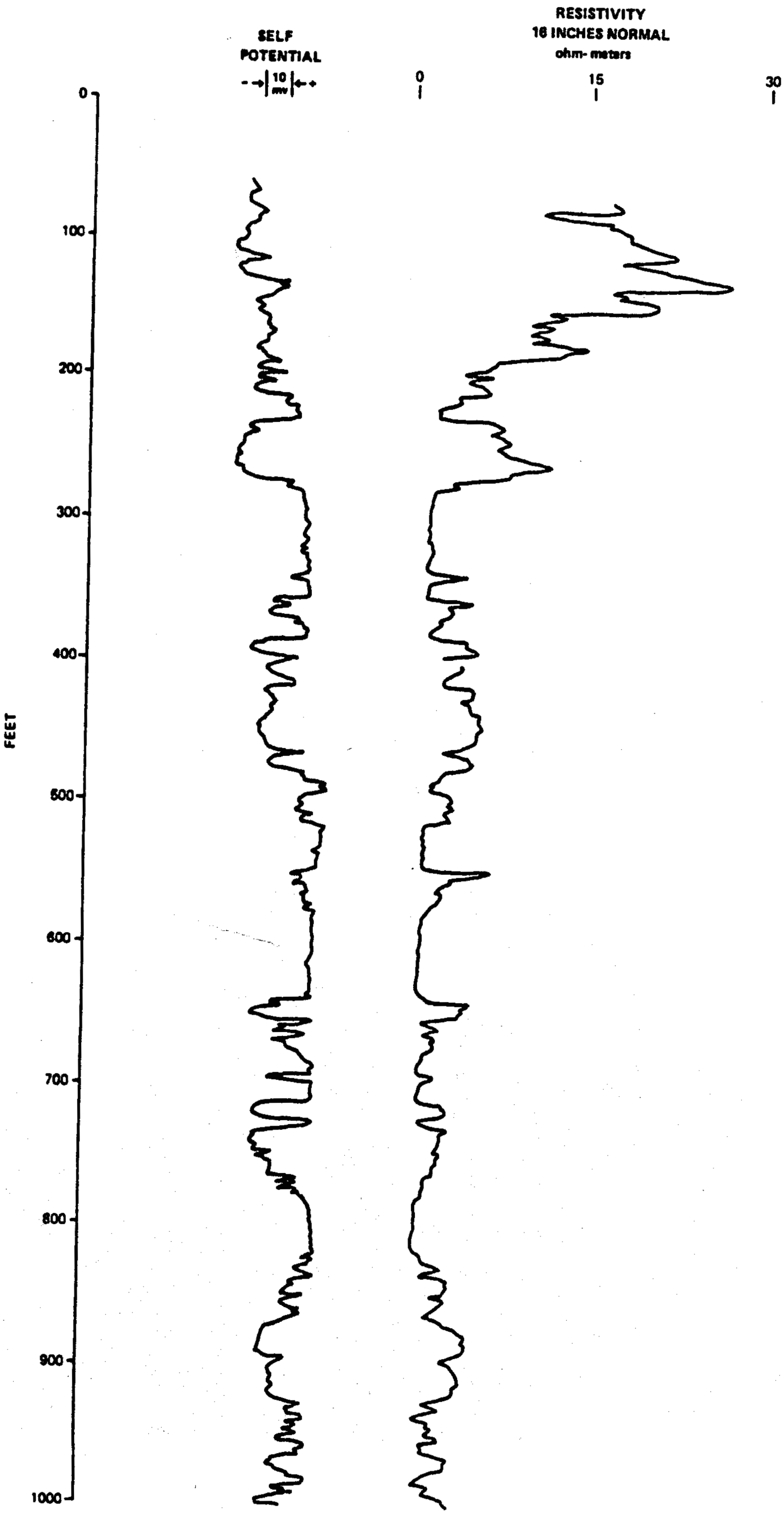
LITHOLOGY

1	Gravel
2	Sand and gravel
3	Sand
4	Silty sand, very fine sand, or silty clay with sand
5	Silty clay, clay silt, or silty clay with fine sand
6	Clay

JACOBS WELL 1 (TMJ)
ALTITUDE N.A.
T12S/R9E - 22A2



SOUTHERN PACIFIC RAILROAD CO. (SPC)
ALTITUDE 220 FEET (67.1 Meters)
T12S/R16E-9A



II. COSO

APPENDIX A

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APPENDIX B

TOPICS	KEY WORDS	AUTHOR Bloyd & Robson TITLE Math Ground water Model of Indian Wells, Valley, Ca. REFERENCE NO. B4-C	AUTHOR Dutcher & Moyle TITLE Geologic & Hydrologic Features of Indian Wells, Valley, Ca REFERENCE NO. D1-C	AUTHOR Kunkel & Chase TITLE Geology & Ground Water in Indian Wells, Valley, Ca REFERENCE NO. K3-C
GROUNDWATER	AQUICLUDE			
	AQUIFER			
	AQUITARD			
	BOUNDARY			
	CONFINED		p.9	
	DISCHARGE	p.12, p.18, Fig.9		p.63-72
	GEOHYDROLOGY			
	GRADIENT			
	HYDRAULIC CONDUCTIVITY	p.8		
	INFLOW			
	LEAKAGE			
	MOVEMENT		p.13	p.42
	OUTFLOW			
	PERMEABILITY			
	PIEZOMETRIC			
	POTENTIOMETRIC			
	RECHARGE	p.12, p.18, Fig.9		p.72
	SEEPAGE			
	SPECIFIC CAPACITY			
	SPECIFIC YIELD			
	SPRING			
	STORAGE COEFFICIENT	p.8, Fig. 8	p.10, Plate 4	
	TEMPERATURE			
	TRANSMISSIVITY	p.8, Fig. 6 & 7	p.10, Plate 4	p.58
	UNCONFINED			
	WATER BUDGET			
	WATER DEMAND			
	WATER LEVEL	p.25, p.28, Fig.3,4,5	p.17	p.43, p.47
	WATER QUALITY		p.26, Plate 5	p.49-51
	WATER SUPPLY			
	WATER USE	Fig. 12	p.23	
	WELL COMPLETION			
	WELL DEPTH			
	WELL LOGS			
GEOLOGY	CLAY			
	FAULT			
	FRACTURE			p.32
	GEOCHEMISTRY			
	GEOPHYSICAL LOGS			
	GEOTHERMAL			
	HAZARD			
	ISOPACH			
	JOINT			
	LINEATION			
	POROSITY			
	SAND			
	SHALE			
	STRATIGRAPHY			
	STRUCTURE			p.34
	THICKNESS			
SURFACE WATER	AQUEDUCT			
	CANAL			
	CONSUMPTIVE USE			
	DAM			
	DISCHARGE			
	DIVERSION			
	DRAW			
	EVAPORATION		p.21	p.63
	EXPORT			
	HYDROLOGY			
	IMPORT			
	INFLOW			
	IRRIGATION			
	LAKE			
	OUTFLOW			
	PRECIPITATION			
	RESERVOIR			
	RIVER			
	RUNOFF			
	SEA			
	SEEPAGE			
	SPRING			
	STORAGE CAPACITY			
	TEMPERATURE			
	TRANSPIRATION			
	WATER BUDGET			
	WATER DEMAND			
	WATER QUALITY			
	WATER SUPPLY			
	WATER USE			
	COMMENTS			

TOPICS	KEY WORDS	AUTHOR McClelland TITLE Aquifer Test Compilation for the Mojave Desert Region, Ca. REFERENCE NO. M2-C	AUTHOR Moyle Jr. TITLE Data on Wells in Indian Wells Valley Area REFERENCE NO. C3-C	AUTHOR Zbur TITLE A Geophysical Invest. of Ind.Wells Va. REFERENCE NO. Z1-C
GROUNDWATER	AQUICLUDE			
	AQUIFER	p.13, p.21, p.26, p.34		
	AQUITARD			
	BOUNDARY			
	CONFINED			
	DISCHARGE			
	GEOHYDROLOGY			
	GRADIENT			
	HYDRAULIC CONDUCTIVITY			
	INFLOW			
	LEAKAGE			
	MOVEMENT			
	OUTFLOW			
	PERMEABILITY			
	PIEZOMETRIC			
	POTENTIOMETRIC			
	RECHARGE			
	SEEPAGE			
	SPECIFIC CAPACITY	p.25		
	SPECIFIC YIELD			
	SPRING			
	STORAGE COEFFICIENT			
	TEMPERATURE			
	TRANSMISSIVITY			
	UNCONFINED			
	WATER BUDGET			
	WATER DEMAND			
	WATER LEVEL		p.78 Table 2	
	WATER QUALITY		p.129 Table 3	
	WATER SUPPLY			
	WATER USE		p.240	
	WELL COMPLETION			
	WELL DEPTH			
	WELL LOGS		p.194 Table 4	
GEOLOGY	CLAY			
	FAULT			
	FRACTURE			
	GEOCHEMISTRY			
	GEOPHYSICAL LOGS			
	GEOTHERMAL			
	HAZARD			
	ISOPACH			
	JOINT			
	LINEATION			
	POROSITY			
	SAND			
	SHALE			
	STRATIGRAPHY			~~p.60~~
	STRUCTURE			
	THICKNESS			Fig. 5-13
SURFACE WATER	AQUEDUCT			
	CANAL			
	CONSUMPTIVE USE			
	DAM			
	DISCHARGE			
	DIVERSION			
	DRAW			
	EVAPORATION			
	EXPORT			
	HYDROLOGY			
	IMPORT			
	INFLOW			
	IRRIGATION			
	LAKE			
	OUTFLOW			
	PRECIPITATION			
	RESERVOIR			
	RIVER			
	RUNOFF			
	SEA			
	SEEPAGE			
	SPRING			
	STORAGE CAPACITY			
	TEMPERATURE			
	TRANSPIRATION			
	WATER BUDGET			
	WATER DEMAND			
	WATER QUALITY			
	WATER SUPPLY			
	WATER USE			
	COMMENTS			

APPENDIX C

APPENDIX C

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APPENDIX D

APPENDIX D

Aquifer Characteristics

The term "aquifer" is applied to any water-bearing formation or rock unit that is capable of yielding an adequate water supply. The adjectives "excellent," "good," "fair," or "poor" may be used to denote the degree to which the yield from an aquifer is adequate, but they are not specific enough for a quantitative appraisal of an aquifer or for comparing one aquifer with another. To be more specific, the water-bearing ability of an aquifer may be expressed in terms of the aquifer's transmissivity. Transmissivity is expressed as the rate of flow in gallons per day through a one-foot-wide vertical strip of the entire saturated thickness of the aquifer under a unit hydraulic gradient at the prevailing temperature of the water.

The water-bearing ability of an aquifer may also be expressed in terms of field hydraulic conductivity. As used in this report, the field hydraulic conductivity is the rate of flow in gallons per day that will occur through a one-foot-square cross-section of the aquifer under a unit hydraulic gradient. Generally, the horizontal hydraulic conductivity of an aquifer is greater than the vertical hydraulic conductivity.

This is especially true for alluvial materials because of size sorting and the alignment of platy and ellipsoidal grains that occurred during deposition of the material. The vertical hydraulic conductivity of some aquifers that consist of many different strata ranging from clay or silt to sand or gravel may be only hundredths or thousandths of the horizontal hydraulic conductivity. Horizontal hydraulic conductivities in Imperial Valley range from a fraction of a gallon per day per square foot to several thousand gallons per day per square foot for well-sorted sand and gravel.

Transmissivities commonly are computed from the results of controlled pumping tests. They also can be computed on the basis of the width of a vertical section through which ground water is moving at a known rate under a known hydraulic gradient, or on the basis of the specific capacity, which is the rate of yield per unit drawdown, of a well.

Another important characteristic of a water-bearing rock is its capacity to store or to release water in response to changes in head. A measure of this characteristic is called the storage coefficient and is a dimensionless number that is defined as the volume of water that is released from or is taken into storage per unit surface area of an aquifer per unit change in the component of head normal to that surface.

When water is confined--that is, when it occurs under artesian conditions--the changes in storage that result from changes in head are attributed entirely to compressibility of the water and of the aquifer materials. Storage coefficients under artesian conditions are small and generally range from about 0.00001 to 0.01.

In water table aquifers, the changes in storage that result in changes in head are defined by the specific yield which is the percentage of water by volume that can be drained from a porous rock under gravity.

Aquifer characteristics can be determined by pump tests. All pump tests for this area are located in the Indian Wells Valley. These tests were conducted by well owners, USGS, the Naval Weapons Center at China Lake and California Electric Power Company. The results of these pump tests are shown in Appendix E. Specific yields for the deep aquifer are shown in Figure IID-1.

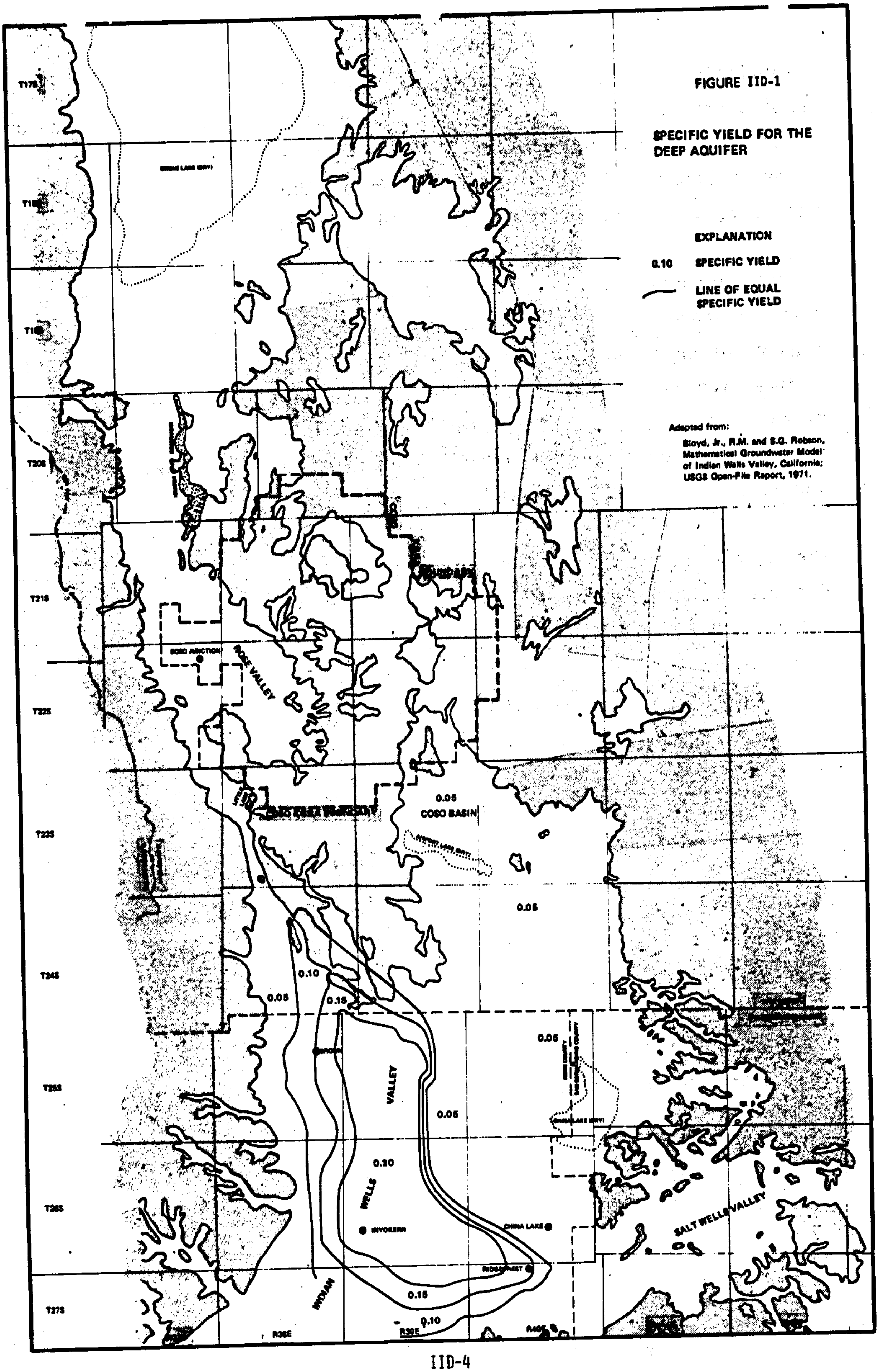
FIGURE IID-1
SPECIFIC YIELD FOR THE DEEP AQUIFER
EXPLANATION
0.10 SPECIFIC YIELD
LINE OF EQUAL SPECIFIC YIELD
Adapted from:
Bloyd, Jr., R.M. and S.G. Robson, Mathematical Groundwater Model of Indian Wells Valley, California; USGS Open-File Report, 1971.
T20S
T21S
T22S
T23S
T24S
T25S
T26S
T27S
COSO JUNCTION
ROSE VALLEY
COSO BASIN
0.05
0.05
0.10
0.05
0.15
0.05
0.05
0.20
INDIAN WELLS VALLEY
INYOKERN
CHINA LAKE
RIDGECREST
0.15
0.10
SALT WELLS VALLEY
R38E
R39E
R40E

APPENDIX E

TABLE IIE-1

RESULTS OF PUMPING TESTS, INDIAN WELLS VALLEY, CALIFORNIA

Well Location	Source of Test Data	Date of Test	Well Depth (ft.)	Interval Tested (ft. below land surface)	Yield (GPM)	Draw-down (ft.)	Specific Capacity (GPM/ft)	Trans-missity (GPM/ft)	Hydraulic Conductivity (GPM/ft²)
T25S/R39E									
-4R1	B1-C	9-19-72	200		71.7	19.2	3.7		
-9J1	B1-C	9-19-72	200		38.2	6.9	5.5		
-12R1	K2-C	4-23-70	180.5		113	2.4	47		
-12R2	B1-C	9-19-72	180		118.8	2.3	51.7		
-35N1	M2-C	7-29-53	152		275	13.2	21	56,000	570
T25S/R40E									
-20F1	M2-C	10-21-52	182.6		96	4.4	22		
T26S/R39E									
-1E1	M2-C	? -20	250		450	20	22		
-5F1	B1-C	9-19-72	200		71.8	14.4	5.4		
-11E1	B1-C	10-3-72			206.8	62.6	3.3		
-19K1	K2-C	11-? -68	803	255-540	1160	114	10		
				590-625					
				700-790					
-19P1	B1-C	9-26-72	446	240-350	1956.6	44	444.7		
				360-390					
				405-420					
T26S/R39E									
-19Q1	M4-C	3-20-53	371	251-371	785	7.9	99		
-19Q2	B1-C	9-26-72	510		1400.5	80.7	17.4		
-20F1	M4-C	10-17-58	333		818	18	45		
-23J1	M4-C	10-17-60	800	210-380	3560	79	45		
				470-660					
-24K1	-C	6-20-44	323	190-197	1000	7	143	146,000	
				230-278					
				287-301					
-24M1	K2-C	4-22-70	800	220-405	2360	37.2	63		
				450-620					
				730-800					
-24P1	K2-C	4-22-70	825	250-350	2290	70.5	32		
				490-580					
				640-780					
-24Q1	K3-C	11-8-44	361	180-200	800	30	28	155,000	
				230-285					
				325-345					

TABLE IIE-1

RESULTS OF PUMPING TESTS, INDIAN WELLS VALLEY, CALIFORNIA

Well Location	Source of Test Data	Date of Test	Well Depth (ft.)	Interval Tested (ft. below land surface)	Yield (GPM)	Draw-down (ft.)	Specific Capacity (GPM/ft)	Trans-missity (GPM/ft)	Hydraulic Conductivity (GPM/ft^2)
T26S/R39E									
-24R1	M2-C	3-5-53	480	160-281	370	26	12.6	147,000	450
				412-460					
-25D2	M4-C	5-?-50	330		180	4	45		
-25E1	M4-C	3-?-52	387		150	4	38		
-28C2	M4-C	2-11-58	364		419	6.3	66		
-30C1	M4-C	9-7-45	370	238-282	126	2.3	55		
				286-338					
-30F1	M4-C	9-7-45	619	250-321	2200	27	81		
				369-386					
-30F3	B1-C	9-26-72	450		1615.3	49.2	32.8		
T26S/R40E									
-1AR	M4-C	3-17-54	197.5	80-100	35	27	1.3		
				110-130					
				170-190					
-19N1	K3-C	9-7-45	306		45	31.7	14	140,000	
-19P1	K3-C	11-8-44	261	192-220	700	39	18	146,000	
				253-259					
-20N1	M4-C	9-7-45	190		127	13	10		
-30E2	M4-C	?-54	402	204-402	1680	50	34		
-33A1	M4-C	?-50	400	124-400	850	53	16		
-33P2	M4-C	8-6-59	130		385	21.4	18		
-34W1	B1-C	10-3-72	232	135-142	1077	26.9	40		
				146-155					
				176-181					
-36A1	M4-C	2-8-54	270	80-90	75	6.3	12		
				107-127					
				187-195					
				240-260					
T27S/R40E									
-4C2	B3-C	9-22-71	280		264	18	15		
-4L1	B3-C	9-22-71	252	120-252	514	11.8	44		

SOURCE OF DATA LISTED BY REFERENCE NUMBER USED IN BIBLIOGRAPHY

TABLE IIE-2

GROUNDWATER QUALITY DATA

Values for dissolved solids indicate the residue on evaporation at 105°C except those preceded by the letter "a" which have been calculated from the sum of determined constituents (Hem, 1970, p. 320).
Laboratory: C, Cook Research Laboratories, Inc., Menlo Park, Calif.; N, Sanitary Engineering Laboratory, Southwest Division, Bureau of Yards and Docks, U.S. Navy, San Diego, Calif.; GS, U.S. Geological Survey, Water Resources Division.

Well number	Date of collection	Depth of well (feet)	Manganese (Mn)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Laboratory
			Results in milligrams per liter																				
U.S. Public Health Service drinking-water standards (1962)			0.05		0.3							250	250	1.0	45		500						
WILCOXEN AREA																							
26S/39E-19K1	6- 6-72	570	0.00	24	0.0	83	11	69	3.4	168	--	98	176	0.8	6.2	0.00	a503	252	64	37	935	7.7	N
19P1	6- 6-72	420	.00	21	.0	30	3.9	55	2.2	113	--	67	45	.7	10	.52	a300	110	16	51	500	7.7	N
19P1	12- -72	430	.00	31	.31	40	8.8	50	3.3	112	--	84	52	.6	7.5	.1	a333	136	36	44	530	8.0	N
19Q2	6- 6-72	510	.00	19	.0	33	5.8	68	2.6	90	--	73	100	.9	7.1	.31	a378	156	24	48	670	7.6	N
19Q2	12- -72	310	.00	28	.0	72	8.8	80	3.6	117	--	93	152	.5	4.9	.2	a501	216	36	44	880	7.9	N
30F3	6- 6-72	450	.00	17	.0	34	4.4	64	2.5	115	--	63	51	1.0	8.0	.68	a302	102	18	57	550	7.6	N
30F3	12- -72	450	.00	31	1.3	63	8.8	63	2.8	107	--	76	78	.7	8.4	.5	a366	144	36	48	610	8.0	N
INTERMEDIATE AREA																							
26S/39E-23J1	6- 6-72	800	.05	21	.0	28	6.8	33	2.9	115	--	36	24	.8	8.9	.20	a218	98	28	41	360	7.0	N
23J1	12- -72	800	.01	34	.0	37	5.9	31	3.0	127	--	50	20	.5	8.7	.3	a255	116	24	36	390	8.2	N
24M1	6- 6-72	800	.02	20	.0	22	4.9	64	2.1	115	--	30	26	.8	11	.32	a218	76	20	55	330	8.0	N
24M1	12- -72	800	.02	32	.0	37	4.9	31	3.4	117	--	51	20	.4	8.2	.1	a246	112	20	37	375	8.2	N
24P1	6- 6-72	825	.01	15	.0	12	2.7	64	1.8	117	9.6	26	29	1.0	8.0	.80	a226	61	11	76	340	8.6	N
24P1	12- -72	825	.00	31	.48	32	5.9	43	2.5	122	--	50	32	.4	11	.3	a269	104	24	47	389	8.2	N
26S/40E-30K1 1/	11-17-72	230	.00	--	.04	2	1.2	94	--	128	17	35	48	1.2	.2	.9	255	10	5	--	404	8.8	C
30K2 1/	11-17-72	802	.00	--	.02	3.6	.5	95	--	128	6	42	52	1.3	.4	1.0	282	16	2	--	431	8.6	C
RIDGECREST AREA																							
26S/40E-31[illegible] 2/	11-17-72	304	.00	--	.03	4	1.5	99	--	126	12	39	36	1.3	.6	1.2	276	16	6	--	439	8.6	C
34N1	6- 6-72	232	.00	23	.0	36	10	55	3.0	113	--	63	62	.9	8.9	.57	a321	132	42	46	555	7.5	N
[illegible]	12- -72	232	.04	44	.0	30	16	55	5.6	112	--	74	66	.6	9.5	.9	a355	144	48	53	350	8.1	N
27S/40E-[illegible] 2/	11-17-72	280	.00	--	12	26	5.8	115	--	126	--	47	149	.9	2.8	.8	a444	90	26	--	769	8.1	C
[illegible]L1 2/	11-17-72	232	.00	--	.05	11	3.6	135	--	159	--	36	117	1.0	1.4	1.2	413	42	16	--	679	8.1	C
OUTLYING AREAS																							
25S/39E-4R1	6- 6-72	200	0.01	23	0.0	21	21	166	26	281	--	130	88	0.9	4.9	3.1	a644	188	136	68	1,185	7.8	N
4R1	12- -72	200	.06	38	1.2	37	26	146	13	293	96	149	92	.6	.9	2.4	a748	200	108	59	1,090	8.4	N
9J1	6- 6-72	200	.01	33	.0	44	20	187	8.9	349	--	70	33	1.1	1.8	1.8	a517	200	80	52	870	7.3	N
9J1	12- -72	200	.02	60	1.3	24	21	97	11	234	96	95	44	.9	1.7	.6	a568	148	88	57	730	8.6	N
12R2	6- 6-72	180	.00	24	.0	44	23	180	12	344	--	130	110	1.0	7.1	2.1	a723	208	98	64	1,150	7.9	N
12R2	12- -72	180	.00	43	.0	37	24	158	15	307	--	160	96	.8	2.2	2.8	a692	192	100	62	1,100	8.3	N
26N1	6- 6-72	302	.10	21	.0	20	12	214	6.8	298	--	120	148	2.6	4.0	.82	a696	100	48	81	1,180	7.9	N
35N1	6- 6-72	152	.00	28	.0	44	12	108	2.9	205	--	92	82	.7	.0	1.1	a464	158	48	58	810	7.5	N
35N1	12- -72	152	.00	36	.0	40	9.8	106	3.1	176	18	85	92	.6	.0	1.0	a508	140	40	62	760	8.4	N
25S/40E-27E1	6-28-72	16	--	60	.20	16	7.5	250	18	396	18	94	140	.6	.0	2.0	799	66	0	86	1,250	8.6	GS
35P1	6-18-74	15	--	31	.04	1.7	.2	2,700	16	1,310	935	730	2,100	5.8	.3	24	7,620	5	0	100	11,200	9.5	GS
25S/41E-21E1	12- -72	202	.12	36	.28	112	16	480	20	146	--	222	760	1.4	2.6	9.8	a1,730	344	64	76	3,450	8.0	N
26S/39E-3P1	6- 6-72	200	.01	21	.05	56	12	130	3.4	193	--	210	73	1.0	3.5	.00	a602	196	50	58	895	7.5	N
3P1	12- -72	200	.01	31	2.5	45	9.8	108	3.7	176	--	140	64	.8	2.2	.6	a466	132	40	58	610	8.2	N
11E1	6- 6-72	250	.00	20	.0	37	7.8	61	2.7	185	--	48	70	.8	3.3	1.9	a366	174	32	43	635	7.7	N
11E1	12- -72	250	.00	32	.0	67	9.8	59	3.4	190	--	63	80	.6	5.7	1.2	a415	208	40	38	770	8.3	N
26S/40E-1J1	6-13-72	--	--	11	.14	108	65	16,000	340	235	--	1,600	25,000	2.1	.0	--	43,600	520	320	97	--	7.9	GS
5P1	6- 6-72	89	.00	20	.0	46	6.3	216	4.4	231	--	85	182	1.2	2.2	2.8	a499	142	26	76	1,160	7.8	N
10P1	6-13-72	39	--	59	.28	19	3.3	140	4.5	310	0	4.7	110	1.4	.0	6.8	520	61	0	84	796	8.3	GS
11J1	6-13-72	18	--	78	5.9	110	30	1,000	36	192	0	490	2,900	2.0	.2	9.4	5,830	400	240	90	9,400	7.1	GS
13C1	6-14-72	22	--	21	.01	200	19	340	20	176	0	130	1,100	1.6	.2	3.5	2,680	580	430	66	3,810	7.1	GS
13N1	6-14-72	22	--	18	110	56	2.2	190	4.3	6	0	130	550	5.7	.5	2.6	1,180	140	140	73	2,020	4.9	GS
14B1	6-12-72	25	--	67	.26	320	62	818	20	328	0	620	1,400	.6	2.8	4.4	3,780	1,100	780	62	5,330	7.6	GS
14N1	6-21-72	18	--	11	130	70	49	300	3.6	0	0	410	340	15	.2	4.3	1,770	380	380	63	2,320	4.6	GS
14L1	6-12-72	37	--	69	.11	41	13	280	12	308	0	220	160	1.2	1.3	1.1	1,070	160	0	78	1,650	7.6	GS
15R1	6-29-72	110	--	60	.04	6.0	1.3	190	2.3	330	0	16	51	1.4	.0	15	463	20	0	93	693	8.4	GS
17J1	6-18-72	97	--	39	.02	31	5.6	52	5.0	162	0	63	35	.9	.1	.19	308	100	0	51	476	7.9	GS
17R1	6-16-72	104	--	32	.03	33	5.7	47	8.3	163	0	43	31	.8	.0	.23	304	110	0	48	440	7.4	GS
21A1	6-13-72	104	--	37	.09	16	3.1	180	8.3	385	0	110	29	2.3	.0	1.6	612	53	0	86	888	7.8	GS
21E1	6-18-72	117	--	34	.05	16	3.4	33	11	149	0	25	31	1.1	.1	.24	280	54	0	63	382	7.9	GS
22B1	6-10-72	63	--	57	.06	170	130	1,200	41	396	0	2,900	320	1.4	2.0	15	5,480	960	640	72	6,600	7.8	GS
22N1	6-12-72	53	--	70	.03	470	380	890	88	205	0	4,100	260	2.7	2.4	12	7,160	2,700	2,600	40	7,110	7.6	GS
22N2	6-12-72	77	--	69	.05	630	990	1,080	70	417	0	10,000	470	4.8	1.5	9	16,500	5,100	4,800	55	15,300	7.7	GS
22N3	6-13-72	97	--	53	.36	790	220	880	41	285	0	3,200	190	3.1	.0	7.6	3,400	1,900	1,600	50	5,740	7.5	GS
22J1	6- 2-72	75	--	68	.06	340	230	530	54	253	0	2,300	260	2.6	1.0	1.6	4,180	1,800	1,600	38	4,610	7.6	GS
22K1	6- 1-72	55	--	67	.11	89	35	180	17	338	0	390	120	2.7	.9	1.1	1,040	370	89	52	1,480	7.4	GS
22N1	6-28-72	203	--	54	.06	40	23	180	9.2	198	0	230	24	2.2	.1	.44	581	190	32	51	842	8.1	GS
22P1	6-17-72	830	--	30	.12	2.1	.4	370	4.9	705	49	18	140	2.7	.1	4.7	1,050	7	0	98	1,640	8.8	GS
22P2	6- 1-72	78	--	78	.05	100	44	188	23	194	0	640	28	2.0	.1	.39	1,200	430	270	46	1,540	7.6	GS
23A1	5-26-72	55	--	63	.05	40	14	710	25	337	0	320	620	4.0	1.2	5.2	2,140	160	0	89	3,310	8.1	GS
23A2	5-26-72	80	--	76	.07	15	3.3	430	16	392	0	61	430	2.3	.0	3.5	1,400	59	0	92	2,090	8.3	GS
23C1	5-26-72	60	--	40	.10	120	64	3,800	61	367	0	3,700	3,000	3.0	.1	23	10,900	560	260	93	15,100	7.9	GS
23J1	5-26-72	63	--	69	.22	30	12	340	17	395	0	210	510	2.6	.8	3.8	1,720	120	0	89	2,650	8.2	GS
23L1	6- 1-72	68	--	53	.04	19	9.1	710	16	670	0	630	260	3.7	.0	6.0	2,100	85	0	94	3,020	7.8	GS
24C1	5-26-72	65	--	31	.10	44	17	780	9.6	665	0	460	570	5.6	16	3.7	2,300	180	0	90	3,560	8.1	GS
24N1	6-12-72	71	--	36	.06	440	120	1,200	89	194	0	340	2,300	.8	9.4	4.4	6,080	1,600	1,400	60	8,820	7.2	GS
26F1	5-26-72	80	--	70	.06	55	17	220	13	224	0	180	220	.6	.0	1.7	952	210	24	68	1,420	8.1	GS
28J1	5-17-72	--	--	55	.02	16	2.0	40	12	129	0	59	21	1.2	.0	.19	298	52	0	66	414	8.3	GS
33D1	6-17-72	--	--	48	.01	24	5.8	35	10	116	0	39	25	.6	1.8	.15	262	84	0	66	364	8.1	GS
32F2	6-17-72	300	--	28	.04	32	8.3	62	3.1	102	0	44	51	.5	4.9	.15	306	110	31	43	452	8.0	GS
35Q2	6-16-72	130	--	71	.03	70	17	200	16	138	0	49	420	.8	.0	2.1	1,050	240	130	62	1,700	7.5	GS
27S/40E-1R2	6-17-72	164	--	55	.01	95	13	390	11	108	0	65	650	1.4	4.3	2.6	1,310	290	200	76	2,420	7.7	GS
2A1	6-16-72	130	--	59	.02	34	13	308	9.3	161	0	38	470	1.1	.9	2.6	1,130	190	61	76	1,890	7.7	GS
2P1	6-16-72	130	--	60	.02	26	3.2	82	5.8	141	0	36	79	1.0	.6	.70	374	86	0	66	559	8.1	GS
2[illegible]1	6-15-72	131	--	55	.03	130	56	320	12	344	0	330	490	.7	12	4.2	1,780	700	420	49	2,690	7.3	GS
2N1	6-18-72	200	--	42	.04	23	1.3	200	4.0	202	0	48	190	1.6	2.4	2.0	648	72	0	85	1,060	8.9	GS
[illegible]	6-17-72	220	--	56	.32	86	15	320	6.3	246	0	76	466	1.0	5.6	3.1	1,230	280	75	71	2,040	7.7	GS
[illegible]	6-29-72	230	--	26	.32	44	7.7	160	3.3	203	0	45	210	1.0	1.2	1.3	632	140	0	70	1,060	8.2	GS
10A7	6-17-72	150	--	50	.03	40	13	230	5.1	169	0	140	280	1.8	6.0	1.5	896	150	15	76	1,500	7.6	GS
15L1	5-29-72	278	--	43	.16	170	40	250	12	121	0	100	670	.6	4.4	1.8	1,370	590	490	47	2,520	7.7	GS

Results in milligrams per liter, except as indicated

Adapted from: R.L. Banta, Groundwater Data, 1972, Indian Wells Valley, California, U.S.G.S. Open-File Report, 1973

III. MONO-LONG VALLEY

APPENDIX A

BIBLIOGRAPHY LISTING

CHAPTER IX

BIBLIOGRAPHY LISTING

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APPENDIX B

LITERATURE CROSS-REFERENCE INDEX

TOPICS	KEY WORDS	AUTHOR Bloyd & Robson TITLE Math Ground water Model of Indian Wells, Valley, Ca. REFERENCE NO. B4-C	AUTHOR Dutcher & Moyle TITLE Geologic & Hydrologic Features of Indian Wells Valley, Ca REFERENCE NO. D1-C	AUTHOR Kunkel & Chase TITLE Geology & Ground Water in Indian Wells Valley, Ca REFERENCE NO. K3-C
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	RUNOFF			
	SEA			
	SEEPAGE			
	SPRING			
	STORAGE CAPACITY			
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	TRANSPIRATION			
	WATER BUDGET			
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	COMMENTS			

TOPICS	KEY WORDS	AUTHOR McClelland TITLE Aquifer Test Compilation For the Mojave Desert Region, Ca. REFERENCE NO. M2-C	AUTHOR Moyle Jr. TITLE Data on Wells in Indian Wells Valley Area REFERENCE NO. C3-C	AUTHOR Zbur TITLE A Geophysical Invest. of Ind.Wells Va. REFERENCE NO. Z1-C
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	WATER SUPPLY			
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	COMMENTS			

APPENDIX C

SUMMARY OF VISITS

APPENDIX C

SUMMARY OF VISITS

The following is a list of people, agency, address and date of visits and telephone contacts.

William R. Moyle, Jr. (Hydrologist)
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James C. Blodgett (Hydraulic Engineer) and Gilbert Bertoldi
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APPENDIX D

SURFACE WATER DATA

APPENDIX D

SURFACE WATER DATA

Precipitation

The average annual precipitation in Mono Basin varies from 40 inches near the top of the Sierra Nevada in the western part of the basin to 10 inches in the east. Precipitation in the area occurs predominantly as snow, and over two-thirds of the average annual precipitation occurs during the months of November through March.

The decreasing rainfall from west to east, as reflected in the mean seasonal precipitation measurements for Ellery, Gem and Lundy Lakes (25.55, 23.93 and 15.6, respectively) is the consequence of the "rain-shadow" effect of the Sierra Nevada. Additional records of precipitation for any length of time for the easternmost portions of the basin are not available.

Evaporation

The amount of water evaporating from Mono Lake has changed as the total surface area of the lake has changed. In 1959, when Mono Lake had surface area of approximately 55,000 acres, evaporation was estimated to be 187,000 acre-feet per year assuming a net evaporation rate of 3.4 acre-feet per year (DWR, 1960). By 1974, the surface area of Mono Lake had decreased to 43,500 acres, and the annual amount of evaporation to approximately 148,000 acre-feet. The reduced surface area of Mono Lake is a continuation of trends since 1919 which has seen the surface elevation of the lake drop from 6,428 feet MSL to 6,382 feet MSL in 1974, an overall reduction of 46 feet. The diversion of water from the basin for irrigation and urban uses is partly responsible for the declining surface area.

Evaporation at Grant Lake is considerably less than at Mono Lake because of its smaller area and higher elevation (cooler year round temperatures). Grant Lake is a man-made reservoir with a maximum storage capacity of 47,500 acre-feet. With an average annual evaporation rate of 2.5 feet per year, mean evaporation from Grant Lake is 2,450 acre-feet per year.

Surface Water Balance

In 1959, surface water inflow into Mono Lake was estimated at 137,000 acre-feet by the California Department of Water Resourcs (1960). The consumptive use of water was 32,000 acre-feet and the annual export was 75,800 acre-feet. In 1974, the consumptive use was 7,300 acre-feet and the export was 102,200 acre-feet. The natural runoff discharge into Mono Lake is 106,500 acre-feet, about 28,300 acre-feet less than the 1959 figure. The Los Angeles Department of Water and Power (LADWP) is currently extracting 102,200 are-feet (140 cfs) from Mono Basin to Owens Basin (Gewee, pers. comm., 1978). Water supply and utilization in the Mono Basin are summarized in Table III-3.

Water Quality

The salinity of Mono Lake has increased as the surface elevation of the lake has dropped. In 1975, the total dissolved solids (TDS) count for the lake was over 60,000 ppm as compared to 51,300 ppm in 1953. Mono Lake is alkaline due primarily to the higher bicarbonate content originating from the surrounding strata. The chemical composition of Mono Lake makes it unsuitable for fish and discourages recreational uses.

Streams fed by melting snow and runoff from the High Sierras are generally calcium carbonate in character, with TDS concentrations of less than 200 mg/l. The water is soft to moderately hard.

Climate and Precipitation

The major climate control of the Long Valley area is the towering Sierra Nevada, which acts as a barrier to the prevailing westerly winds and Pacific storm systems. The average temperature was about 43°F at the Long Valley Dam, which has an elevation of about 6,700 feet.

About 70-80% of the total precipitation in the mountains, and a somewhat smaller proportion in the valley, falls as snow from November through April. Annual precpitation within the Long Valley drainage basin ranges from 62 inches at Mammoth Mountain to 10 inches at Long Valley Dam.

Surface Runoff

Mot streamflow originates in the Sierra Nevada along the west and south margin of the basin, where precipitation exceeds potential evapotranspiration and snowpack lasts into the late spring in most years. The Sierra Nevada streams are measured by the Los Angeles Department of Water and Power. Mammoth Creek, which is the headwaters of Hot Creek, has the following flow regimen as measured at Highway 325 and expressed in cfs.

Jan.	Feb.	Mar.	Apr.	May	June
8.0	7.5	7.4	12.9	43.7	77.4

July	Aug.	Sept.	Oct.	Nov.	Dec.
45.5	18.7	10.1	8.4	8.7	9.1

Evapotranspiration

The surface water balance in the Long Valley Basin is affected by the evaporation and transpiration characteristics of high groundwater table resources within the basin. In 1960, the California Department of

Water Resources adopted two feet per year as the evapotranspiration standard for high groundwater (3 feet depth below surface) level areas in the alkali lakes region north of Lake Crawley. This figure generates an evapotranspiration value of 16,000 acre-feet per year (22 cfs) for these high ground water areas of Long Valley. However, later studies by Sorey (1977) estimated 17.94 cfs of evaporation for shallow ground water areas. Areas of irrigated grassland (4,695 aacres in Long Valley) were found to have an evaporation rate of 15.2 cfs (Sorey, et al., 1977). The Long Valley Basin has a total area of 32 square miles having a shallow ground water level (8 feet or less).

Evaporation directly from Lake Crawley also figures in the overall water budget for the Long Valley Basin. As for ground water evapotranspiration rates, the estimates of water evaporation from Lake Crowley have changed over time. In 1960, the California Department of Water Resources estimated an annual evaporation of 10,000 acre-feet (13.7 cfs), based on 2.4 feet per year rate. In 1967, the evaporation at Lake Crowley was estimated at 9,260 acre-feet per year, or 12.7 cfs (CDWR, 1967). In 1977, Sorey, et al., calculated 12,100 acre-feet (16.6 cfs) of water as having evaporated from a lake surface of 5,187 acres. This last value was used in the water budget computations.

Lake Crowley has enlarged over the past several years as a result of excess water input into the reservoir as opposed to output. At the end of the 1974 water year, 35 cfs more water was stored in Lake Crowley than at the beginning of the 1964 water year. This amounts to an average annual increase of 3.2 cfs (2,336 acre-feet). Based on the estimated evaporation rate and amount in 1960 (2.4 feet per year, 10,000 acre-feet) the lake surface was estimated at 4,166 acres, compared to 5,187 acres in 1977, a 25% increase.

Surface Water Budget

The water budget for Lake Crowley and the Long Valley watershed is shown in Table IIID-1. The annual inflow of water into the reservoir is 384.2 cfs. Discharge from the reservoir, either down the Owens River gorge or into the Los Angeles Aqueduct system, amounted to 346 cfs. The loss through evaporation or irrigation accounts for another 50 cfs of water loss from the basin. The reservoir's average annual increase of storage has amounted to 3.2 cfs, which has a negative effect on the total outflow from the basin.

The total basin outflow for Long Valley, including downstream discharge, aqueduct export, evaporation, and irrigation, is 393.9 cfs, about 8 cfs greater than total inflow. Groundwater inflow into the reservoir which is not accounted for in the above figures may explain the difference.

Water Quality

The quality of the surface water in Long Valley is generally excellent. The waters from the lakes and creeks of the lower slopes of the Sierra Nevada are generally calcium bicarbonate in character and have a TDS level usually less than 100 ppm.

However, a few small isolaed sources, each at hot springs, produce water with a mineral quality which does not meet accepted standards. Generally, the poor quality from these isolated sources stems from concentrations of boron and sodium in excess of that used for irrigation water. However, when the water from these sources is mixed with other water in the area, the result has been a very good overall quality of water supply (CDWR, 1977). The average TDS for 1958 was 184 ppm for water sampled at the outlet of Long Valley Reservoir.

TABLE IIID-1

SUMMARY OF WATER BALANCE FOR THE LONG VALLEY WATERSHED

Item	Cfs	Acre-Feet
Surface runoff	384.2	280,500
Water utilization		
Export to Los Angeles aqueduct	342.0	249,660
Discharge down Owens River Gorge	4.3	3,140
Evaporation		
from shallow groundwater	18.0	13,140
from Lake Crowley	16.6	12,120
Irrigated grassland	15.2	11,100
Change in reservoir storage, 1964-1974	- 3.2	- 2,340
TOTAL	392.9	286,800

Eecler (1976) studied the arsenic concentrations in the Lake Crawley area. About 60% of the arsenic discharged to Lake Crawley is derived from the springs in Hot Creek Gorge. The hot spring water contains about 1 ppm arsenic and is usually diluted to 0.2 ppm in Hot Creek. The arsenic from Hot Creek is diluted to less than 0.1 ppm when mixed with Owens River water. After further dilution, the arsenic concentration in Lake Crowley is within the recommended standard for public water supplies.

APPENDIX E

GROUND WATER DATA

APPENDIX E

GROUND WATER DATA

General Geology

The Mono-Long Valley KGRA study area is located in the basin and ranges geomorphic province on the eastern slopes of the Sierra Nevada. This area is characterized by down chopped blocks which form topographic and structural depressions and uplifted mountain ranges. Valleys and basins of importance which are partially enclosed by the KGRA are the Mono-Valley and Mono Basin to the north and Long Valley to the south. The predominant geomorphic feature is Mono Lake which is encircled by the Mono groundwater basin.

Mono Basin is a large roughly rectangular block that has subsided along nearly vertical faults and has accumulated approximately 18,000 feet of low density sediments and volcanic deposits of Cenozoic age. Long Valley is of similar structure in that it is a collapsed caldera bounded on all sides by near vertical faults and has accumulated approximately 11,000 feet of low density sediments and volcanic deposits of Cenozoic age (Pakister 1964). Cenozoic deposits inlude lake beds, alluvial fan deposits, glacial moraines, rhyolitic and basaltic flows, tuff and breceia. Recent soil and windblown sand cover much of the valley area (Pakister 1964).

APPENDIX F

GROUND WATER PROCUREMENT

APPENDIX F

GROUND WATER PROCUREMENT

The ground water procurement will generally require data collection for the following:

- Physical definition of the areal extent, thickness, and depths to productive aquifers.
- Information on water levels, water quality and temperature.
- Determination of hydraulic properties on ground water movement, recharge, discharge, and ground water in storage. The general ground water evaluation procedure is outlined on Figure III F-1.

Ground Water Exploration Program

The ground water exploration program will include drinking wells for geophysical logging and aquifer testing. Exploration wells will extend to a depth of 1000 feet. The number of wells should be approximately 1 well for every 10 square miles of surfical area in the two ground water basins. Therefore, this will require a total of 51 exploration wells for the various basins which have ground water potential (see Figure III F-2). Table III F-1 is a summary of these potential areas with the number of exploration wells required. The methods used in this program will conform to the standard methods and equipment.

GENERAL GROUNDWATER EVALUATION PROCEDURE

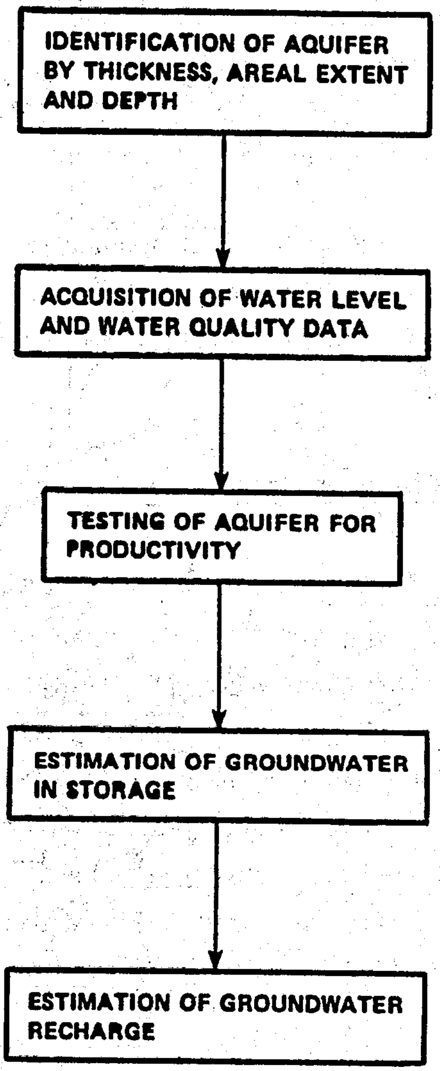

Figure IIIF-1

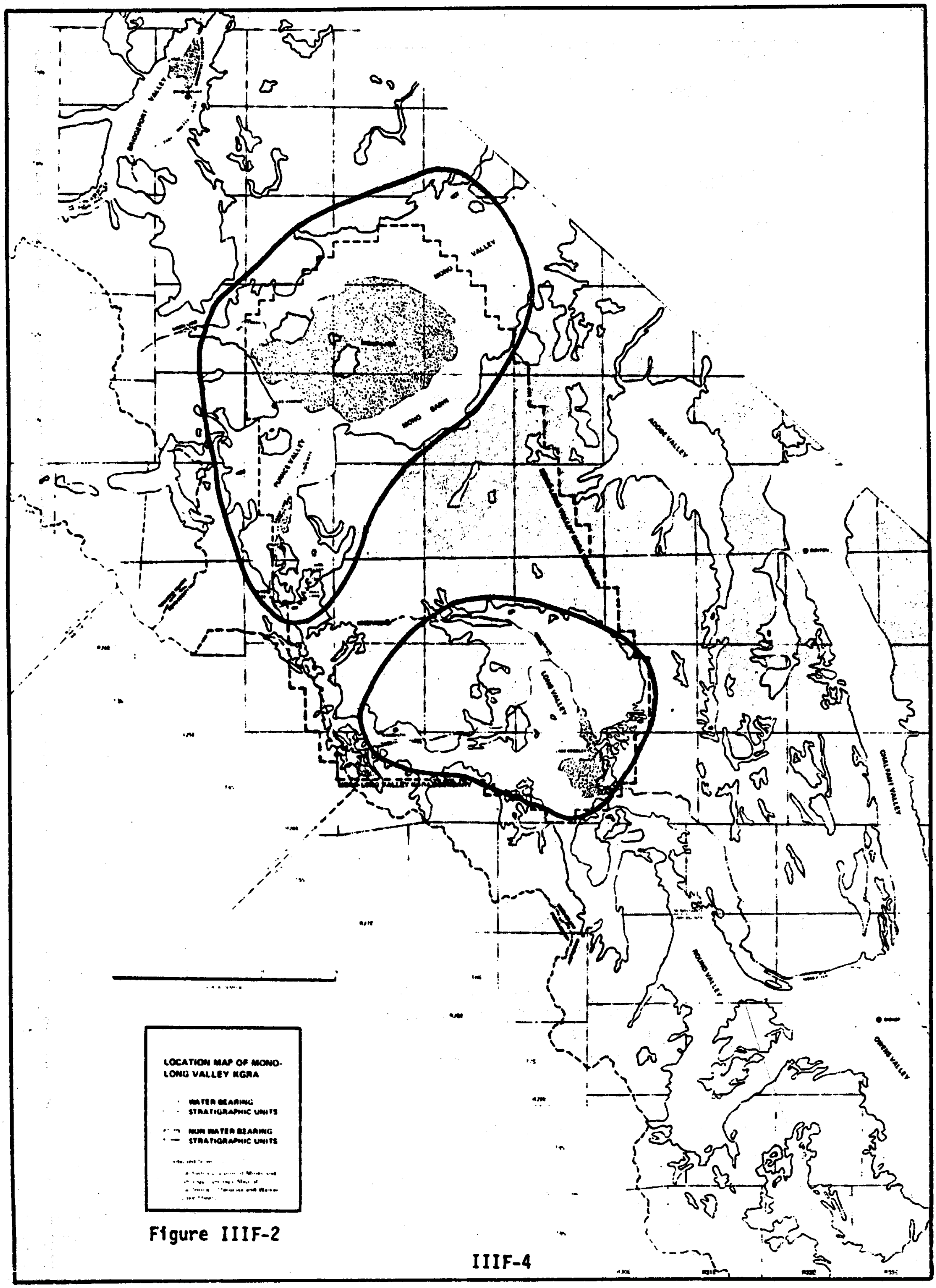

Figure IIIF-2

TABLE III F-1

SUMMARY EXPLORATION WELLS REQUIRED

Area	No. of Exploration Test Wells
Mono Basin	35
Long Valley Basin	16
TOTAL	51

Geophysical Logging Program

This program will determine the areal extent, thickness, and depths to potential stratigraphic units that may be productive aquifers to a depth of 1000 feet. This program should include the following geophysical logging:

a. Spontaneous electrical potential
b. Resistivity
c. Acoustic logs
d. Temperature logs

Spontaneous electrical potential measurements should report: a) location of aquifer, b) thickness of aquifer and, c) water quality.

Resistivity logs should indicate: a) water quality; b) porosity of formation; c) location of aquifer and, d) salinity of pore fluid.

Acoustic logs should report porosity of formations.

For temperature logs, indicate temperature encountered with depths.

In addition, drill cuttings should be logged for all wells.

Ground Water Quality Testing Program

Analysis of ground water quality will be done upon completion of each well water levels should be measured and water samples taken quarterly for a minimum of one year. Water sample analysis should be performed for total dissolved solids and temperature for the various aquifers.

Aquifer Testing Program

The aquifer testing program will determine the hydraulic properties of the existing aquifers. Well design and aquifer test criteria will consider the following:

a. Well diameter
b. Well depth
c. Well screen length
d. Type of pump to be employed
e. Capacity of the pump
f. Rate of discharge and measurement techniques to be employed
g. Length of time of the test period
h. Method of discharge disposal
i. Number and location of observation wells

Measurements of water depth should be conducted according to the following schedule:

RANGE OF TIME INTERVALS BETWEEN WATER LEVEL MEASUREMENTS IN THE PUMPED WELL

Time Since Pumping Started	Time Intervals
0 - 5 minutes	0.5 minutes
5 - 60 minutes	5 minutes
60 - 120 minutes	20 minutes
120 - shut down of the pump	60 minutes

After the pumping test is completed and all information has been collected on well discharge, drawdowns in pumped well, regional trend of the water table, etc., the available data should be analyzed. This data processing should include: a) compilation of the data in the form of graphs; b) correction of the drawdown data for regional changes of the water level in the aquifer not induced by pumping, and for changes, if any, in barometric pressure during the test, and c) determination of the type of aquifer that has been pumped.

IV. GEYSERS CALISTOGA

APPENDIX A

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APPENDIX B

LITERATURE CROSS-REFERENCE INDEX

TOPICS	KEY WORDS	AUTHOR-Bureau of Reclamation TITLE- Feasibility Studies of North Coast Project REFERENCE NO. B2-G	AUTHOR-Cardwell, G.T. TITLE- Geology & Groundwater in the Russian River Valley REFERENCE NO. C1-G	AUTHOR-Calif. DWR TITLE- Clear Lake Water Quality Investigation REFERENCE NO. C2-G
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APPENDIX C

SUMMARY OF VISITS

APPENDIX C

SUMMARY OF VISITS

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APPENDIX D

SURFACE WATER DATA

APPENDIX D

SURFACE WATER DATA

IV.D.1.0 Cache Creek Basin

IV.D.1.1. Climate

The climate of this region is a Mediterranean type characterized by mild wet winters and cool dry summers. The seasonable distribution of precipitation is largely controlled by the high pressure cell that is normally present off the California coast, particularly in summer. The frequent winter storms generally occurs when this high pressure cell moves away of its summer position. Snow occurs in moderate amount above 2000 feet elevation, but rarely remains on the ground for long periods of time, and has little or no effect on the regimen of runoff. Precipitation rarely occurs from June through September, and is likewise geographically influenced.

Along the coast the climate is marked by moderate and equable temperatures, heavy and recurrent fogs, and prevailing west to northwest winds. In land, temperatures have a wide range and winds are generally moderate, in the neighborhood of 10 mph. Temperatures are largely influenced by altitude and by local topography. The influence of ocean decreases markedly with distance from coast. Therefore, summers become hotter and winters ooler going east from coast to Putah-Cache watersheds. Similarly, diurnal extremes become greater to the east.

IV.1.1.2 Precipitation

Annual precipitation ranges from 22 inches on the surface of Clear Lake to about 80 inches over Mayacmas Mountain southwest of the basin.

On the average, about 95% of the precipitation occurs from October through April (Figure IVD-1), the intervening summer months are largely devoid of precipitation. Data showing average rainfall for a 48-year period for Lakeport and Clear Lake Highlands indicate a very erratic pattern of precipitation. Precipitation with about 90 precent probability of being exceeded in a given year averages about 60 percent of the annual precipitation (see Figure IVD-2).

Snow covers the summit areas for periods ranging from a few days to several months, depending on storm intensity and general ambient temperatures. During the winter of 1973-74, snow depths of three feet or more were observed. Lesser amounts were observed for shorter periods, and snow squalls were common as late as May, 1974 (Environmental Consultants 1974).

IV.D.1.1.3. Surface Runoff

Soil permeability in the Cache Creek Basin is generally good, but the soil mantle is relatively thin, and the water-holding capacity is low to moderate, hence the majority of the precipitation runs off rapidly. The monthly distribution of surface runoff is similar to the precipitation as illustrated in Figure IVD-1. Winter storms begin in October and reach their peak in January or February. The surface runoff does not respond quickly to precipitation in October and November, because the soil moisture deficit formed in the summer must be satisfied first. Generally, runoff peaks in January and February and then recedes with the diminishing rainfall.

Skeleton relations of precipitation and runoff for the hydrologic units in which the study area is located are indicated in Table IVD-1. Actual amounts for a specified time would be expected to differ somewhat due to unique topographic and vegetative characteristics of any specific site. However, the relationships shown in the table can be used for comparative purposes.

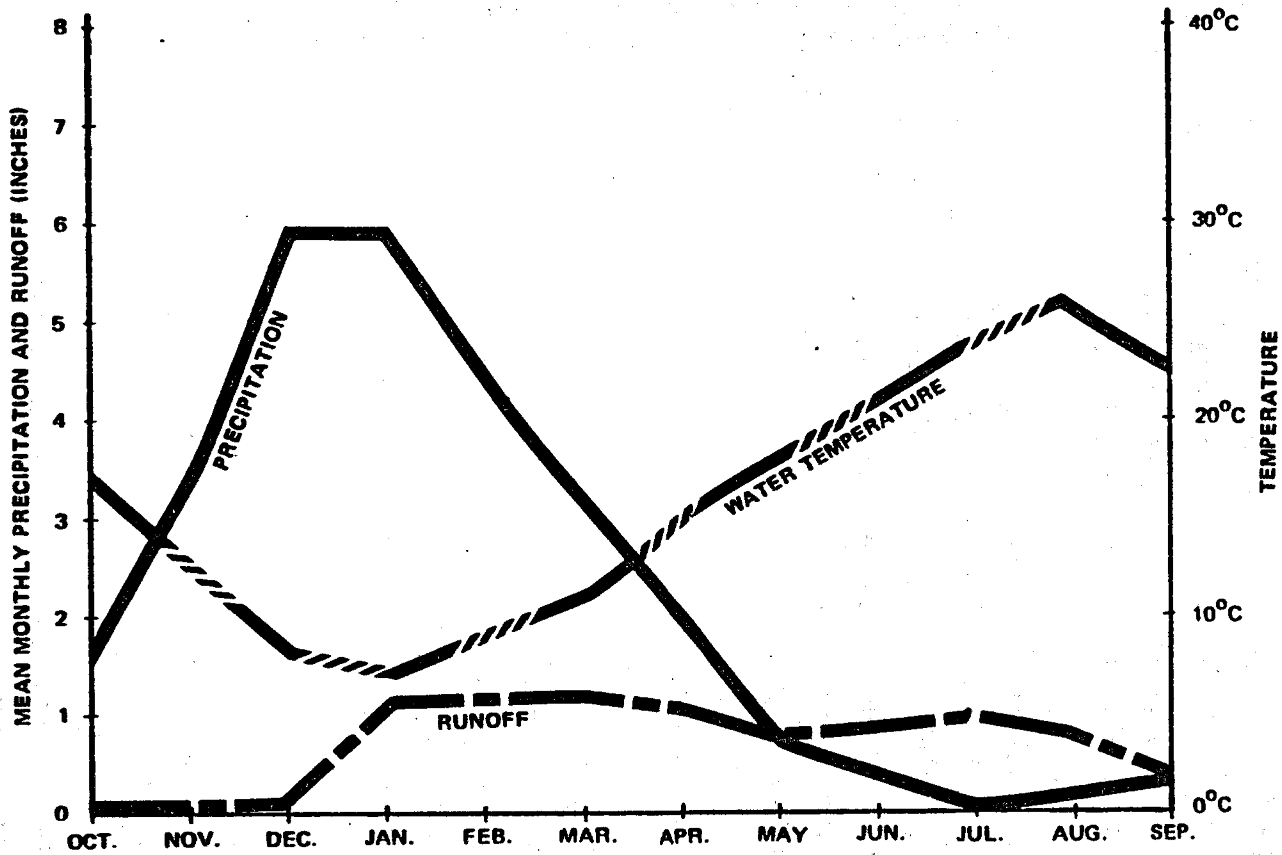


FIGURE IVD-1

MEAN MONTHLY WATER TEMPERATURE (1951-68) AND RUNOFF (1945-68) CACHE CREEK NEAR LOWER LAKE, LAKE COUNTY, CALIFORNIA, U.S.G.S. 11-4510, AND PRECIPITATION (1920-71) AT LAKEPORT

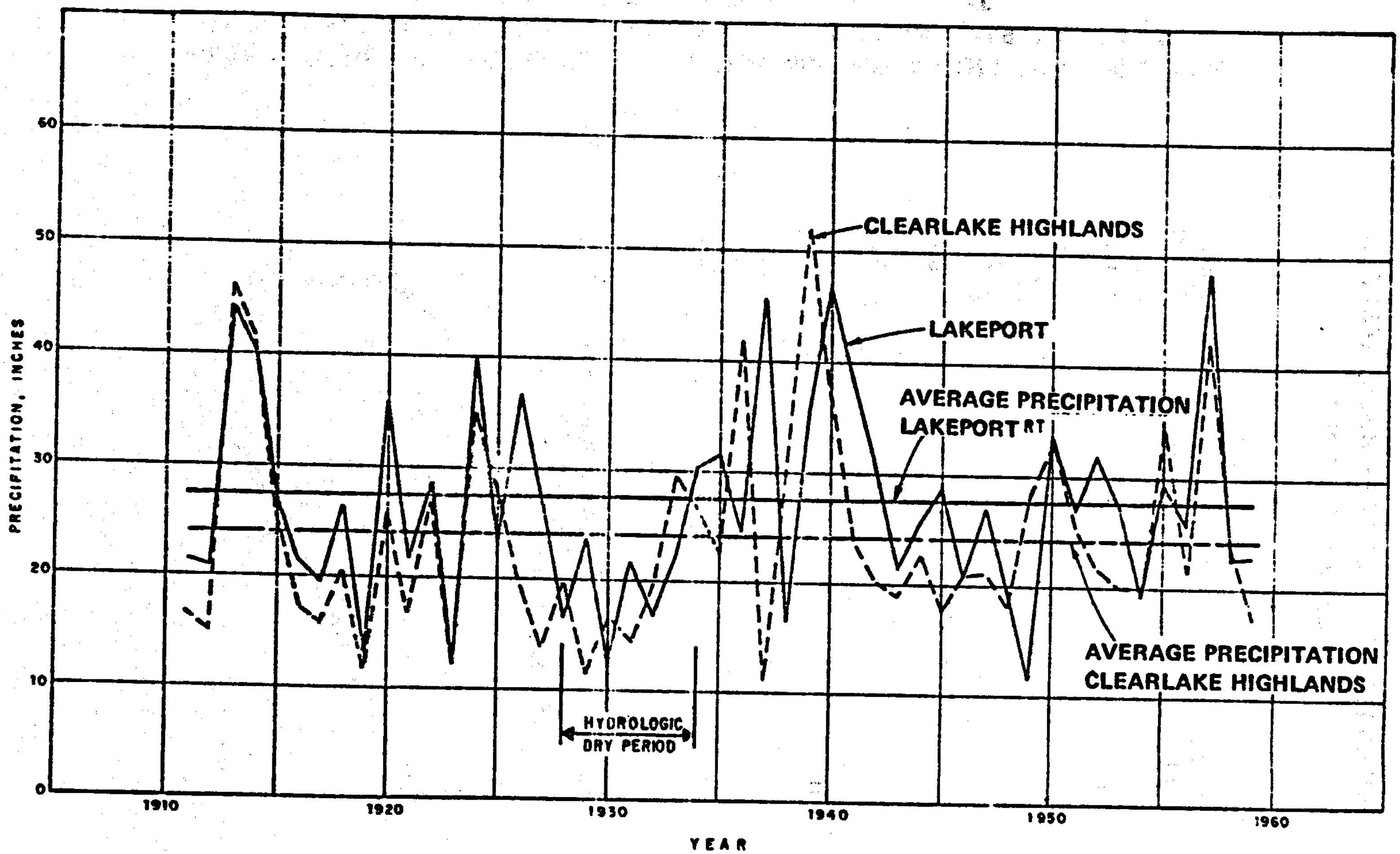


FIGURE IVD-2

AVERAGE ANNUAL PRECIPITATION AT LAKEPORT AND CLEARLAKE HIGHLANDS

Source: Development and Resources Corporation, 1978.

TABLE IVD-1

PRECIPITATION – RUNOFF RELATIONS FOR CLEAR LAKE AREA

Precipitation (inches)	Runoff (inches)
14	1.6
17	3.4
26	7.9
28	9.1
29	9.8
31	11.4
35	15.0
80	60.0

Source: Rantz, S.E., Mean Annual Runoff in the San Francisco Bay Region, California, 1931 – 1970. MF-613. U.S.G.S., 1974.

The flow duration curve is the simplest means of expressing the time distribution of discharge--it shows the percentage of time, for a given period, that any specified discharge is equaled or exceeded. It provides a useful device for analyzing the availability and variability of stream flows.

Flow duration curves were developed for the North fork of Cache Creek and Cache Creek near Lower Lake (Figure IVD-3, IVD-4). The steep slopes of these two similar curves show that the flow is highly variable, indicating the streams have a wide range of discharge. This type of pattern usually indicates that there is little lag between rainfall and runoff. In the North Fork of Cache Creek area, this condition is due to the shallowness of soil, the lack of a snow pad and no ground water fed baseflow. Figure IVD-3 indicates the flow duration curve for the North Fork of Cache Creek.

The flow duration curve of Cache Creek near Lower Lake has minor difference from the North Fork's. This difference is caused by the regulated flow at Clear Lake dam. Therefore the flood peak and the dry period slopes of Cache Creek are not steeper than that of the North Forks. The steepest slope happens at the 50 percent probability, which indicates the flow regimen is artificially controlled. Figure IVD-4 indicates the flow duration curve for Cache Creek.

Appendix E gives skewness (g), coefficient of variation (CV), and percentage of annual discharge. If skewness is positive, it means the probability distribution has long tail in the right; on the other hand, if skewness (g) is negative, the distribution curve has long tail on the left. The coefficient of variability indicates the consistency of flow. Most of the ephemeral streams have coefficient of variability greater than one. That means their discharges vary greatly year from year. For a year-round, sustained base-flow stream, the coefficient should be less than one. Most of the streams in Cache Creek basin have coefficient of variability greater than one in October when the rainy

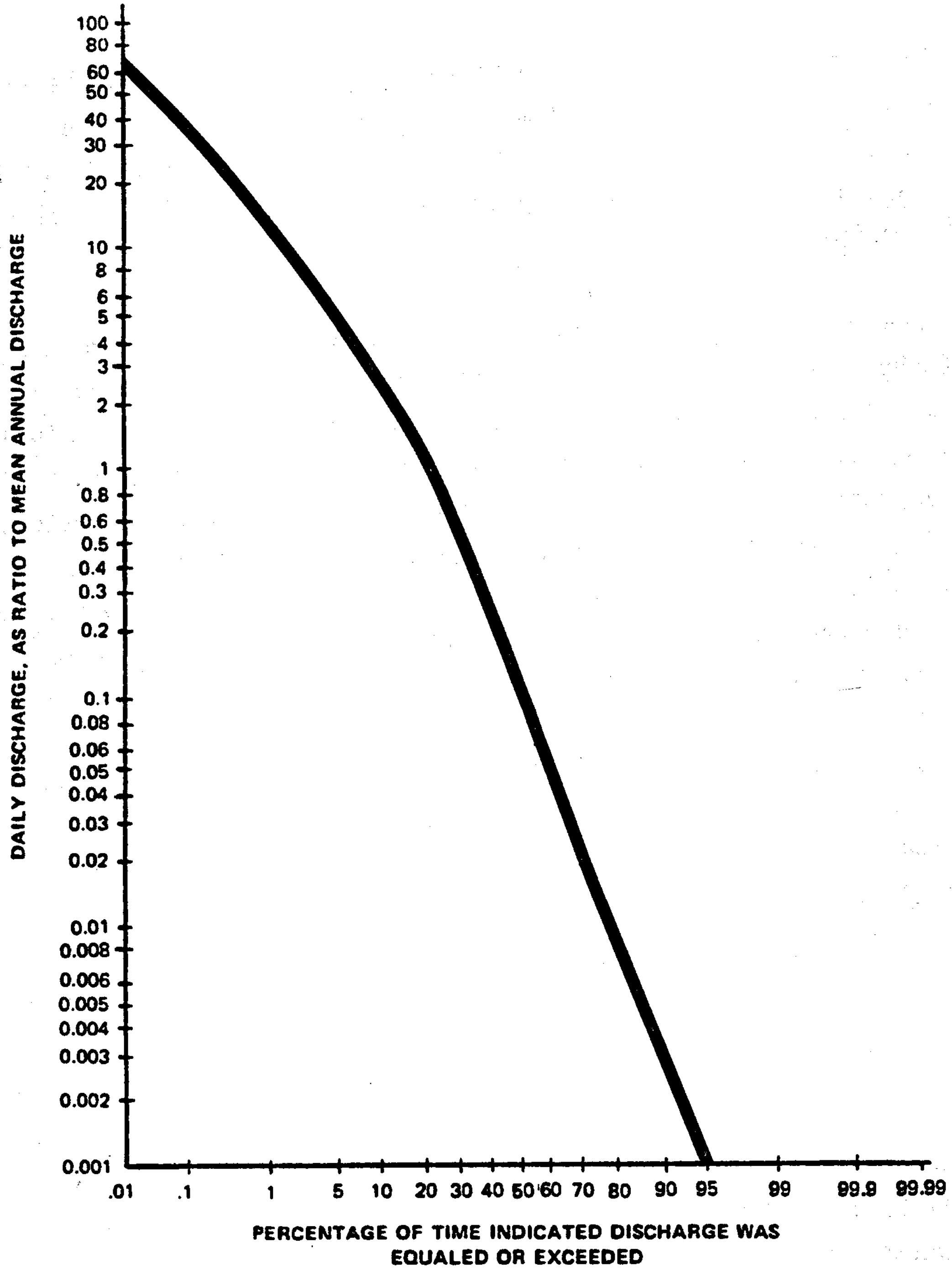


FIGURE IVD-3

FLOW DURATION CURVE OF NORTH FORK CACHE CREEK NEAR LOWER LAKE, LAKE COUNTY, CALIFORNIA, 11-4515, MEAN ANNUAL DAILY DISCHARGE WAS 188.1 CFS FROM 1931 TO 1968

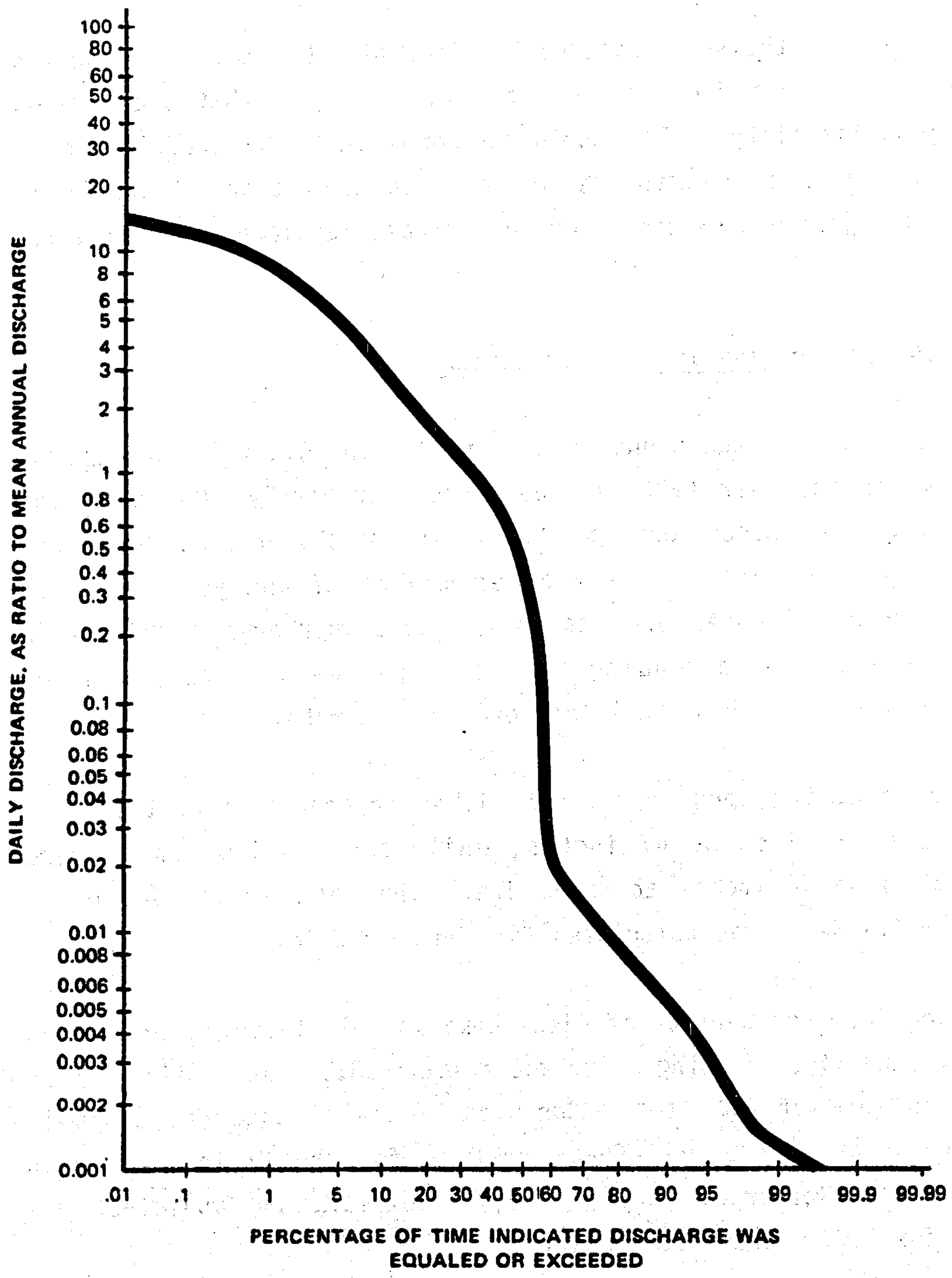


FIGURE IVD-4

FLOW DURATION CURVE OF CACHE CREEK NEAR LOWER LAKE, LAKE COUNTY, CALIFORNIA, 11-4510, MEAN DAILY DISCHARGE WAS 318.2 CFS FROM 1945 TO 1968.

season begins and the soil moisture is depleted. In summer the Pacific High prevents storms from moving into this basin so that the streams have less variability. It should be noted that the coefficient of variability of a big stream is always less than that of the small stream and negative skewness occurs on streams regulated by artificial means.

IV.D.1.1.4 Evaporation and Transportation

Evaporation data in Lake County are limited. The Class A pan evaporation data for the year 1971 were 68 inches for Finely, 78 inches for Lower Lake and 59 inches for Upper Lake. The months of June, July, and August evaporate more than any other months of the year. Ten to fourteen inches of water are lost into the atmosphere in the single month of July. Corresponding to the rainy season, the period of October through April has the lowest evaporation rate.

For Clear Lake, the long term annual lake evaporation from the Upper Arm was estimated to be 47 inches, while the two lower arms were estimated to be 54 inches at each site. The weighted average of 49 inches, or 4.1 feet, was calculated for the entire lake.

Evaporation from the surface of Clear Lake is calculated to be 199,750 acre-feet annually, assuming a surface area of 68.5 square miles and an evaporation rate of 4.1 feet. Consumptive use of water by crops is estimated to be 45,620 acre-feet per year for the Clear Lake basin (Development & Resources Corp., 1976). Domestic and municipal use accounts for 4,000 acre-feet annually.

IV.D.1.1.5 Clear Lake Outflow

Outflow from Clear Lake is controlled to a large extent by the Clear Lake outlet canal or that portion of Cache Creek above Clear Lake Dam and Clear Lake Dam itself. Clear Lake Dam is owned and operated by the Yolo County Flood Control and Water Conservation District.

The annual outflow from Clear Lake for the period 1910-1911 to 1971-1972 is reported on Table IVD-2 and depicted in Figure IVD-5. The average annual outflow for this period is calculated to be 226,400 acre-feet, with the highest, 684,500 acre-feet, occurring in 1940-1941 and the lowest, no outflow, occurring in 1932-1933.

For the period 1910-1911 through 1959-1960 the apparent net supply of water to Clear Lake, accounting for evaporation and upstream depletions, averaged 408,000 acre-feet.

For the same period the average outflow was 221,800 acre-feet. The difference indicates an average annual loss of 186,200 acre-feet. This loss is for all practical purposes attributable to evaportion from the surface of the Lake.

Shown in Table IVD-3 is the DWR calculated apparent net water supply to Clear Lake in relation to the runoff reported for the principal tributary creeks--Kelsey, Abode, Highland, Scott and Middle. The information presented reflects the relative significance of these tributaries during historically dry and wet years. On the average the five major tributaries constitute 33% of the total apparent net supply, or about 20% of the total water supply to Clear Lake. The major tributaries probably do not contribute more than an average of 5% each.

IV.D.1.1.6 <u>Water Quality</u>

The quality of surface waters in this region is generally good except certain waters in Clear Lake are high in boron as a result of recent volcanic activity. Clear Lake is classified as Class II water for use primarily in irrigation due to its high concentration of boron.

The streams of the Cache Creek watershed are calcium-bicarbonate in type. The water in Clear Lake can be classified as a magnesium-calcium

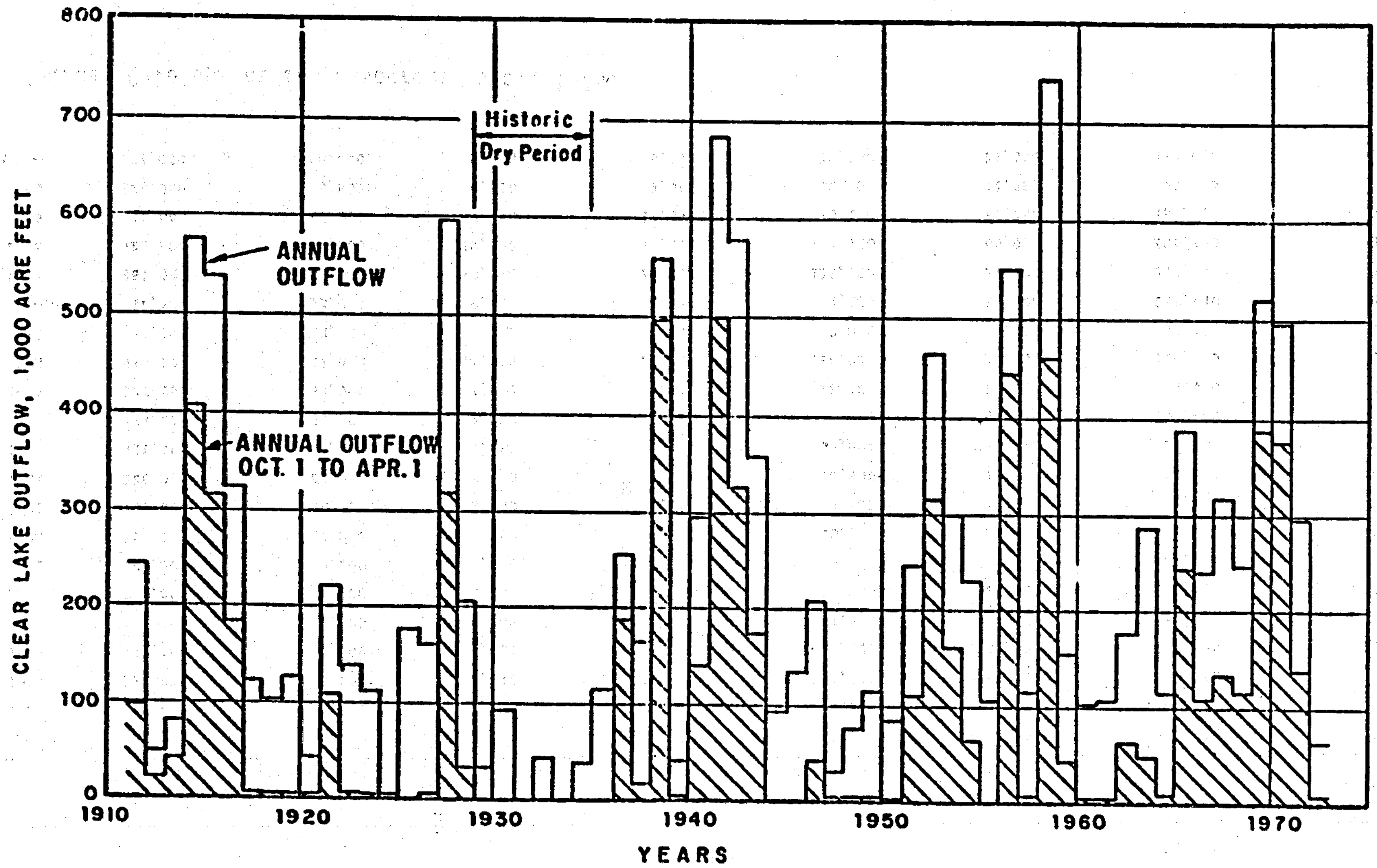
CLEAR LAKE OUTFLOW
(acre-feet)

Water Year	Total Annual Outflow from Clear Lake	Total Seasonal Outflow October 1 - March 31
1910-11	246,250	96,000
1912	48,960	21,000
1913	82,980	41,000
1914	577,570	406,000
1915	539,160	314,000
1916	322,230	183,000
1917	125,700	9,000
1918	102,100	6,000
1919	129,400	3,000
1920	4,600	4,000
1921	221,090	110,000
1922	140,520	6,000
1923	113,600	4,000
1924	7,400	7,000
1925	177,710	0
1926	161,760	5,000
1927	597,500	317,000
1928	206,750	36,000
1929	36,200	4,000
1930	93,800	0
1931	2,400	2,000
1932	44,720	0
1933	0	0
1934	38,800	0
1935	115,800	0
1936	254,130	187,000
1937	163,100	18,000
1938	558,780	497,000
1939	41,440	1,000
1940	294,710	139,000
1941	684,500	501,000
1942	578,950	326,000
1943	357,280	173,000
1944	90,560	2,100
1945	134,280	1,800
1946	207,570	40,300
1947	31,610	1,900
1948	77,540	1,200
1949	115,540	2,400
1950	84,380	2,700
1951	244,900	109,100
1952	460,850	313,000
1953	295,000	159,800
1954	228,460	64,800
1955	105,170	2,100
1956	549,150	441,400
1957	114,880	1,600
1958	741,620	458,900
1959	155,360	46,100
1960	101,270	3,100
1961	105,000	2,900
1962	175,300	61,100
1963	285,500	48,900
1964	113,400	7,900
1965	332,700	240,600
1966	239,900	107,300
1967	314,100	134,900
1968	243,400	115,400
1969	519,900	385,000
1970	494,000	371,100
1971	293,400	137,500
1972	61,810	6,000
Average	226,400	107,600

FIGURE 1VD-5

LAKE COUNTY

CLEAR LAKE OUTFLOW



Source: Development and Resources Corp., 1976.

Table IVD-3

LAKE COUNTY

APPARENT NET WATER SUPPLY TO CLEAR LAKE AND CONTRIBUTION BY MAJOR TRIBUTARIES
(acre-feet)

Year	Apparent Net Supply	Runoff from Principal Tributaries						Difference Between Net Supply and Total Runoff
		Kelsey Creek	Adobe Creek	Highland Creek	Scotts Creek	Middle Creek	Total	
1924-25	533,000	52,000	7,030	12,420	52,200	46,600	170,300	32
1926	348,000	45,000	4,210	7,310	30,300	19,850	106,670	31
1927	683,000	79,000	11,310	19,930	94,700	78,320	283,260	41
1928	417,000	36,000	6,180	10,800	39,900	38,670	131,550	32
1929	139,000	18,000	3,200	5,510	8,700	7,480	42,890	31
1929-30	339,000	34,000	5,140	8,950	30,600	29,190	107,880	32
1931	88,000	9,000	2,920	5,000	5,300	4,420	26,640	31
1932	259,000	24,000	4,860	8,500	26,000	23,080	86,440	33
1933	165,000	18,000	3,690	6,390	13,500	16,800	58,380	35
1934	228,000	21,000	4,000	6,940	16,900	13,960	62,800	28
1935	444,000	46,000	5,980	10,440	37,500	35,010	134,930	30
1936	475,000	53,000	7,070	12,390	49,000	45,960	167,420	35
1937	327,000	31,000	4,880	8,510	26,100	20,970	91,460	28
1938	985,000	111,000	14,310	25,300	126,000	102,890	379,500	38
1939	133,000	8,000	3,060	5,270	7,000	9,790	33,120	25
1939-40	612,000	73,000	9,460	16,650	74,600	66,700	240,410	39
1941	961,000	99,000	13,880	24,530	122,300	84,100	343,810	36
1942	720,000	74,000	10,140	14,900	82,100	66,010	250,150	35
1943	518,000	47,000	7,040	12,340	49,100	45,250	160,730	31
1944	229,000	29,000	4,350	7,540	20,400	12,580	73,870	32
1944-45	302,000	40,000	5,160	8,990	29,000	27,530	110,680	37

Source: Development and Resources Corp., 1976.

bicarbonate type. The ionic composition of the water in Clear Lake is typical of all waters in the coastal range which are influenced by the inflow of winter rains, followed in summer by long periods of intense evaporation with little or no inflow.

Total dissolved solids of Clear Lake is less than 200 ppm. For the period measured, pH values were between 7.2 and 9.7 (CDWR 1966). Generally, pH values remained below 8 during the winter months. As algae production increased, pH values increased to between 8 and 9. Surface water temperature varies from 26°C in August to 7°C in January (Figure IVD-1).

IV.D.1.2 Putah Creek Basin

IV.D.1.2.1. Precipitation

Precipitation over Monticello Dam was 21.7 inches for the period 1914-47, and was 42.4 inches at Middletown. About 80 inches of precipitation falls over the Mayacamas Mountains, and 30 inches around the valley floors. Average annual precipitation over Upper Putah Creek above Middleton was estimatd to be 4.4 feet (Development and Resource Corp., 1976).

The monthly distribution of the precipitation is shown in Figure IVD-6. Over 95% of the annual precipitation occurs during October through April. At Middleton, the heaviest precipitation occurs during December, 9.56 inches, January, 10.85 inches, and February,7.5 inches.

IV.D.1.2.2 Surface Runoff

Putah Creek near Guenoc has the same type of flow-duration curve as North Fork of Cache Creek. Figure IVD-7 indicates that 50% of the time flow, is 19.7 cubic feet per second. About ten percent of the time in a year the flow would exceed 7,880 cubic feet per second. The

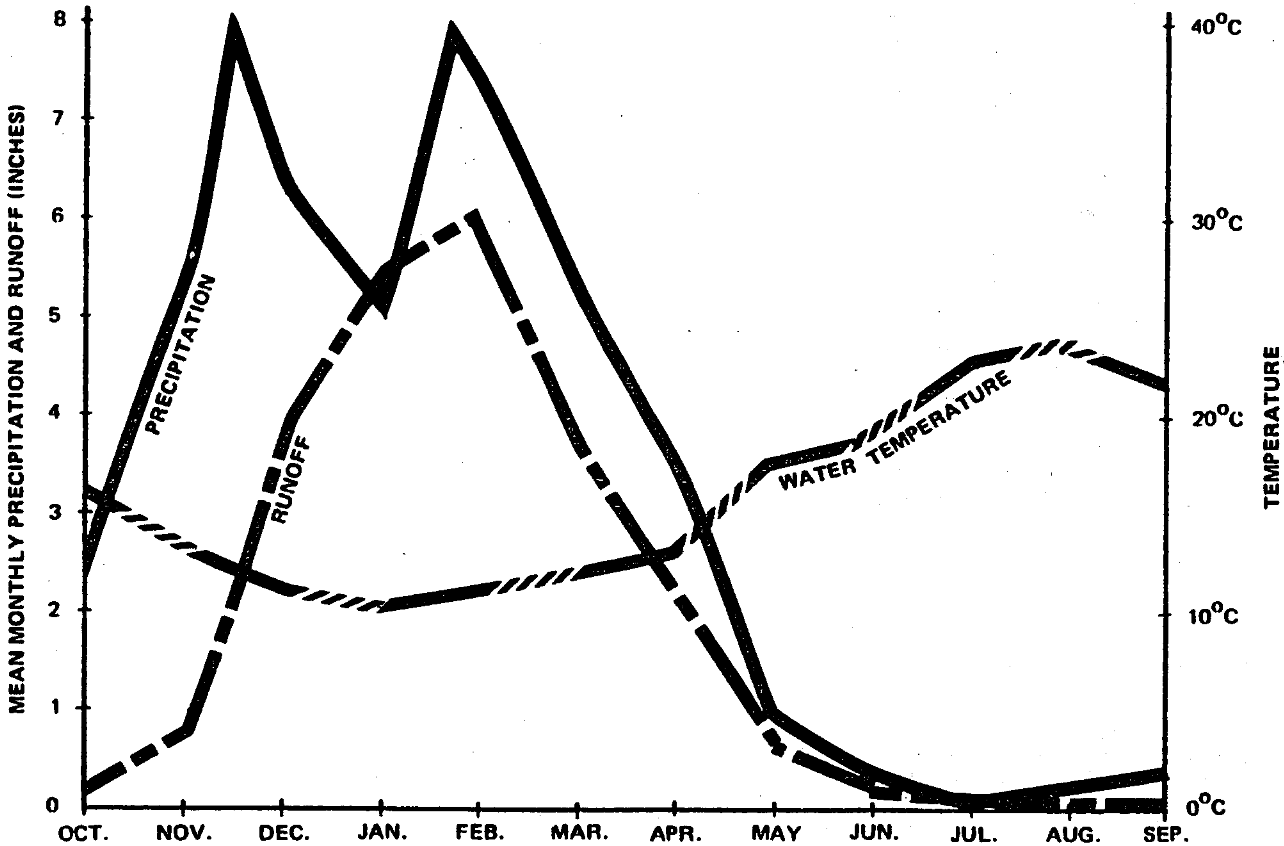


FIGURE IVD-6

MEAN MONTHLY WATER TEMPERATURES (1960-68) AND RUNOFF (1931-68) AT PUTAH CREEK NEAR GUENOC, LAKE COUNTY, CALIFORNIA, U.S.G.S. 11-4535, AND PRECIPITATION (1938-77) AT MIDDLETOWN

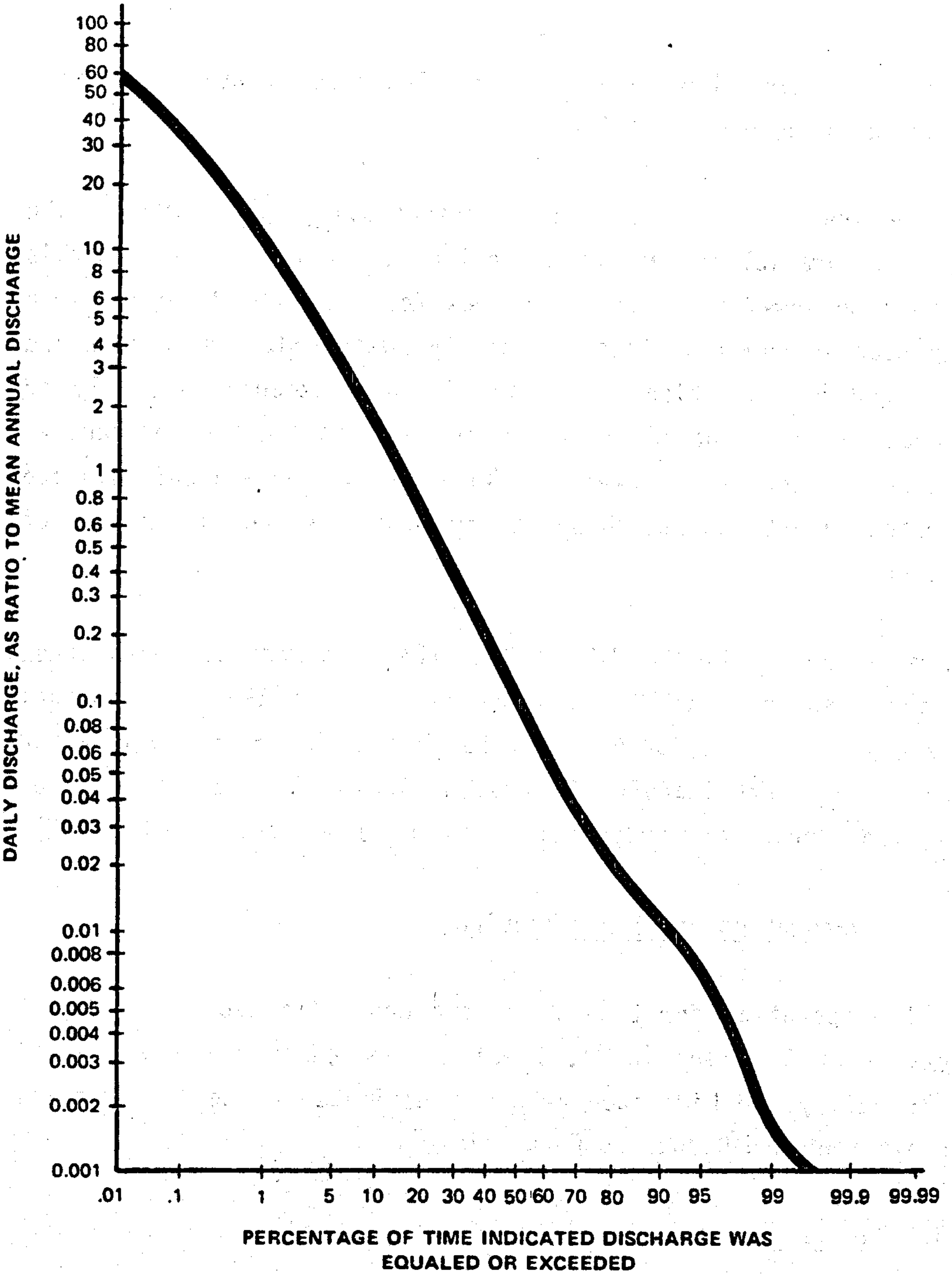


FIGURE IVD-7

FLOW DURATION CURVE OF THE PUTAH CREEK NEAR GUENOC, CALIFORNIA, 11-4535, MEAN DAILY DISCHARGE WAS 1971 CFS FROM 1905, 1906, 1931 TO 1968.

steep slope of this flow-duration curve indicates that Putah Creek near Guenoc has wide range of flow.

Low-flow frequency curve was derived in this study (Figure IVD-8). The flat, roughly parallel curves are typical of those for streams in this area. The nine low-flow frequency curves for Putah Creek near Guenoc are steep because the low flows are poorly sustained. The curves are closely spaced for durations of 1 to 120 days because virtually no runoff producing rains occurs in the region for at least 4 consecutive months in each year. The curves for durations of 183 and 365 days are spaced farther apart because these longer durations include periods of storm runoff.

Before completion of the Monticello Dam, the discharge of Putah Creek near Winters measured 460.4 cfs annually. After 1957, the annual discharge was reduced to 282.6 cfs. USGS has estimated the unimpaired discharge to be approximately 518 cfs, including the adjustments for the change in storage and evaporation from Lake Berryessa (USGS 1977).

IV.D.1.2.3 Evaporation and Transpiration

The annual evaporation for Lake Berryessa was estimated to be 74,000 acre-feet, about 3.9 feet (CDWR, 1965). Consumptive use of water in the Coyote Valley and Middleton area was estimated to be 11,300 acre-feet (Development and Resources Corp., 1976).

IV.D.1.3. Russian River Basin

IV.D.1.3.2 Precipitation

Precipitation over most of the watershed is in the form of rain and shows wide seasonal variations. Any snow falling on the higher elevations melts quickly and does not retard runoff. The monthly distribution of precipitation at Healdsburg shows the influence of the

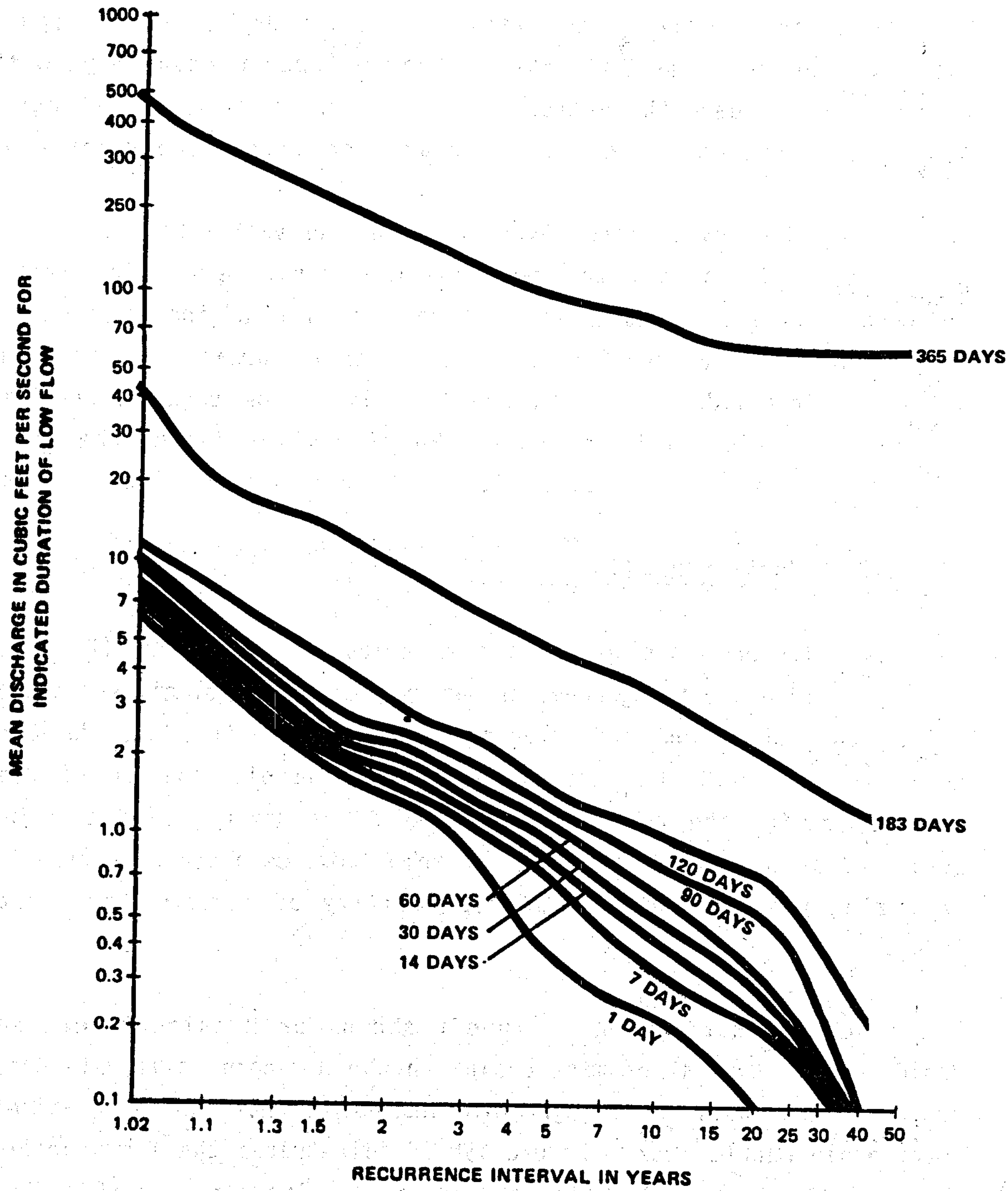


FIGURE IVD-8

LOW FLOW FREQUENCY CURVES OF PUTAH CREEK NEAR GUENOC, CALIFORNIA, LAKE COUNTY, USGS GAUGING STATION 11-4535, YEARS ANALYZED ARE 1906 AND 1932 TO 1968

Mediterranean climate, with distinct wet and dry seasons (Figure IVD-9). The rainy period extends from October through May, with December and January the wettest months. The summer months of July, August and September are virtually dry throughout the watershed.

The 40-inch isopluvial line covers most of the valley floors. Heavy precipitation falls over the Mayacamas Mountains, between Mt. Helena and Cobb Mountain. Annual precipitation as high as 80 inches is normal in the Putah, Cache, and Russian River watershed areas. Mt. Hood and Bald Mountain divide the Russian and Napa Rivers, and each has precipitation of over 60 inches. In the Russian River Basin, the areal distribution of precipitation is mainly a function of elevation.

IV.D.1.3.2 Surface Runoff

The basic factors that affect the distribution of stream flow with respect to time are topography, tributary patterns, geologic structure, soil, vegetation, and meterological conditions. The flow duration curve is the simplest means of expressing the distribution of discharge, showing the percentage of time for a given period that any specified discharge is exceeded. It then provides a useful device for analyzing the availability and variability of stream flow (Rantz 1964).

The monthly distribution of runoff shown for Russian River near Healdsburg is typical of most basins in the northern California Coast Ranges. These basin have negligible snow-melt runoff and a relatively impermeable mantle rock. Figure IVD-10 illustrates the flow duration curve of the Russian River near Healdsburg. The slope of this flow-duration curve is as steep as those of Putah and Cache Creek watersheds. The Russian River discharged 118 cfs 90% of the time. Near Healdsburg about 10% of the time the discharge would exceed 3,000 cfs. Approximately 50% of the time, the runoff was 368 cfs.

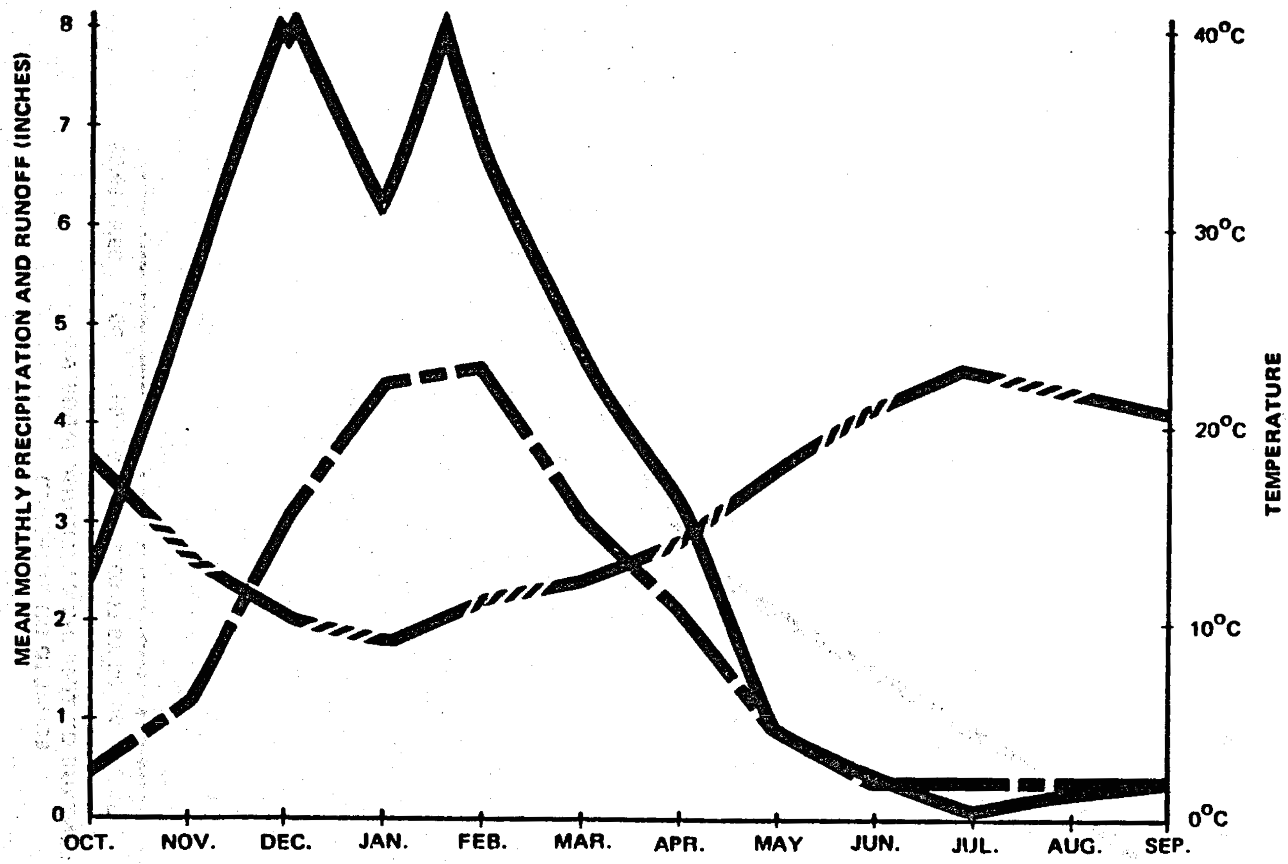


FIGURE IVD-9

MEAN MONTHLY WATER TEMPERATURE (1966-68) AND RUNOFF (1959-68) AT RUSSIAN RIVER NEAR HEALDSBURG, SONOMA COUNTY, CALIFORNIA, U.S.G.S. 11-4640, AND PRECIPITATION (1876-1977) AT HEALDSBURG.

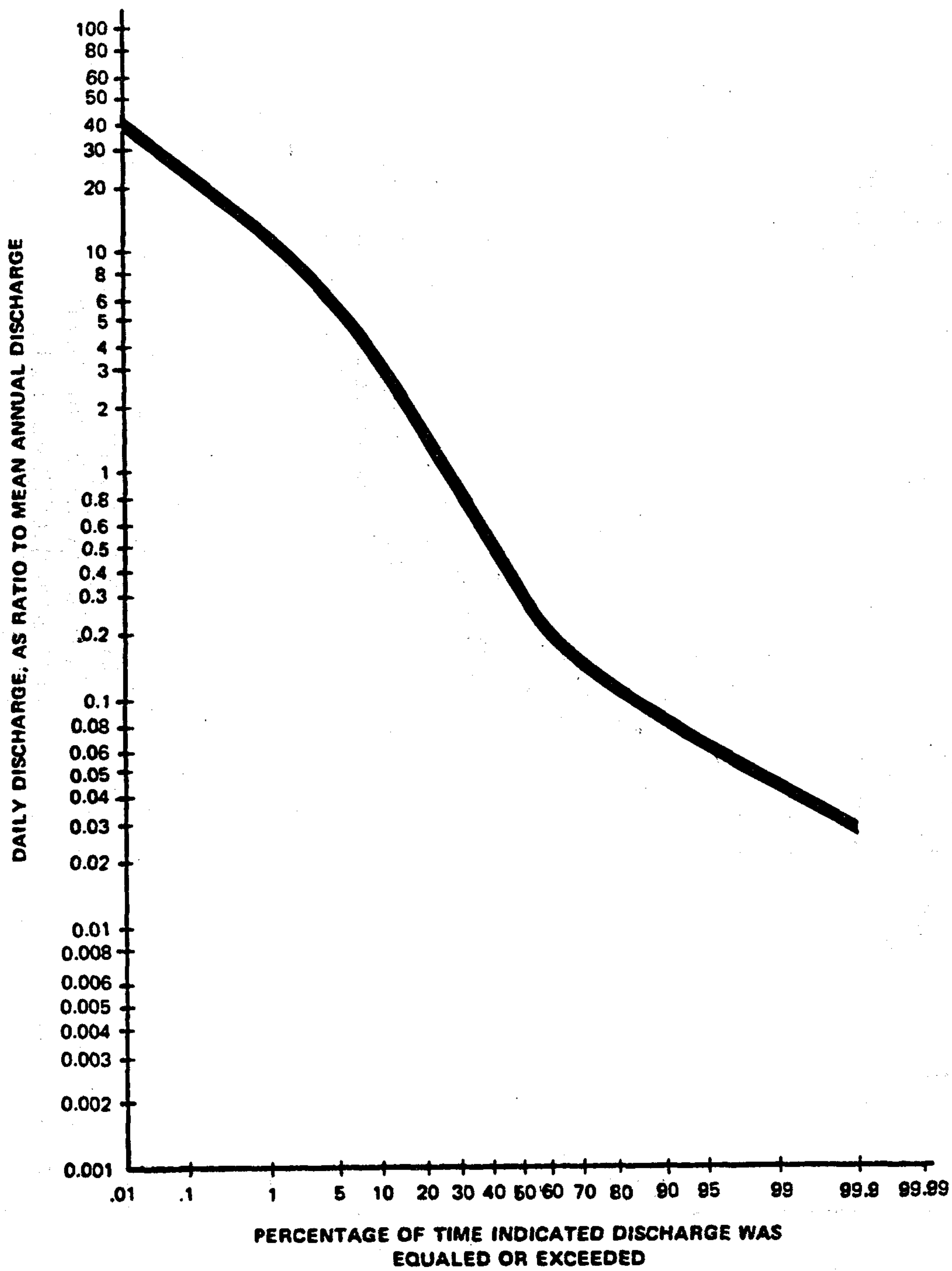


FIGURE IVD-10

FLOW DURATION CURVE OF THE DAILY DISCHARGES AT RUSSIAN RIVER NEAR HEALDSBURG, SONOMA, CALIFORNIA, 11-4640, 1940-1958. MEAN DAILY DISCHARGE WAS 1473 CFS

Figure IVD-11 shows the low-flow frequency curves for Russian River near Healdsburg. The curves can be used for design of reservoir, water supply, and waste discharge. Because most of the runoff occurs during the period of November through April, all of the curves, except 365 days, are spaced closely together.

IV.D.1.3.3 Evaporation and Transpiration

The Russian River Basin has an evaporation regimen quite similar to that of the Putah and Cache Creek watersheds. The recorded annual evaporation at Coyote Dam was 67.05 inches (CDWR, 1974). Assuming the surface area of Lake Mendocino is constant throughout the whole year, 1,700 acres, about 9,500 acre feet of water would return to the atmosphere.

There are approximately 18,000 acres of irrigated land above the gaging station near Healdsburg. If consumptive use of water is three feet on the average, a total of 54,000 acre-feet of water is consumed within the Russian River basin.

IV.D.1.3.4 Water Quality

Generally, the surface water in the Russian River watershed is of excellent quality. Chemical analyses for russian River near Guerneville indicate the specific conductance ranging from 82 to 384 micromhos and percentage sodium ranged from 11 to 23. The water was generally moderately hard (average 116 ppm as $CaCo_3$). It was Class 1 (excellent to good) irrigation water with all parameters since 1958 when releases from Coyote Dam commenced. The ratio of total dissolved solids to specific conductance is 0.6 (DWR, 1968).

The specific characteristics of surface water are described in 5 subunits. The Coyote Valley subunit is located in the northeastern corner of the watershed. Lake Mendocino is within the subunit and the principal streams are the East Fork Russian River and Cold Creek. Most

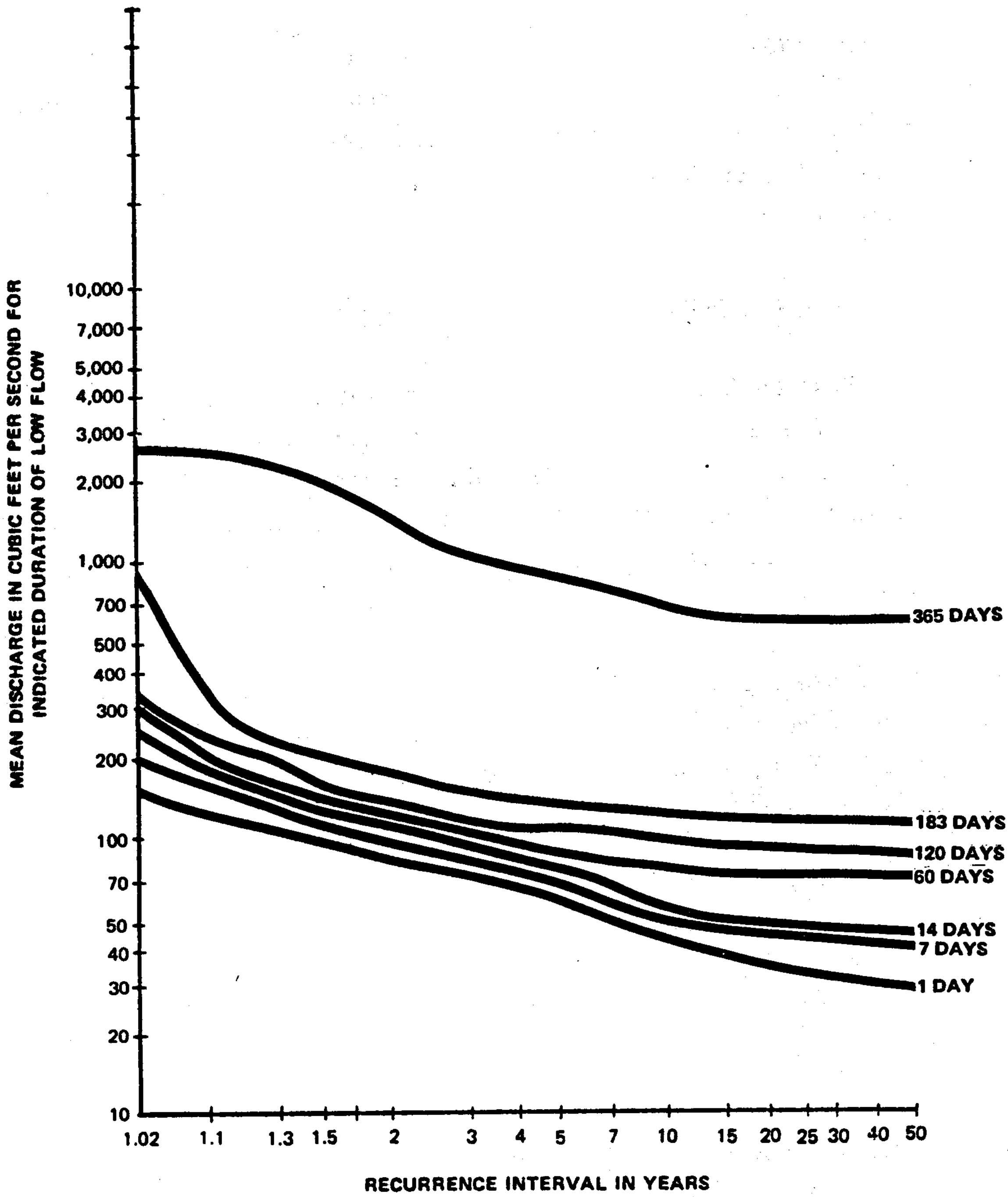


FIGURE IVD-11

LOW FLOW FREQUENCY CURVE OF RUSSIAN RIVER NEAR HEALDSBURG, SONOMA COUNTY, CALIFORNIA, U.S.G.S. GAUGING STATION 11-4640. YEAR ANALYZED IS FROM 1940-1958

of the water in the subunit is imported from the Eel River. The Forsythe Creek subunit is lcoated in the northeastern corner of the watershed. The principal stream is Forsythe Creek. Walker Creek, Mill Creek and Seward Creek are tributary to Forsythe Creek. The upper Russian River subunit contains the Ukiah to Sanel Valleys. The principal streams are the Russian River, York Creek, East Fork Russian River, Orrs Creek, Robinson Creek, McNeb Creek, Feliz Creek, Sulphur Creek, Cummisky Creek and Piston Creek. The Sulphur Creek subunit consists Big and Little Sulphur Creeks. The Middle Russian River subunit is northeast of Healdsburg. The principal stream are Ash Creek, the Russian River, Franz Creek, Sausal Creek, and Mayacama Creek. This subunit receives drainage from the upper Russian River and Sulphur Creek subunits.

The water in Coyote Valley subunit is calcium-bicarbonate. It was excellent quality and tested as Class 1 irrigation water. Total dissolved solids ranged from 84 to 186 ppm and hardness ranged from 55 to 174 ppm as $CaCO_3$. High concentration of iron (0.01 to 2 ppm) and maganese (0.08 to 0.14 ppm) were recorded in the East Fork Russian River above Lake Mendocino. Values of pH ranged from 7.3 to 8.5. Hach turbidities ranged from 5 to 275 JTU. The highest values occured during periods of high runoff.

The water quality of Forsythe Creek subunit was calcium bicarbonate in type and was excellent. Total dissolved solids ranged from 99 to 164 ppm and hardness sfrom 64 to 144 ppm as $CaCO_3$. values of pH ranged from 7.1 to 8.3 and turbidity ranged from less than 5 to 55 JTU.

The water quality in all the streams of the upper Russian River subunit, except Sulphur Creek, was excellent. It was calcium-magnesium bicarbonate in type. Total dissolved solids ranged from 90 to 232 ppm and hardness ranged from 61 to 200 ppm as $CaCO_3$. High concentrations of iron were recorded int he East Fork Russian River below Lake Mendocino (0-3.5 ppm), York Creek (0.15-0.57 ppm), and Sulphur

Creek (0.02-0.67ppm). Manganse ranged from 0.32 to 0.47 ppm were recorded below Lake Mendocio.

Sulphur Creek contained highly mineralized water from Vichy Springs. Downstream from Vichy Springs, the water was sodium bicarbonate in type. Total dissolved solids was 769 ppm. Boron was 69 ppm. Fortunately, Sulphur Creek is diluted as it flows into the Russian River.

The upper Russian River subunit had pH ranged from 6.7 to 8.9 and turbidity from less than 5 to 375 JTU. Temperature ranged from 39 to 90°F. The discharge of Lake Mendocino's turbid water increases the subunit's turbidity (DWR 1976).

The water of the Sulphur Creek subunit was calcium magnesium bicarbonate. It was excellent quality except boron concentration. Total dissolved solids ranged from 98 to 300 ppm and hardness ranged from 93 to 300 ppm as $CaCO_3$. Highly mineralized water flows into Big Sulphur Creek from hot springs, steam vents, and coding towers of the geothermal power plant at The Geysers. Values of pH ranged from 7.7 to 8.9 and turbidities ranged from less than 5 to 8 JTU.

The water in Middle Russian River subunit was excellent quality, suitable for Class 1 irrigation water. Water in this subunit was calcium-magnesium bicarbonate. Total dissolved solid ranged from 113 to 206 ppm and hardness ranged from 43 to 180 ppm as $CaCO_3$. Values of pH ranged from 7.1 to 8.8 and turbidities ranged from less than 5 to 91 JTU. Figure IVD-9 shows the monthly water temperature of the Russian River near Healdsburg.

The water quality below the Middle Russian River subunit differ not too much from the Middle Russian River subunit. But the biological quality is degradated because of the discharge of waste water and recreation in the lower Russian River reach. The coliform counts increased in summer due to the increase of visitors. Phytoplankton growth are approaching nuisance levels in many sections of lower Russian River.

IV.D.1.4 Napa River Basin

IV.D.1.4.1 Precipitation

The Napa River Basin is under the influence of the "Pacific High". Therefore, its climate is a Mediterranean type with about 90% of the total precipitation occurring during the period October through March (Figure IVD-12). January is the wettest month and July through September is the driest period.

The areal distribution of rainfall is a function of elevation and distance from the ocean. Most of the precipitation falls over the mountains along the Napa and Sonoma County boundary on the west side of the Napa River. Mt. Helena, the headwater area of the Napa River, has an annual precipitation of 70 inches, and Bald Mountain, to the southwest of St. Helena, has an annual precipitation of over 60 inches. Down in the valley floor, the precipitaion varies from 37 inches at Calistoga to 35 inches at St. Helena and 25 inches at Napa State Hospital. Precipitation decreases from north to south along the Napa River.

IV.D.1.4.2 Surface Runoff

Figure IVD-13 is a flow-duration curve of the Napa River near near St. Helena. This one resembles the curves shown for the Cache and Putah Creek basins. The steep slope definitely indicates that there is no sustained base flow in Napa River Basin and runoff is only fed by precipitation. Shallow soil depth and impermeable rock mantle can not retain precipitation for later release and hence the time of concentration is short.

Figure IVD-13 also indicates that about 10% of the time, the Napa River has runoff of 200 cfs and 90% of the time, 0.37 cfs. The median discharge was about 7.5 cfs, and the mean discharge was about 94 cfs. This latter figure occurred only about 15% of the time.

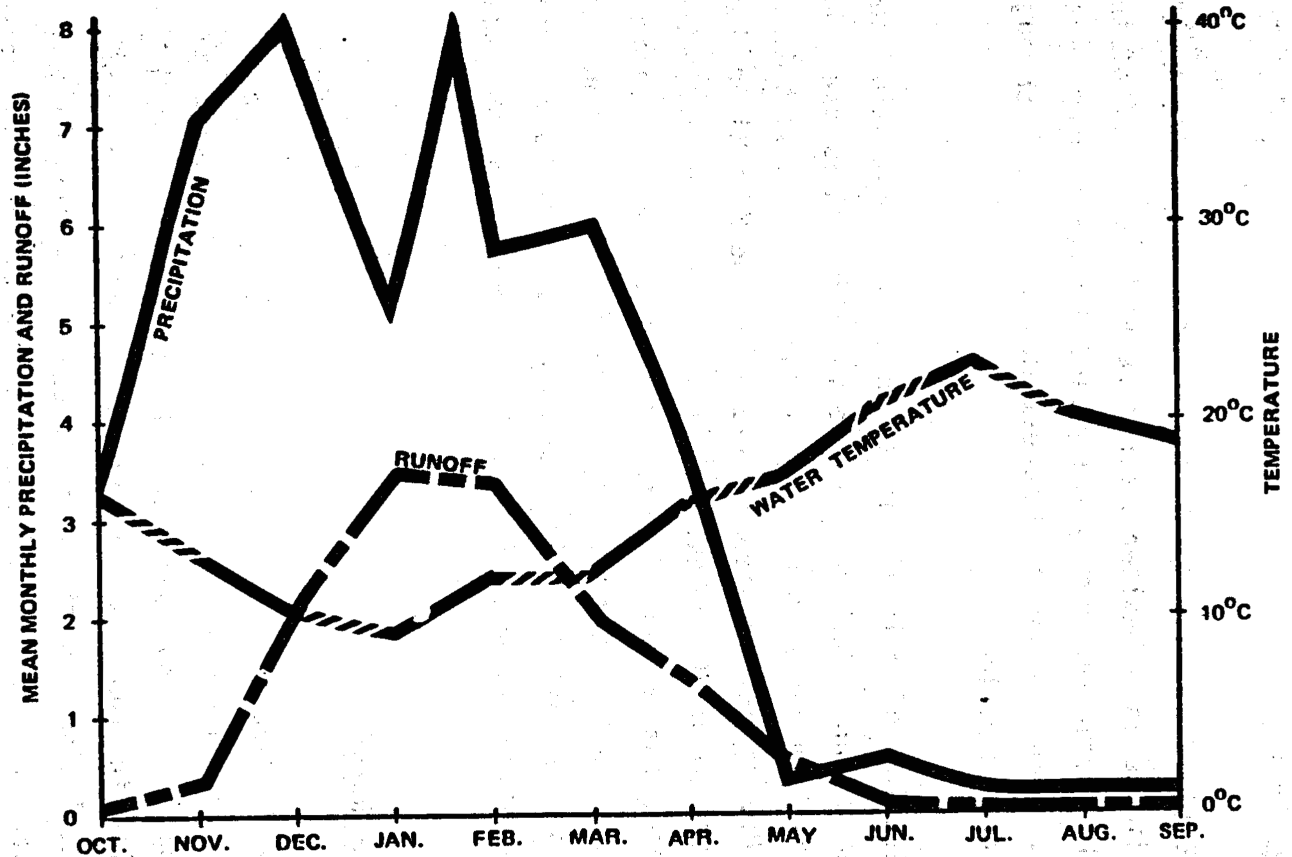


FIGURE IVD-12

MEAN MONTHLY WATER TEMPERATURE (1962–68) AND RUNOFF (1931–68) AT NAPA RIVER NEAR ST. HELENA, NAPA COUNTY, CALIFORNIA, U.S.G.S. 11-4560, AND PRECIPITATION (1963–75) ST. HELENA 4WSW

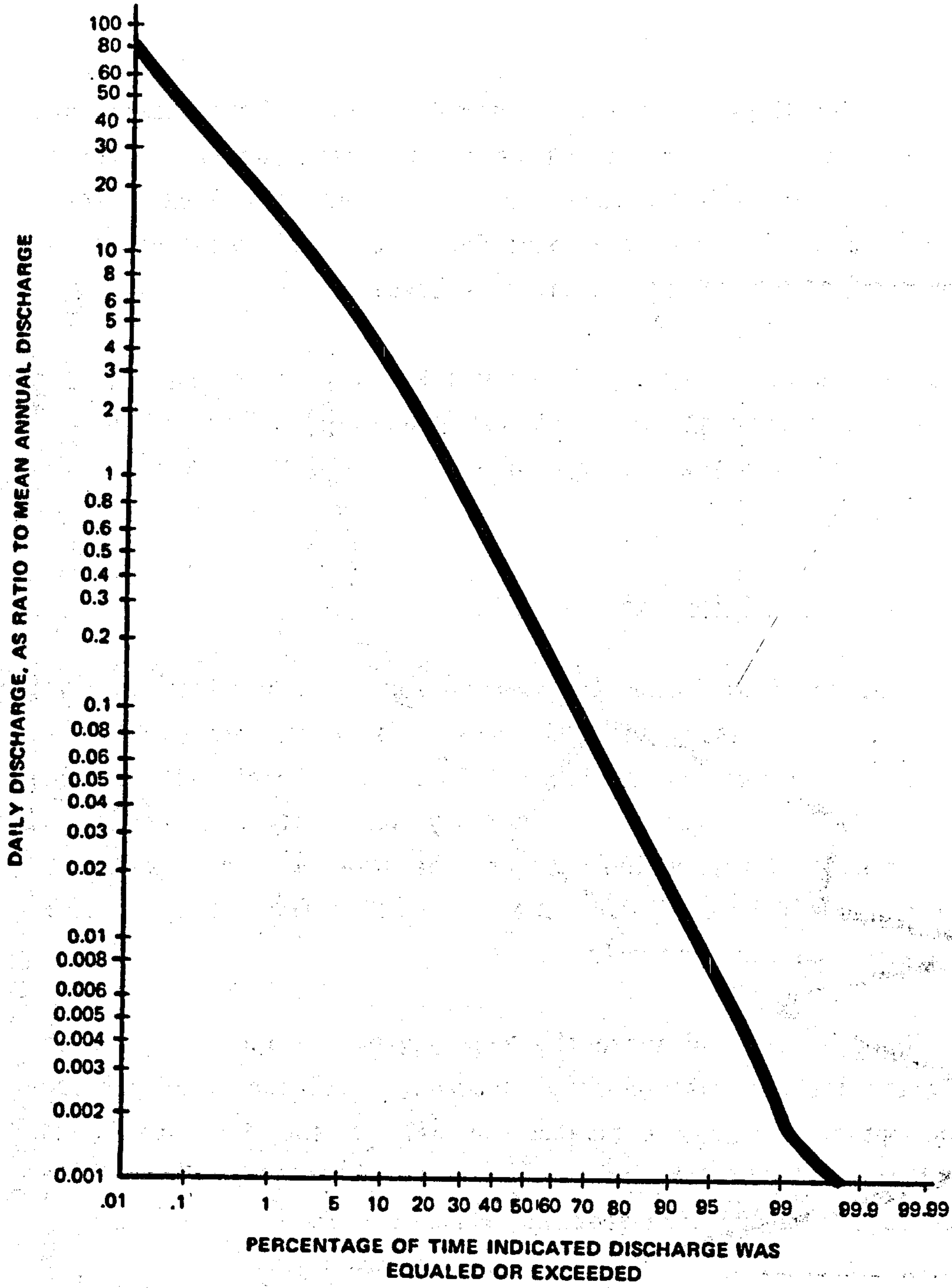


FIGURE IVD-13

FLOW DURATION CURVE OF NAPA RIVER NEAR ST. HELENA, NAPA COUNTY, CALIFORNIA, MEAN ANNUAL DAILY DISCHARGE WAS 93.73 CFS FOR 1931 – 1968

The average annual discharge measured near the City of Napa was 150 cfs (Appendix F). The Napa River near Napa has the same runoff regimen as near St. Helena but only the magnitude is larger near Napa. Agricultural and domesic withdrawal account for most of the water depletion in Lake Hennessey, and the ground water reservoir.

The import of Russian River water through Knights Valley Aqueduct to Lake Hennessey has been studied, yet not authorized. The proposal of this aqueduct indicates the shortage of dependable water in the Russian River basin.

IV.D.1.4.3 Evaporation and Transpiration

Evaporation was about 51 inches per year measured at the Class A pan near Yountville. Lake Hennessey has 860 acres of surface area (California Region Framework and Study Committee 1970). The total Lake surface area within the Napa River Basin probably would never exceed 1,000 acres. Assuming the evaporation rate was the same over whole watershed and had a pan coeffcient of 0.8, the evaporation from Lake Hennessey would be 3,450 acre-feet per year.

About 10,000 acres of land above the Napa gaging station is irrigated. Because of the lack of data on crop patterns, a 1.5 acre-feet per acre water consumption use was estimated to all of the irrigated land. Based on this analysis, the consumptive use of water in Napa Valley above Napa totals 15,000 acre-feet annually.

The extraction of water by ground water recharge, evaporation and transpiration outside the evaporation from lakes and irrigated lands probably would amount 290,000 acre-feet for a 218 square miles watershed above Napa. The assumption of a uniform precipitation of 3 feet depth was adopted for this estimation.

APPENDIX E

WATERSHED DATA

APPENDIX E

This appendix presents in tabulation form of hydrologic data used in The Geyser's KGRA study. Most of the data are excerpted from Volume 1 and 2 of the California Streamflow Characteristics, published by U.S. Geologic Survey at Menlo Park, California, 1971. The meanings of several symbols and abbreviations are explained as follows.

In the table, Q means average discharge, expressed in cubic feet per second for all days. The small g is the skewness which indicates the flow distribution curve having long tail over the right side if g is positive; and to the left if g is negative. Statistically speaking skewness is the third moment about the mean. CV is the abbreviation of the coefficient of variability which is the quotient of standard deviation divided by mean. % is the percentage of monthly discharge to annual discharge.

	Conn Creek Near St. Helena[1] Napa Watershed 1946 – 1959				Napa River Near Napa[2] Napa Watershed 1930 – 1932, 1960 – 1968				Big Sulfur Creek Near Cloverdale[3] Russian Watershed 1959 – 1968			
	Q	g	CV	%	Q	g	CV	%	Q	g	CV	%
Oct.	1.75	1.50	1.35	.63	29.51	3.46	3.29	1.64	49.22	2.17	1 95	2.20
Nov.	.40	2.72	2.37	.14	32.96	1.32	1.36	1.83	107.9	.81	.95	4.82
Dec.	40.93	2.42	2.13	14.71	272.2	1.22	1.20	15.10	328.6	.88	1.09	14.66
Jan.	72.58	1.53	1.76	26.09	504.2	1.32	1.01	27.97	474.8	.43	.64	21.19
Feb.	79.43	2.10	1.74	28.56	453.1	.71	.77	25.13	602.7	2.02	.85	26.9
Mar.	36.58	1.81	1.43	13.15	264.4	.19	.77	14.66	298.4	.94	.67	13.31
Apr.	28.19	3.54	2.40	10.14	103.4	1.90	1.49	10.73	260.9	.98	1.01	11.64
May	4.28	.67	.48	1.54	37.52	1.65	1.03	2.08	66.30	1.41	.71	2.96
Jun.	4.96	- .08	.42	1.78	11.09	2.46	1.43	.62	28.88	1.16	.64	1.29
Jul.	4.27	- .83	.52	1.53	2.64	2.93	1.96	.15	11.01	.85	.55	.49
Aug.	2.84	- .58	.59	1.02	1.10	1.26	1.46	.06	6.56	.63	.47	1.29
Sept.	1.94	1.04	.91	.70	.68	1.51	1.54	.04	5.82	1.05	.44	.26
Annual	22.94	1.36	1.27		149.0	.78	.68		184.5	.97	.49	

1 — A = 52.3 mi^2; regulated by Lake Hennessey (Conn Valley Reservoir), 31,000 AF capacity; 11-4565

2 — A = 218 mi^2; slightly regulated by Lake Hennessey; numerous diversions for irrigation; 11-4580

3 — A = 82.3 mi^2; 11-4632

	Putah Creek Near Winter[1] Putah Watershed 1931 – 1957				Putah Creek Near Winter[2] Putah Watershed 1958 – 1968				Napa River Near St. Helena[3] Napa Watershed 1931 – 1968			
	Q	g	CV	%	Q	g	CV	%	Q	g	CV	%
Oct.	8.60	2.59	1.10	.15	163.7	1.21	1.03	4.82	8.01	5.27	4.13	.71
Nov.	93.78	3.31	1.81	1.68	51.25	1.47	.88	1.51	19.88	2.63	1.51	1.75
Dec.	957.0	1.52	1.37	17.53	38.73	- .21	.48	1.14	184.9	1.88	1.41	16.27
Jan.	1238.0	1.04	1.04	22.16	361.2	2.88	2.28	10.64	292.5	.72	.90	25.75
Feb.	1648.0	1.29	1.11	29.51	305.5	2.71	1.88	9.00	312.4	1.35	.89	27.49
Mar.	941.0	1.44	.93	16.85	252.0	2.48	1.48	7.43	165.9	1.09	.70	14.60
Apr.	497.0	2.43	1.19	8.90	377.2	2.91	1.39	11.11	115.0	1.73	1.22	10.12
May	133.4	1.64	.82	2.39	376.4	- .47	.57	11.09	24.69	1.36	.72	2.17
Jun.	42.24	2.02	.90	.76	379.2	- .12	.49	11.17	8.02	1.49	.72	.71
Jul.	13.33	2.43	1.11	.24	425.1	- .12	.49	12.52	2.69	.99	.74	.24
Aug.	7.14	2.36	.96	.13	366.8	- .86	.52	10.81	1.37	1.16	.72	.12
Sept.	6.08	1.82	.81	.11	296.9	.20	.66	8.75	.84	1.68	.74	.07
Annual	460.4	1.12	.82		282.6	1.13	.78		93.73	.84	.64	

1 — A = 574 mi^2; flow regulated by Berryesen beginning January 1957 (1.592 maf); 11-4540

2 — A = 574 mi^2; flow regulated by Berryesen beginning January 1957 (1.592 maf); 11-4540

3 — A = 81.4 mi^2; small diversion for irrigation; 11-4560

	Bear Creek Near Rumsey[1]				Cache Creek Above Rumsey[2]				Putah Creek Near Guenoc[3]			
	Cache Watershed 1959 – 1968				Cache Watershed 1961 – 1968				Putah Watershed 1931 – 1968 and 1905, 1906			
	Q	g	CV	%	Q	g	CV	%	Q	g	CV	%
Oct.	9.28	3.16	2.58	2.08	57.04	- .32	.20	.80	17.36	4.84	3.31	.72
Nov.	8.18	.74	0.90	1.84	94.01	.60	.90	1.32	71.7	1.25	1.56	3.00
Dec.	48.88	2.21	1.53	10.98	354.8	1.67	.74	4.97	390.3	1.20	1.27	16.32
Jan.	142.8	.89	.99	32.07	1062.0	.58	.92	14.87	545.3	.70	.85	22.81
Feb.	123.1	.05	.63	27.65	1523.0	- .97	.35	21.33	666.2	1.13	.87	27.86
Mar.	49.7	.64	.72	11.16	1248.0	- .40	.53	17.47	367.7	1.46	.74	15.38
Apr.	39.94	1.69	1.30	8.97	792.1	2.23	1.27	11.09	231.1	1.56	1.04	9.66
May	13.08	1.93	1.12	2.94	467.2	- .76	.15	6.54	64.92	1.37	.72	2.72
Jun.	5.81	2.61	1.38	1.30	460.0	.07	.09	6.44	22.44	1.43	.65	.94
Jul.	1.88	.68	.72	.42	495.6	.88	.06	6.94	7.49	1.14	.58	.31
Aug.	1.31	1.67	.68	.29	383.1	.86	.10	5.36	3.82	.66	.59	.16
Sept.	1.28	1.10	.30	.29	205.9	- .73	.16	2.88	2.74	.94	.67	.11
Annual	36.73	.62	.61		590.7	.92	.39		197.1	.86	.59	

1 – A = 100 mi^2; 11-4517.2

2 – A = 955 mi^2; regulated by Clear Lake beginning in 1915 (capacity 319,000 AF); 11-4517.6

3 – A = 113 mi^2; diversion and groundwater withdrawals for 1,600 acres; 11-4535

	Adobe Creek Near Kelseyville[1] Cache Watershed 1955 – 1968				Highland Creek Above Highland Creek Dam[2] Cache Watershed 1963 – 1968				Highland Creek Near Kelseyville[3] Cache Watershed 1956 – 1962			
	Q	g	CV	%	Q	g	CV	%	Q	g	CV	%
Oct.	2.52	3.09	2.72	1.76	4.81	2.44	2.23	2.15	2.48	2.82	2.49	1.01
Nov.	5.78	0.93	1.13	4.05	13.42	- .02	.75	6.02	4.26	0.78	1.05	1.73
Dec.	25.63	1.62	1.19	17.94	48.57	1.75	1.07	21.78	37.16	2.11	1.31	15.13
Jan.	35.95	.69	.76	25.17	69.43	- .34	.30	31.13	41.62	2.01	1.04	16.94
Feb.	39.38	1.28	.89	27.57	30.50	- .03	.72	13.68	96.92	.71	.68	39.45
Mar.	16.97	.88	.82	11.88	24.98	.22	.83	11.20	34.41	1.25	.87	14.01
Apr.	13.58	1.35	1.26	9.51	24.70	.88	1.04	11.07	21.32	2.49	1.47	8.68
May	2.60	2.07	1.24	1.82	4.52	.86	.77	2.03	5.37	2.17	0.89	2.19
Jun.	0.33	2.49	1.40	.22	1.63	1.17	.75	.73	1.39	0.96	0.65	0.57
Jul.	.01	3.49	3.10	.01	.39	.51	.76	.17	0.31	0.57	0.82	0.13
Aug.	0	0	0	0	.06	1.76	1.33	.03	0.07	0.18	0.90	0.03
Sept.	.11	3.74	3.74	.08	.05	1.86	1.28	.02	0.35	2.77	2.22	0.14
Annual	11.78	.74	.56		18.6	-1.00	.39		20.05	1.30	0.67	

1 – A = 6.36 mi^2; Regulation and diversion for irrigation; 11-4485

2 – A = 11.9 mi^2; 11-4489

3 – A = 12.7 mi^2; 11-4690

	Kelsey Creek Near Kelseyville[1] Cache Watershed 1947 – 1968			
	Q	g	CV	%
Oct.	17.14	3.54	1.98	1.98
Nov.	39.89	1.30	1.01	4.61
Dec.	142.1	1.89	1.23	16.43
Jan.	191.6	.49	.75	22.16
Feb.	204.9	1.90	.92	23.69
Mar.	123.0	1.45	.66	14.22
Apr.	86.98	1.54	.92	10.06
May	31.8	1.09	.59	3.68
Jun.	13.39	1.04	.49	1.55
Jul.	5.99	1.08	.56	.69
Aug.	3.83	.62	.52	.44
Sept.	4.16	2.86	.76	.48
Annual	71.48	1.23	.53	

	Cache Creek Near Lower Lake[2] Cache Watershed 1945 – 1968			
	Q	g	CV	%
Oct.	24.13	.42	.72	.63
Nov.	3.72	1.43	1.28	.10
Dec.	38.58	3.69	3.31	1.01
Jan.	509.6	1.86	1.77	13.30
Feb.	572.4	2.11	1.66	14.94
Mar.	510.4	2.64	1.67	13.32
Apr.	512.6	2.59	1.71	13.38
May	309.2	- .002	.39	8.07
Jun.	394.7	.15	.28	10.3
Jul.	428.0	-1.10	.21	11.17
Aug.	351.4	-1.76	.27	9.17
Sept.	176.8	- .85	.34	4.61
Annual	318.2	1.56	.73	

	North Fork Cache Creek Near Lower Lake[3] Cache Watershed 1931- 1968			
	Q	g	CV	%
Oct.	10.95	4.05	3.25	.48
Nov.	42.48	2.02	1.39	1.85
Dec.	340.4	1.71	1.37	14.92
Jan.	499.2	1.09	.99	21.87
Feb.	643.3	1.99	1.05	28.19
Mar.	386.0	2.21	.94	16.92
Apr.	246.3	1.86	1.03	10.79
May	76.43	.81	.63	.33
Jun.	27.27	1.36	.70	1.20
Jul.	6.58	1.24	.83	.29
Aug.	2.09	1.26	.92	.09
Sept.	1.35	1.02	1.01	.06
Annual	188.1	1.23	.75	

1 – A = 36.6 mi^2; 11-4495

2 – A = 528 mi^2; regulated by Clear Lake (319,000 AF capacity); 11-4510

3 – A = 197 mi^2; small diversion; 11-4515

	Scotts Creek Near Lakeport[1] Cache Watershed 1961 – 1968				Copsey Creek Near Lower Lake[2] Cache Watershed 1961 – 1968				Russian River Near Healdsburg[3] Russian Watershed 1959 – 1968			
	Q	g	CV	%	Q	g	CV	%	Q	g	CV	%
Oct.	3.28	2.83	2.83	0.39	3.10	2.83	2.67	1.89	376.3	3.06	.94	2.50
Nov.	28.14	.34	.98	3.38	6.75	1.39	1.23	4.10	820.9	.78	.71	5.47
Dec.	164.8	2.51	1.38	19.8	25.78	1.15	1.05	15.66	2135.0	2.26	1.19	14.22
Jan.	236.4	.15	.68	27.3	54.65	- .26	.66	33.19	3101.0	.49	.68	20.65
Feb.	172.0	- .12	.62	19.5	34.69	.95	.88	21.07	3533.0	- .09	.49	23.53
Mar.	117.4	- .59	.60	14.1	18.66	1.06	.91	11.33	2127.0	.28	.55	14.16
Apr.	109.8	1.17	1.22	13.2	17.08	1.34	1.38	10.37	1540.0	1.46	1.01	10.21
May	15.95	1.02	0.99	1.91	2.54	1.62	1.03	1.54	500.0	.94	.70	3.33
Jun.	3.07	1.26	2.14	.37	.98	2.43	1.08	.60	241.7	1.50	.51	1.61
Jul.	.01	2.83	2.83	.00	.24	1.59	1.15	.14	204.4	1.70	.20	1.36
Aug.	0				.10	1.83	1.31	.06	211.8	1.52	.22	1.41
Sept.	0				.08	1.12	1.39	.05	226.4	1.50	.25	1.51
Annual	70.52	.63	.45		13.64	.20	.54		1240.0	.44	.33	

1 – A = 52.3 mi^2; small diversion for irrigation; 11-4491

2 – A = 13.2 mi^2; minor diversion for irrigation; 11-4494.5

3 – A = 793 mi^2; since November 1958, regulated by Lake Mendocino (122,900 AF); 11-4640

APPENDIX F

TECHNICAL DATA

WATER CHEMISTRY
RUSSIAN RIVER AREA

Area	Geologic Formation *	Water Type	EC (micromhos)	Cl (ppm)	B (ppm)	NO_3 (ppm)	Na (%)	Total Hardness (ppm)	N.C. Hardness (ppm)
Santa Rosa	Tsv	$NaHCO_3$	476-531	21-31	0.3-1.0	0.0-12	28-40	156-169	0-7
	Tm	$NaHCO_3$ $Ca(HCO_3)_2$	187-307	15-31	0.0-0.31	0.0-0.31	0.0-0.31	45-117	0-9
	TQge	$MgHCO_3$ $NaHCO_3$ $Ca(HCO_3)_2$	246-820	17-49	0.0-0.84	0.0-25	21-68	61-319	0-41
Healdsburg	Qsc	$MgHCO_3$	285	22	0.14	7.7	13	126	17
Alexander Valley	Kc	$NaHCO_3$	457	13	0.0	0.0	63	89	0
	TQge	$NaHCO_3$	350-583	15-41	0.12-0.34	0.0-0.8	37-92	16-114	0
	Qsc	$MgHCO_3$ $Ca(HCO_3)_2$	323-329	6.5-18	0.18-0.4	5.6-8.3	10-13	151-170	12-14
Cloverdale Valley	Qt	$NaHCO_3$ $Ca(HCO_3)_2$	239-248	7.5-30.0	0.6-0.8	0.6-11.0	19	65-111	0
	Qal	$Ca(HCO_3)_2$	310	10	0.16	---	11	150	0
	Qsc	$Ca(HCO_3)_2$	283-366	7.5-9.3	0.3	0.0-1.4	10-17	155-183	0
Sanel Valley	TQc	$MgHCO_3$	327	8.5	0.42	0.0	19	230	0
	Qal	$MgHCO_3$ $Ca(HCO_3)_2$	229-349	4.8-9.0	0.02-0.44	1-11	21-32	96-166	0-9
	Qsc	$MgHCO_3$	335-351	5.5-11.0	0.08-1.87	2.7-8.0	5-22	147-177	0.15
Ukiah Valley	Qt	$MgHCO_3$ $Ca(HCO_3)_2$	223-371	12-29	0.0-0.1	0.9-8.0	25-36	84-139	0-12
	Qal	$NaHCO_3$ $MgHCO_3$ $Ca(HCO_3)_2$	339-566	3.8-23.0	0.05-1.14	0.0-2.0	13-40	138-214	0-12
	Qsc	$MgHCO_3$ $Ca(HCO_3)$ $Ca(HCO_3)_2$	203-483	4.8-13.0	0.11-0.24	0.0-27.0	12-60	86-182	0-32
Potter Valley	Qt	$MgHCO_3$ $Ca(HCO_3)_2$	243-269	7.2-8.0	0.12	1.5-21.0	12-18	107-120	0-21
	Qal	$MgHCO_3$ $Ca(HCO_3)_2$	232-593	3.7-22.0	0.04-0.61	0.1-3.5	12-18	105-245	0-22

* Qsc: Stream channel deposits; Qal: Alluvium; Qt: Terraces; TQc: Plio-Pleistocene Sediments; TQge: Glen Ellen Formation; Tm: Merced Formation; Tsv: Sonoma volcanics; Kc: Cretaceous conglomerate.

Source: California Department of Water Resources Bulletin #143-4

IVF-3

Table 20.—*Chemical analyses of water in Sonoma Valley, Calif.*

Samples collected by the Geological Survey were analyzed by the Geological Survey's Quality of Water laboratory. These are indicated by the symbol "S" for the Sacramento, California, laboratory. Samples collected by the Sonoma County farm advisor were analyzed by the University of California Division of Plant Nutrition at Berkeley, Calif. These are indicated by the symbol "UC." Samples collected and analyses made by other individuals or agencies are indicated by special footnotes. Figures in analyses by other than the Geological Survey are given as reported and hence they have not been rounded or corrected to conform with Survey standards.

Sum of determined constituents is the arithmetic total in parts per million of all constituents determined, except bicarbonate for which the figure is divided by 2.03 before addition. For sodium and potassium, where no figure is given for potassium, the concentration of sodium was computed by difference, and that figure includes potassium computed as sodium plus any error of analysis.

Well	Collector, analyst, and laboratory number	Depth (feet)	Geologic deposit from which water was withdrawn	Date sampled	Specific conductance (micromhos at 25° C)	pH	Constituents, in parts per million: Sum of determined constituents	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Boron (B)	Fluoride (F)	Hardness as $CaCO_3$	Percent sodium
4/5- 3C1	UC 8565	261	(1)	1- 9-51	3,190	8.1	......	......	......	......	95	45	490	......	410	30	105	735	......	0.64	......	[2]422	72
3C2	UC 8564	110	(1)	1- 9-51	3,000	8.1	......	......	......	......	110	90	375	......	340	5	40	800	......	.32	......	[2]644	56
14D1	(3) (4)	540	Qh	7-26-49	957	7.4	636	78	0.15	0.19	10	10	197	......	310	......	45	140	0.8	......	......	67	87
14D2	(3) (4)	1,620	Qh?	9- 7-51	880	7.0	604	52	0	3.0	12	18	175	......	275	......	92	120	0	......	2.5	104	79
14L1	(3) (4)	650	Qh?	7-26-49	1,223	7.4	763	68	.57	.30	25	19	222	......	327	......	44	220	.2	......	......	142	77
5/5- 9M2	S 2717	257	Qoal, Qh?	9-15-51	630	7.6	387	36	......	......	5.2	4.1	128	9	229	0	.6	30	0	1.0	.2	30	87
16E1	(4)	393	Qoal, Qh?	......	1,730	7.4	......	......	3.8	.25	......	......	......	......	......	......	......	280	......	......	......	104	......
19L1	S 2716	150	Qoal	9-21-51	208	7.8	226	72	......	......	14	19	18	1.3	138	0	5.4	16	11	.09	.2	113	25
20C1	S 2791	125	Qoal	9-19-51	395	7.6	233	16	......	......	46	20	10	.7	241	0	11	6.2	0	.56	0	231	10
28C1	UC 8719	210	Qoal? Qh	8-27-51	1,100	8.3	[2]610	......	......	......	10	5	230	......	365	25	35	125	......	......	......	[2]46	91
28N1	S 2715	130	Qoal	9-20-51	455	7.6	318	91	......	......	12	18	49	2.2	90	0	4.8	86	10	.10	.2	[2]104	50
31A1	S 4178	408	Qge?	4- 8-52	854	8.3	......	29	......	......	6.8	3.6	205	1.5	488	0	.7	65	.2	5.3	0	32	93
	S 4388	......	......	6-10-52	957	......	......	......	......	......	8.0	7.3	245	......	......	......	......	66	......	6.6	......	[2]50	......
31A2	S 4387	100	Qyal, Qoal?	6-10-52	5,360	......	......	......	......	......	159	192	848	......	......	......	......	1,580	......	.08	......	[2]1,190	......
31A3	S 2718	56	Qyal	9-20-51	5,010	7.2	2,800	74	......	......	204	261	430	8.1	285	0	199	1,480	2.9	.21	0	1,580	37
	S 4386	......	......	6-10-52	4,530	......	......	......	......	......	190	217	455	......	......	......	......	1,350	......	.20	......	[2]1,370	......
5/6- 2A2	(2) (4)	350	Tsv	......	......	......	845	76	0.93	......	9	1.0	295	......	......	61	2.9	392	......	......	7.0	[2]27	96
2A5	(2) (4)	80	Tsv	......	......	......	......	......	Tr.	Tr.	5.0	2.0	195	......	......	128	17	150	......	......	......	[2]20	95
13K1	S 2792	150	Qyal, Qoal?	9-20-51	368	7.3	218	16	......	......	24	19	28	.8	204	0	9.1	15	.3	4.4	.1	138	30
6/6-10M1	UC 8490	165	Qyal, Qoal?	8-23-50	250	8.2	135	......	......	......	15	15	15	......	90	10	15	20	......	0	......	[2]99	25
15J1	S 2714	75	Tsv	9-19-51	344	7.7	252	90	......	......	14	9.5	32	5.9	126	0	12	24	.5	.54	.5	74	46
16B2	S 2719	211	Qge	9-19-51	672	8.2	445	74	......	......	3.7	4.6	134	9.0	300	0	.8	60	.5	7.7	.3	28	88
16H1	UC 8656	210	Qge	7- 3-51	550	8.3	314	......	......	......	5	0	120	......	195	5	0	80	......	6.2	......	15	95
16J2	UC 8252	102	Qge	10-25-49	550	8.6	308	......	......	......	15	10	90	......	120	20	23	90	......	7.7	......	[2]79	70
22R2	S 2794	418	Qge	9-19-51	203	6.8	137	35	......	......	12	8.0	14	.6	60	0	5.8	22	10	0	0	63	32
35M3	S 2793	53	Qyal	9-19-51	270	7.8	139	......	......	......	7.2	20	10	.2	138	0	6.3	17	0	.07	.1	100	29

[1] Contaminated from nearby tidal slough.
[2] Calculated by U. S. G. S.
[3] Collected from owner or owner's agent.
[4] Analyses by International Filter Co., Chicago, Illinois, converted from hypothetical combinations in grains per gallon to ions in parts per million.
[5] For explanation of symbols see geologic map (pl. 2).

Table 21.—*Partial chemical analyses of water in Sonoma Valley, Calif.*

[Analyzed by Geological Survey except as indicated]

Well	Date of collection	Depth (feet)	Geologic deposit from which water was withdrawn[1]	Chloride (Cl) (ppm)	Hardness as $CaCO_3$ (ppm)	Specific conductance (micromhos at 25°C)
4/5-14D1	Mar. 16, 1950	540	Qh	121	59	957
14L1	.....do..........	650	Qh?	203	137	1,225
32B1	Feb. 17, 1950	....	Qyal, Qoal?	314	360	1,880
32C1	.....do..........	....	Qyal, Qoal?	836	380	3,400
34P1	Nov. 8, 1949	200+	Qyal, Qoal	632	406	2,876
5/5- 9N1	Aug. 14, 1951	185	Qoal	90	55	908
17C1	Oct. 9, 1950	70	Qoal	9.2	37	226
20A2	[2]1949	390	Qoal, Qh?	400	....	....
27H1	Jan 26, 1950	750	Qh, Tsv	12	40	334
30E1	July 29, 1951	755	Qh	24	130	467
31A1	Apr. 8, 1952	408	Qge?	65	32	925
	May 22, 1952	....	....	87	30	920
	June 10, 1952	....	....	66	50	957
31A2	May 22, 1952	100	Qyal, Qoal?	1,160	880	4,390
	June 10, 1952	....	....	1,380	1,190	5,380
31A3	Apr. 8, 1952	56	Qyal	111	116	1,060
	June 10, 1952	....	....	1,350	1,370	4,530
31H1	Apr. 8, 1952	203	Qyal, Qoal	234	100	1,310
5/6- 2A2	June 20, 1951	350	Tsv?	378	30	1,550
2A3	.....do..........	450	Tsv?	273	35	1,220
2A4	.....do..........	128	Tsv?	208	....	1,050
2A5	June 20, 1951	80	Tsv?	132	30	901
13K1	Aug. 16, 1951	150	Qyal, Qoal?	16	160	317
14B1	Oct. 9, 1950	116	Qoal	90	85	218
14G1	.....do..........	48	Qoal	13	98	251
6/6- 10F1	June 26, 1951	350	Qoal, Qge	64	55	465
10G1	.....do..........	147	Tsv	164	395	1,310
18B1	.....do..........	426	Qoal	93	15	690
22R1	Apr. 8, 1952	152	Qt, Qge	121	12	653
23F1	July 28, 1950	452	Tsv	42	27	394
23M1	.....do..........	255	Qt, Qoal	97	77	558
28E1	Aug. 17, 1951	215	Tsv	7.2	115	246

[1] For explanation of symbols see geologic map (pl. 2).
[2] Collected from owner.

IVF-4

Table 22.—*Drillers' logs of water wells in Sonoma Valley, Calif.*

[For wells having no perforated interval shown, customary practice is to pre-perforate all casing except the top few lengths]

	Thickness (feet)	Depth (feet)
4/5-3C1		
[John Lawler. Drilled by J. W. Evans & Sons. On terrace. Altitude 30 ft]		
Terrace deposit:		
Boulders	5	5
Huichica formation:		
Clay, yellow	102	107
Gravel, tuff, water	3	110
Clay, gray	17	127
Clay, blue	15	142
Clay, gray	23	165
Clay, blue	9	174
Clay, gray	57	231
Blue and gray clay, gravel, water	27	258
Clay, yellow	3	261
4/5-14D1		
[U. S. Navy No. 1. Drilled by N. F. Keyt. On tidal marshland. Altitude 0 ft. Casing cemented from 0 to 225 ft, perforated from 495 to 531 ft]		
Formations undifferentiated:		
Soil	2	2
Clay, blue	10	12
Clay, blue	37	49
Gravel	6	55
Clay, blue	5	60
Clay, yellow	15	85
Clay, yellow, and gravel	5	90
Clay, blue	16	106
Clay, blue, and gravel	9	115
Clay, blue	70	185
Clay, yellow	23	208
Clay, blue	12	220
Clay, blue, and gravel	25	245
Clay, blue, sandy	26	271
Clay, blue	29	300
Clay, blue, and gravel	34	334
Clay, yellow	78	412
Clay, yellow, sandy	83	495
Clay, yellow, sandy, and gravel	7	502
Yellow sand and gravel	10	512
Yellow sand and gravel	23	535
Yellow "cement" and gravel	2	537
Clay, yellow, and gravel	3	540
4/5-14D2		
[U. S. Navy No. 3. Drilled by N. F. Keyt. Material logged by Geological Survey, formations undifferentiated. On tidal marshland. Altitude 0 ft. Well plugged at 620 ft. Casing cemented from 0 to 260 ft. Casing perforated for 252 ft between 260 and 620 ft]		
Formations undifferentiated:		
Peat and adobe	10	10
Peat and silt	38	48
Silt, sandy	12	60

PUMP TEST DATA

CALISTOGA AREA , NAPA VALLEY

Time: Time of measurement, in minutes after pump was started.

Static water level: The depth to water, in feet below or above (+) land-surface datum, prior to start of test.

Pumping water level: The depth to water, in feet below or above (+) land-surface datum, at end of test.

Drawdown: The difference, in feet, between the static and pumping water levels.

Yield: The yield of the well, in gallons per minute, for drawdown indicated.

Specific capacity: Yield, in gallons per minute, divided by drawdown, in feet. The specific capacity is a measure of the physical condition of the well and the aquifer or aquifers which it penetrates. A well with a large specific capacity is capable of a greater yield than a well with a small specific capacity.

State well number	Date	Time (minutes)	Static water level (feet)	Pumping water level (feet)	Drawdown (feet)	Yield (gpm)	Specific capacity (gpm/ft of dd)
08N/06W-04F01 M	07 24 68	1440	62.2	88.4	26.2	71.0	2.71
08N/06W-05P01 M	05 27 68	240	20	88	68	200.0	2.94
08N/06W-05Q02 M	09 18 68	240	20	160	140	100.0	0.71
08N/06W-05Q02 M	08 13 69	1440	90.2	136.0	45.8	137.0	2.99
08N/06W-05Q03 M	09 11 68	360	20	140	120	150.0	1.25
08N/06W-05Q03 M	08 13 69		62.2	70.0	7.8		
08N/06W-06L06 M	08 01 69	240	12	190	178	30.0	0.17
08N/06W-07A01 M	04 10 64	120	FLOW	35	35	55.0	1.57
08N/06W-07F01 M	03 08 65	360	8	80	72	30.0	0.42
08N/06W-08D02 M	01 27 68	240	6	116	110	200.0	1.42
08N/06W-08D02 M	07 24 68	1440		388.0		125.0	
08N/06W-09C01 M	07 24 68	1440	53.0	95.5	42.5	143.0	3.36
08N/06W-10Q03 M	12 04 58	60	15	65	50	15.0	0.30
08N/06W-14E01 M	10 42 47	0180	10	50	40	40.0	1.00
08N/06W-15G02 M	08 30 66	150	0	28	28	70.0	2.50
08N/07W-01H01 M	01 21 66	2160	8	194	186	155.0	0.83
08N/07W-02G02 M	07 03 70		22	90	68	40.0	0.59
08N/07W-02G02 M	07 03 70		22	134	112	60.0	0.54
08N/07W-02G02 M	07 03 70		22	182	160	75.0	0.47
08N/07W-03L01 M	05 17 67	240	420	430	10	20.0	2.00
09N/06W-31Q03 M	06 30 64	60	12	20	8	100.0	12.50
09N/07W-24E01 M	06 03 64	60	25	30	5	35.0	7.00
09N/07W-24P01 M	07 01 66	120	14	70	56	30.0	0.54
09N/07W-25K01 M	09 03 70	60	18	80	62	6.0	0.10
09N/07W-25K02 M	09 17 63	60	.6	90.6	90	10.0	0.11
09N/07W-26G01 M	03 22 50		FLOW			0.5	
09N/07W-26M02 M	01 06 67	60	12	52	40	15.0	0.38
09N/07W-26P02 M	10 22 65	120	5	50	45	35.0	0.78
09N/07W-26R04 M	09 20 62		FLOW	10	10	30.0	3.00
09N/07W-35H01 M	07 23 66	60	12	22	10	45.0	4.50
09N/07W-35K02 M	03 19 64	120	0	60	60	20.0	0.33
09N/07W-36C01 M	03 03 59	60	4	16	12	12.0	1.00
09N/07W-36H04 M	12 16 63	60	4	59	55	15.0	0.27
09N/07W-36J01 M	03 13 63		4			20.0	
09N/07W-36J02 M	07 15 71	60	9	100	91	12.0	0.13
09N/07W-36K01 M	10 05 66	60	20	70	50	50.0	1.00
09N/07W-36K02 M	03 04 63	60	12	25	13	20.0	1.54
09N/07W-36R01 M	01 12 63	60	12	20	8	30.0	3.75

Source: Bader and Svitek, 1973
USGS Open File Report

PUMP TEST DATA

NAPA AREA, NAPA VALLEY

Time: Time of measurement, in minutes after pump was started.

Static water level: The depth to water, in feet below or above (+) land-surface datum, prior to start of test.

Pumping water level: The depth to water, in feet below or above (+) land-surface datum, at end of test.

Drawdown: The difference, in feet, between the static and pumping water levels.

Yield: The yield of the well, in gallons per minute, for drawdown indicated.

Specific capacity: Yield, in gallons per minute, divided by drawdown, in feet. The specific capacity is a measure of the physical condition of the well and the aquifer or aquifers which it penetrates. A well with a large specific capacity is capable of a greater yield than a well with a small specific capacity.

State well number	Date	Time (minutes)	Static water level (feet)	Pumping water level (feet)	Drawdown (feet)	Yield (gpm)	Specific capacity (gpm/ft of dd)
06N/04W-15H01 M	11 20 68	120			525	60.0	0.11
06N/04W-15L02 M	04 12 51	180	32		50	3.0	0.06
06N/04W-17G04 M	09 23 68	2880		144.8		600.0	
06N/04W-17H04 M	10 04 68	120	20		90	100.0	1.11
06N/04W-17J02 M	11 12 68	1440	29.0	68.3	39.3	170.0	4.33
06N/04W-18A04 M	09 12 69				112	120.0	1.07
06N/04W-19J02 M	08 05 50	30	19		80	15.0	0.19
06N/04W-23J04 M	03 08 71	1680	40		300	1020.0	3.40
06N/04W-23Q02 M	07 21 70	120	19		30	30.0	1.00
06N/04W-28F02 M	07 05 68	120	35		65	15.0	0.23
06N/04W-28F03 M	11 12 60	60	60		12	20.0	1.67
06N/04W-29H01 M	06 28 50	60	18		24	30.0	1.25
06N/04W-34C01 M	05 26 59	60	24		18	40.0	2.22
06N/04W-36F02 M	04 10 62	60	90		12	30.0	2.50
06N/04W-36F03 M	12 20 58	120	22		48	30.0	0.63
06N/05W-24C01 M	03 04 63	120	60			30.0	
06N/05W-25A01 M	09 10 66				95	20.0	0.21

Source: Bader and Svitek, 1973
USGS Open File Report

PUMP TEST DATA

RUTHERFORD AREA, NAPA VALLEY

Time: Time of measurement, in minutes after pump was started.

Static water level: The depth to water, in feet below or above (+) land-surface datum, prior to start of test.

Pumping water level: The depth to water, in feet below or above (+) land-surface datum, at end of test.

Drawdown: The difference, in feet, between the static and pumping water levels.

Yield: The yield of the well, in gallons per minute, for drawdown indicated.

Specific capacity: Yield, in gallons per minute, divided by drawdown, in feet. The specific capacity is a measure of the physical condition of the well and the aquifer or aquifers which it penetrates. A well with a large specific capacity is capable of a greater yield than a well with a small specific capacity.

State well number	Date	Time (minutes)	Static water level (feet)	Pumping water level (feet)	Drawdown (feet)	Yield (gpm)	Specific capacity (gpm/ft of dd)
07N/05W-03C01 M	04 71	2640	40		350	110.0	0.31
07N/05W-05A07 M	67				230	3500.0	15.22
07N/05W-08L01 M	10 57	60	15	60	45	20.0	0.44
07N/05W-08P02 M	11 62		12		23	60.0	2.61
07N/05W-09E02 M	11 67	60	10		30	30.0	1.00
07N/05W-09J01 M	10 64				221	1260.0	5.70
07N/05W-09J01 M	05 01 67	1440	4	159	155	1230.0	7.94
07N/05W-09J01 M	06 01 67	1440	53.0	236.5	183.5	1085.0	5.91
07N/05W-09Q04 M	07 10 71	1080	7	64	57.0	1360.0	23.86
07N/05W-14C01 M	04 71	120	8		10	40.0	4.00
07N/05W-14F01 M	07 72	1920	20		105	325.0	3.10
07N/05W-15J01 M	09 71	360	18.7		130	1250.0	9.62
07N/05W-15P03 M	02 71		18	98		1200.0	15.00
07N/05W-15Q01 M	09 71	360	17.5		113	1000.0	8.85
07N/05W-16B05 M	11 56		20		10	40.0	4.00
07N/05W-16D02 M	11 56	120	16		54	80.0	1.48
07N/05W-20B01 M	05 64	60	75		20	60.0	3.00
07N/05W-20B01 M	09 09 68		105.7	140.2	34.5	108.0	3.13
07N/05W-20B02 M	10 67	480	10.5	18.5	8.0	23.0	2.88
07N/05W-20B02 M	09 09 68	1440	133.3	207.2	73.9	305.0	4.13
07N/05W-20J01 M	10 63	60	105		5	60.0	12.00
07N/05W-20J01 M	10 29 69	1440	126.5	19.5	19.5	73.0	3.74
07N/05W-21B02 M	06 71	240	40		175	25.0	0.14
07N/05W-21F01 M	06 66		20		255	5.0	0.02
07N/05W-21M01 M	03 64	60	80	120		40.0	1.00
07N/05W-21M02 M	11 63	60	100	110		50.0	5.00
07N/05W-22A01 M		1440			80	2000.0	25.00
07N/05W-23C01 M	10 70	1800	10		120	1050.0	8.75
07N/05W-23H01 M	10 57		10		130	452.0	3.48
07N/05W-26D03 M	10 59	60	11	40		40.0	1.38
07N/05W-26G01 M	06 28 61	1440				780.0	
07N/05W-26G01 M	08 30 62	1440				720.0	
07N/05W-26G01 M	08 10 72	1440				840.0	
07N/05W-26K01 M	06 70	60	20	160		60.0	0.43
07N/05W-26N02 M	09 69	60	8		30	40.0	1.33
07N/05W-27A01 M	06 70	60	10		40	60.0	1.50
07N/05W-34H02 M	03 64	90	25	165		8.5	0.06
07N/06W-01B01 M	02 71	360	12		90	40.0	0.44
07N/06W-02H01 M	09 68	60	12		48	40.0	0.83
08N/05W-31Q01 M	05 63	120	12		23	20.0	0.87
08N/05W-31R01 M	05 60	6000	16		87	226.0	2.60
08N/05W-33N03 M	02 65			165		1025.0	
08N/05W-34R01 M	09 63	60	100	300			
08N/06W-35R02 M	08 64	60	16		20	75.0	3.75
08N/06W-35R04 M	10 64	120	75		65	25.0	0.38

Source: Bader and Svitek, 1973
USGS Open File Report

PUMP TEST DATA

YOUNTVILLE AREA, NAPA VALLEY

Time: Time of measurement, in minutes after pump was started.

Static water level: The depth to water, in feet below or above (+) land-surface datum, prior to start of test.

Pumping water level: The depth to water, in feet below or above (+) land-surface datum, at end of test.

Drawdown: The difference, in feet, between the static and pumping water levels.

Yield: The yield of the well, in gallons per minute, for drawdown indicated.

Specific capacity: Yield, in gallons per minute, divided by drawdown, in feet. The specific capacity is a measure of the physical condition of the well and the aquifer or aquifers which it penetrates. A well with a large specific capacity is capable of a greater yield than a well with a small specific capacity.

State well number	Date	Time (minutes)	Static water level (feet)	Pumping water level (feet)	Drawdown (feet)	Yield (gpm)	Specific capacity (gpm/ft of dd)
06N/04W-04D01 M	10 13 70	[illegible]	30	121	91	35.0	0.38
06N/04W-04D02 M	10 22 70	[illegible]	26	86	60	127.0	2.12
06N/04W-04P01 M	08 29 67	180	30	90	60	250.0	4.17
06N/04W-06D01 M	03 [illegible] 71	240	5	25	20	350.0	17.50
06N/04W-06P01 M					26	400.0	15.38
06N/04W-08B01 M	06 04 71		10	35	25	40.0	1.60
06N/04W-08E02 M					35	360.0	10.29
06N/04W-08E04 M	07 23 69	60	20	24	4	45.0	11.25
06N/04W-09B01 M	08 27 69	240	240	265	25	350.0	14.00
06N/04W-09B02 M	06 14 70	240	300	320	20	300.0	15.00
06N/04W-09B03 M	05 03 65	960	11	18	7	450.0	64.29
06N/04W-09D01 M	03 22 65				200	100.0	0.50
06N/04W-09F01 M	05 21 65	180	6	226	220	50.0	0.23
06N/04W-09Q01 M	08 23 71	180	45	185	140	10.0	0.07
06N/04W-09Q02 M	11 16 71	180	75	285	210	35.0	0.17
06N/04W-10L01 M	08 25 67	1440	100	209	109	230.0	2.11
06N/04W-10L01 M	07 15 68	1440	155.3	287.8	132.5	208.0	1.57
06N/04W-12P01 M	07 28 62		265	270	5	30.0	6.00
06N/04W-12P02 M	07 24 61	60			28	30.0	1.07
07N/04W-31K01 M	04 05 68	60	6	20	14	50.0	3.57
07N/04W-32J01 M	04 29 68	180	0.0	50	50	200.0	4.00
07N/04W-32P01 M	05 13 [illegible]	300	6	42	36	50.0	1.39
07N/05W-13N01 M	02 11 70	180	10	60	50	20.0	0.40
07N/05W-23A01 M	08 08 70	300	20	70	50	80.0	1.60
07N/05W-24B02 M	11 17 58	60	12	15	3	60.0	20.00
07N/05W-24M01 M	03 17 57	120	4	169	165	185.0	1.12
07N/05W-24M02 M	10 05 57	4140	11	201	190	725.0	3.82
07N/05W-24M02 M	08 09 72	1440	27.0	56.5	28.0	330.0	11.79
07N/05W-24M03 M	10 24 57	3060	10	140	130	452.0	3.48
07N/05W-24P01 M	11 19 60	3600	14	192	178	351.0	1.97
07N/05W-24P01 M	08 30 62	1440	90.0	163.4	73.4	255.0	3.47
07N/05W-24Q01 M	06 28 61	1440	25.2	96.8	71.6	250.0	3.49
07N/05W-24Q01 M	08 30 62	1440				342.0	
07N/05W-24Q01 M	08 09 72	1440	21.2	64.0	42.8	310.0	7.24
07N/05W-25E01 M	06 28 61	1440	44.0	110.8	66.8	545.0	8.16
07N/05W-25E01 M	08 30 62	1440	62.0	136.0	74.0	550.0	7.43
07N/05W-25E01 M	08 09 72	1440	34.9	75.9	41.0	270.0	6.59
07N/05W-25M01 M	06 28 61	1440	26.0	42.3	16.3	770.0	47.24
07N/05W-25M01 M	08 30 62	1440	43.7	62.7	19.0	727.0	38.26
07N/05W-25M01 M	08 09 72	1440	24.0	51.5	27.5	885.0	32.18
07N/05W-36R02 M	05 14 69	1440	12.2	46.4	34.2	2020.0	59.06

Source: Bader and Svitek, 1973
USGS Open File Report

PUMP TEST DATA

ST. HELENA AREA , NAPA VALLEY

Time: Time of measurement, in minutes, after pump was started.

Static water level: The depth to water, in feet below or above (+) land-surface datum, prior to start of test.

Pumping water level: The depth to water, in feet below or above (+) land-surface datum, at end of test.

Drawdown: The difference, in feet, between the static and pumping water levels.

Yield: The yield of the well, in gallons per minute, for drawdown indicated.

Specific capacity: Yield, in gallons per minute, divided by drawdown, in feet. The specific capacity is a measure of the physical condition of the well and the aquifer or aquifers which it penetrates. A well with a large specific capacity is capable of a greater yield than a well with a small specific capacity.

State well number	Date	Time (minutes)	Static water level (feet)	Pumping water level (feet)	Drawdown (feet)	Yield (gpm)	Specific capacity (gpm/ft of dd)
08N/05W-32G03 M	05 22 68		FLOW		15	1000.0	66.67
08N/06W-14J01 M	07 31 67	60	55	80	25	60.0	2.40
08N/06W-23A01 M		120			6	100.0	16.67
08N/06W-24B02 M	02 66	120	25		125	15.0	0.12
08N/06W-24C01 M	12 65	60	10		25	30.0	1.20
08N/06W-25G03 M	12 68	60	21		30	90.0	3.00
08N/06W-25G03 M		360	21	194	173	200.0	1.16

Source: Bader and Svitek, 1973
USGS Open File Report

APPENDIX G

WATER QUALITY CONTROL POLICY ON THE
USE AND DISPOSAL OF INLAND WATERS
USED FOR POWER PLANT COOLING

WATER QUALITY CONTROL POLICY ON THE USE AND DISPOSAL OF INLAND WATERS USED FOR POWERPLANT COOLING

Introduction

The purpose of this policy is to provide consistent statewide water quality principles and guidance for adoption of discharge requirements, and implementation actions for powerplants which depend upon inland waters for cooling. In addition, this policy should be particularly useful in guiding planning of new power generating facilities so as to protect beneficial uses of the State's water resources and to keep the consumptive use of freshwater for powerplant cooling to that minimally essential for the welfare of the citizens of the State.

This policy has been prepared to be consistent with federal, state, and local planning and regulatory statutes, the Warren-Alquist State Energy Resources Conservation and Development Act, Water Code Section 237 and the Waste Water Reuse Law of 1974.

Section 25216.3 of the Warren-Alquist Act states:

> "(a) The commission shall compile relevant local, regional, state, and federal land use, public safety, environmental, and other standards to be met in designing, siting, and operating facilities in the State; except as provided in subdivision (d) of Section 25402, adopt standards, except for air and water quality,...."

Water Code Section 237 and Section 462 of the Waste Water Reuse Law, direct the Department of Water Resources to:

> 237. "...either independently or in cooperation with any person or any county, state, federal, or other agency, including, but not limited to, the State Energy Resources Conservation and Development Commission, shall conduct studies and investigations on the need and availability of water for thermal electric powerplant cooling purposes, and shall report thereon to the Legislature from time to time...."

> 462. "...conduct studies and investigations on the availability and quality of waste water and uses of reclaimed waste water for beneficial purposes including, but not limited to ... and cooling for thermal electric powerplants."

Decisions on waste discharge requirements, water rights permits, water quality control plans, and other specific water quality control implementing actions by the State and Regional Boards shall be consistent with provisions of this policy.

The Board declares its intent to determine from time to time the need for revising this policy.

Definitions

1. Inland Water - all waters within the territorial limits of California exclusive of the waters of the Pacific Ocean outside of enclosed bays, estuaries, and coastal lagoons.

2. Fresh Inland Waters - those inland waters which are suitable for use as a source of domestic, municipal, or agricultural water supply and which provide habitat for fish and wildlife.

3. Salt Sinks - areas designated by the Regional Water Quality Control Boards to receive saline waste discharges.

4. Brackish Waters - includes all waters with a salinity range of 1,000 to 30,000 mg/l and a chloride concentration range of 250 to 12,000 mg/l. The application of the term "brackish" to a water is not intended to imply that such water is no longer suitable for industrial or agricultural purposes.

5. Steam-Electric Power Generating Facilities - electric power generating facilities utilizing fossil or nuclear-type fuel or solar heating in conjunction with a thermal cycle employing the steam-water system as the thermodynamic medium and for the purposes of this policy is synonomous with the word "powerplant".

6. Blowdown - the minimum discharge of either boiler water or recirculating cooling water for the purpose of limiting the buildup of concentrations of materials in excess of desirable limits established by best engineering practice.

7. Closed Cycle Systems - a cooling water system from which there is no discharge of wastewater other than blowdown.

8. Once-Through Cooling - a cooling water system in which there is no recirculation of the cooling water after its initial use.

9. Evaporative Cooling Facilities - evaporative towers, cooling ponds, or cooling canals, which utilize evaporation as a means of wasting rejected heat to the atmosphere.

10. Thermal Plan - "Water Quality Control Plan for Control of Temperature In The Coastal and Interstate Waters and Enclosed Bays and Estuaries of California"

11. Ocean Plan - "Water Quality Control Plan for Ocean Waters of California"

Basis of Policy

1. The State Board believes it is essential that every reasonable effort be made to conserve energy supplies and reduce energy demands to minimize adverse effects on water supply and water quality and at the same time satisfy the State's energy requirements.

2. The increasing concern to limit changes to the coastal environment and the potential hazards of earthquake activity along the coast has led the electric utility industry to consider siting steam-electric generating plants inland as an alternative to proposed coastal locations.

3. Although many of the impacts of coastal powerplants on the marine environment are still not well understood, it appears the coastal marine environment is less susceptible than inland waters to the water quality impacts associated with powerplant cooling. Operation of existing coastal powerplants indicate that these facilities either meet the standards of the State's Thermal Plan and Ocean Plan or could do so readily with appropriate technological modifications. Furthermore, coastal locations provide for application of wide range of cooling technologies which do not require the consumptive use of inland waters and therefore would not place an additional burden on the State's limited supply of inland waters. These technologies include once-through cooling which is appropriate for most coastal sites, potential use of saltwater cooling towers, or use of brackish waters where more stringent controls are required for environmental considerations at specific sites.

4. There is a limited supply of inland water resources in California. Basin planning conducted by the State Board has shown that there is no available water for new allocations in some basins. Projected future water demands when compared to existing developed water supplies indicate that general fresh-water shortages will occur in many areas of the State prior to the year 2000. The use of inland waters for powerplant cooling needs to be carefully evaluated to assure proper future allocation of inland waters considering all other beneficial uses. The loss of inland waters through evaporation in powerplant cooling facilities may be considered an unreasonable use of inland waters when general shortages occur.

5. The Regional Boards have adopted water quality objectives including temperature objectives for all surface waters in the State.

6. Disposal of once-through cooling waters from powerplants to inland waters is incompatible with maintaining the water quality objectives of the State Board's "Thermal Plan" and "Water Quality Control Plans".

7. The improper disposal of blowdown from evaporative cooling facilities may have an adverse impact on the quality of inland surface and groundwaters and on fish and wildlife.

8. An important consideration in the increased use of inland water for powerplant cooling or for any other purpose in the Central Valley Region is the reduction in the available quantity of water to meet the Delta outflow requirements necessary to protect Delta water quality objectives and standards. Additionally, existing contractual agreements to provide future water supplies to the Central Valley, the South Coastal Basin, and other areas using supplemental water supplies are threatening to further reduce the Central Valley outflow necessary to protect the Delta environment.

9. The California Constitution and the California Water Code declare that the right to use water from a natural stream or watercourse is limited to such water as shall be reasonably required for beneficial use and does not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion. Section 761, Article 17.2, Subchapter 2, Chapter 3, Title 23, California Administrative Code provides that permits or licenses for the appropriation of water will contain a term which will subject the permit or license to the continuing authority of the State Board to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of said water.

10. The Water Code authorizes the State Board to prohibit the discharge of wastes to surface and groundwaters of the State.

Principles

1. It is the Board's position that from a water quantity and quality standpoint the source of powerplant cooling water should come from the following sources in this order of priority depending on site specifics such as environmental, technical and economic feasibility consideration: (1) wastewater being discharged to the ocean, (2) ocean, (3) brackish water from natural sources or irrigation return flow, (4) inland wastewaters of low TDS, and (5) other inland waters.

2. Where the Board has jurisdiction, use of fresh inland waters for powerplant cooling will be approved by the Board only when it is demonstrated that the use of other water supply sources or other methods of cooling would be environmentally undesirable or economically unsound.

3. In considering issuance of a permit or license to appropriate water for powerplant cooling, the Board will consider the reasonableness of the proposed water use when compared with other present and future needs for the water source and when viewed in the context of alternative water sources that could be used

for the purpose. The Board will give great weight to the results of studies made pursuant to the Warren-Alquist State Energy Resources Conservation and Development Act and carefully evaluate studies by the Department of Water Resources made pursuant to Sections 237 and 462, Division 1 of the California Water Code.

4. The discharge of blowdown water from cooling towers or return flows from once-through cooling shall not cause a violation of water quality objectives or waste discharge requirements established by the Regional Boards.

5. The use of unlined evaporation ponds to concentrate salts from blowdown waters will be permitted only at salt sinks approved by the Regional and State Boards. Proposals to utilize unlined evaporation ponds for final disposal of blowdown waters must include studies of alternative methods of disposal. These studies must show that the geologic strata underlying the proposed ponds or salt sink will protect usable groundwater.

6. Studies of availability of inland waters for use in powerplant cooling facilities to be constructed in Central Valley basins, the South Coastal Basins or other areas which receive supplemental water from Central Valley streams as for all major new uses must include an analysis of the impact of such use on Delta outflow and Delta water quality objectives. The studies associated with powerplants should include an analysis of the cost and water use associated with the use of alternative cooling facilities employing dry, or wet/dry modes of operation.

7. The State Board encourages water supply agencies and power generating utilities and agencies to study the feasibility of using wastewater for powerplant cooling. The State Board encourages the use of wastewater for powerplant cooling where it is appropriate. Furthermore, Section 25601(d) of the Warren-Alquist Energy Resources Conservation and Development Act directs the Commission to study, "expanded use of wastewater as cooling water and other advances in powerplant cooling" and Section 462 of the Waste Water Reuse Law directs the Department of Water Resources to "...conduct studies and investigations on the availability and quality of waste water and uses of reclaimed waste water for beneficial purposes including, but not limited to ... and cooling for thermal electric powerplants."

<u>Discharge Prohibitions</u>

1. The discharge to land disposal sites of blowdown waters from inland powerplant cooling facilities shall be prohibited except to salt sinks or to lined facilities approved by the Regional and State Boards for the reception of such wastes.

2. The discharge of wastewaters from once-through inland powerplant cooling facilities shall be prohibited unless the discharger can show that such a practice will maintain the existing water quality and aquatic environment of the State's water resources.

3. The Regional Boards may grant exceptions to these discharge prohibitions on a case-by-case basis in accordance with exception procedures included in the "Water Quality Control Plan for Control of Temperature In The Coastal and Interstate Waters and Enclosed Bays and Estuaries of California.

Implementation

1. Regional Water Quality Control Boards will adopt waste discharge requirements for discharges from powerplant cooling facilities which specify allowable mass emission rates and/or concentrations of effluent constituents for the blowdown waters. Waste discharge requirements for powerplant cooling facilities will also specify the water quality conditions to be maintained in the receiving waters.

2. The discharge requirements shall contain a monitoring program to be conducted by the discharger to determine compliance with waste discharge requirements.

3. When adopting waste discharge requirements for powerplant cooling facilities the Regional Boards shall consider other environmental factors and may require an environmental impact report, and shall condition the requirement in accordance with Section 2718, Subchapter 17, Chapter 3, Title 23, California Administrative Code.

4. The State Board shall include a term in all permits and licenses for appropriation of water for use in powerplant cooling that requires the permittee or licensee to conduct ongoing studies of the environmental desirability and economic feasibility of changing facility operations to minimize the use of fresh inland waters. Study results will be submitted to the State Board at intervals as specified in the permit term.

5. Petitions by the appropriator to change the nature of the use of appropriated water in an existing permit or license to allow the use of inland water for powerplant cooling may have an impact on the quality of the environment and as such require the preparation of an environmental impact statement or a supplement to an existing statement regarding, among other factors, an analysis of the reasonableness of the proposed use.

6. Applications to appropriate inland waters for powerplant cooling purpose shall include results of studies comparing the environmental impact of alternative inland sites as well as alternative water supplies and cooling facilities. Studies of alternative coastal sites must be included in the environmental impact report. Alternatives to be considered in the environmental impact report, including but not limited to sites, water supply, and cooling facilities, shall be mutually agreed upon by the prospective appropriator and the State Board staff. These studies should include comparisons of environmental impact and economic and social benefits and costs in conformance with the Warren-Alquist State Energy Resources Conservation and Development Act, the California Coastal Zone Plan, the California Environmental Quality Act and the National Environmental Policy Act.

RESOLUTION NO. 75-58

WATER QUALITY CONTROL POLICY ON THE USE AND DISPOSAL OF INLAND WATERS USED FOR POWERPLANT COOLING

WHEREAS:

1. Basin planning conducted by the State Board has shown that there is presently no available water for new allocations in some basins.

2. Projected future water demands, when compared to existing developed water supplies, indicate that general freshwater shortages will occur in many areas of the State prior to the year 2000.

3. The improper disposal of powerplant cooling waters may have an adverse impact on the quality of inland surface and groundwaters.

4. It is believed that further development of water in the Central Valley will reduce the quantity of water available to meet Delta outflow requirements and protect Delta water quality standards.

THEREFORE, BE IT RESOLVED, that

1. The Board hereby adopts the "Water Quality Control Policy on the Use and Disposal of Inland Waters Used for Powerplant Cooling".

2. The Board hereby directs all affected California Regional Water Quality Control Boards to implement the applicable provisions of the policy.

3. The Board hereby directs staff to coordinate closely with the State Energy Resources Conservation and Development Commission and other involved state and local agencies as this policy is implemented.

CERTIFICATION

The undersigned, Executive Officer of the State Water Resources Control Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on June 19, 1975.

Bill B. Dendy

Bill B. Dendy
Executive Officer

APPENDIX A

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APPENDIX A

BIBLIOGRAPHY LISTING

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APPENDIX B

LITERATURE CROSS-REFERENCE

TOPICS	KEY WORDS	AUTHOR CDWR TITLE Northeastern Counties Groundwater Investigation REFERENCE NO. C5-GEN	AUTHOR CDWR TITLE Northeastern Counties Investigation REFERENCE NO. C2-GEN	AUTHOR USDA TITLE Water & Related Land Res.Cen.Lahontan B. REFERENCE NO. U1-GEN
GROUNDWATER	AQUICLUDE			
	AQUIFER	p.77 p.96 p.166	Table 25	III-39
	AQUITARD			
	BOUNDARY			
	CONFINED		Table 25	
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	HYDRAULIC CONDUCTIVITY			
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	POTENTIOMETRIC			
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	SPECIFIC CAPACITY			
	SPECIFIC YIELD			
	SPRING			
	STORAGE COEFFICIENT			
	TEMPERATURE			
	TRANSMISSIVITY			
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	WATER BUDGET			
	WATER DEMAND			
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	WATER SUPPLY			
	WATER USE	p.88 p.106	Table 25	
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	GEOPHYSICAL LOGS			
	GEOTHERMAL			
	HAZARD			
	ISOPACH			
	JOINT			
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	DIVERSION			
	DRAW			
	EVAPORATION		p.149	III-46
	EXPORT			
	HYDROLOGY		p.22 p.51	
	IMPORT			
	INFLOW			
	IRRIGATION		p.109 p.149	Table 51,80; III-48
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	OUTFLOW			
	PRECIPITATION		p.52, Plate 3	
	RESERVOIR			Table 19
	RIVER			
	RUNOFF		p.54	III-35
	SEA			
	SEEPAGE			
	SPRING			
	STORAGE CAPACITY			Table 19
	TEMPERATURE			
	TRANSPIRATION			
	WATER BUDGET			
	WATER DEMAND		p.109 p.147	V-22
	WATER QUALITY		p.63	III-43
	WATER SUPPLY		p.54	III-35, V-20
	WATER USE		p.147	III-46
	COMMENTS			

APPENDIX C

SUMMARY OF VISITS

APPENDIX C

SUMMARY OF VISITS

The following is a list of persons, agencies, addresses and dates of visits and telephone contacts.

James C. Blodgett (Hydraulic Engineer) and Gilbert Bertoldi
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APPENDIX D

SURFACE WATER DATA

APPENDIX D

SURFACE WATER DATA

Climate

The Pacific High pressure cell dominates the climate of Surprise Valley. More moisture-laden air masses move inland in winter when this high moves away from the California coast. Hence, the winter precipitation is more than the summer precipitation. Because of the orographic effect, the air masses drop most of their moisture while climbing over the coast range and the Cascades. The Warner Mountains produce a rain shadow effect on Surprise Valley. Annual precipitation is 30 inches on Warner Mountains and 4 inches over cool desert, valley floor.

The frost-free season can be expected to be shorter than that of the Honey Lake, which is about 70 to 80 miles due south of the Surprise Valley.

In Surprise Valley, the weather station at Cedarville indicates an annual temperature of 49.3°F, with a high in July (72°F) and a low in January (29.6°F). The annual pan evaporation is 60 inches and annual precipitation is 14 inches.

Precipitation

Annual precipitation varies from approximately 15 inches along the western portion of the basin to less than 10 inches along the eastern port'on of the basin (CDWR #58 1960). Precipitation generally decreases from west to east due to a rain shadow effect of the Warner Mountains. The mean annual precipitation at Cedarville is 14.2 inches (NOAA 1976). About 70% of the precipitation at Cedarville occurs as snow from October through March. This is typical for the basin

Table VD-2 gives the mean annual discharge for the gaging stations within the basin. Almost two-thirds of the annual discharge for the gaging station on Bidwell Creek occurs during April, May and June from snowmelt as shown in Table VD-1 (CDWR 1971). This is typical for other perennial streams in the basin.

Evaporation

The mean annual total pan evaporation from 1961 through 1963 at Cedarville 2 E was 63.4 inches. The mean total pan evaportion during June through September, 1960-1969, at Cedarville 12SE was 42.4 inches. From June through September, 1960-1963, total pan evaporation at Cedarville 12 SE was an average of 11% greater than total pan evaporation at Cedarville 2E. At Cedarville 2E, the type of pan is a class A pan; the type of environment is pasture, and the elevation is 4,500 feet. At Cedarville 12 SE, the type of pan is a class A pan; the type of environment is dry, nonirrigated; and the elevation is 4,800 feet (CDWR #73-1 1974).

TABLE VD-2

MONTHLY MEAN WATER TEMPERATURE IN JANUARY AND AUGUST
FOR GAGING STATIONS IN SURPRISE VALLEY BASIN

Gaging Station	Monthly Mean Water Temperature in °C	
	January	August
Bidwell Creek below Mill Creek, near Fort Bidwell, USGS Sta.#10360900	4	17
Cedar Creek at Cedarville, USGS Sta.#10360320	3	22
Eagle Creek at Eagleville, USGS Sta.#10360230	2	16

Source: USGS-WRD, 1971

TABLE VD-1

MONTHLY STREAMFLOW REGIME, BIDWELL CREEK BELOW MILL CREEK NEAR FORT BIDWELL

Bidwell Creek 1964-1968

Month	Discharge (cfs all days)	Percent %	Coefficient of Variation
October	5.5	2.39	0.82
November	6.2	2.70	0.48
December	14.3	6.20	1.33
January	8.5	3.71	1.14
February	13.1	5.70	0.77
March	13.7	5.96	0.37
April	37.8	16.41	0.50
May	65.8	28.6	0.58
June	43.6	18.93	0.51
July	12.3	5.33	0.51
August	5.4	2.37	0.36
September	3.9	1.7	0.27

Mean annual discharge = 14,000 acre-feet

Coefficient of Variation = 0.45

Source: USGS, California Streamflow Characteristics, Vol. 2, 1971

APPENDIX E

GROUND WATER DATA

APPENDIX E

GROUND WATER DATA

General Geology

The Surprise Valley KGRA is located in Surprise Valley in the basin and range physiographic province. In the basin and range province, displacement along faults forming north to northwest trending valleys and ranges is the predominant component of present terrain. The valley floors are underlain by up to 5,000 feet of water bearing sediments and flow basalts which rest on large subsided fault blocks. Three basins, Surprise Valley, Goose Lake Valley and Alturas Basin, are located in the vicinity of the Surprise Valley KGRA.

Surprise Valley lies east of the Warner Mountains. Elevations range from about 4500 feet in the valley floor to 9833 feet at Eagle Peak in the Warner Mountains. The valley floor is underlain by alluvium, which ranges in thickness from 0 to 5000 feet. The Surprise Valley KGRA lies in the eastern side of the valley. Alluvium beneath the KGRA consists of lake, near-shore and fan deposits thinly covered in some areas by sand dunes, basin deposits and intermediate alluvium. Goose Lake Valley and Alturas Basin lie west of the Warner Mountains, with elevations of 4692 and 4300 feet in their valley floors, respectively. Water bearing sediments and basalt flows beneath their valley floors range in thickness from 0 to 2500 feet.

Ground Water Hydrology

Introduction

Ground water resources in the study area were considered in two groups: water bearing and non-water bearing stratigraphic units. Sedimentary rock units were classified as water bearing. Volcanic basalts and associated igneous rock units were classified as non-water bearing. The most extensive bodies of sedimentary rocks occur over down faulted blocks which underlie Goose Lake Valley, Alturas Basin and Surprise Valley. These comprise the principal known aquifers in the study area. The volcanic rocks of the uplands which separate these ground water basins are not entirely non-water bearing. The younger volcanic rocks vary in permeability and water yielding capacity with location. These basalt flows comprise important recharge areas and locally in the upland area may provide significant quantities of water to wells. Where interbedded with sedimentary rocks in the valleys the basalts combine with the sediments to form some of the most productive areas of the known aquifers.

The follwing discussion describes the ground water conditions in the aquifers which underlie Surprise Valley, Alturas Basin and Goose Lake Valley. Information in the following discussions is drawn from CDWR Bulletin No. 98, unless otherwise referenced.

Surprise Valley

The Surprise Valley KGRA is almost completely contained in Surprise Valley, a north/south trending basin. Water bearing sediments in Surpirse Valley consist of near-shore deposits, recent valley sediments, and lake deposits. The near-shore and recent valley sediments which underlie the margins of the valley floor constitute the aquifer under Surprise Valley. The lake deposits in the central part of the valley, although extensive and saturated, are not sufficiently permeable to yield large quantities of water to wells. The near shore deposits are comprised of moderately coarse alluvium deposited in and on the shoreline of ancient Lake Surprise. The recent valley sediments include alluvial fans, intermediate alluvium and basin deposits. Of the recent valley sediments, only the deposits in the alluvial fans on the western margin of the valley are sufficiently extensive and permeable to yield significant quantities of water to wells.

Water in the near shore and alluvial fan deposits of the recent valley sediments is under conditions ranging from confined to water table. The piezometric surface is higher than the land surface over much of the valley. Confinement within the near-shore and alluvial fan deposits is provided by intertongueing with lower permeability lake deposits, interbedding with beds and lenses of fine grained sediments, and displacement along faults.

Surprise Valley is bounded on the west by Surprise Fault and on the east by Hays Fault. Cross faults connect these major faults. Maximum displacement along Surprise Fault is estimated to be about 7,000 feet. Interpretation of gravity surveys of Surprise Valley indicates that sediments below the valley floor range in thickness from 2000 to 5000 feet. The thickness of the near shore and alluvial fan deposits which comprise the principal aquifer range from 0 to 5000 and 0 to 1000 feet, respectively.

Along the western and northern sides of Surprise Valley, recharge results from stream flow infiltrating near-shore and alluvial fan deposits. Basalt and tuffs exposed extensively east of Surprise Valley in upland areas transmit recharge to the valley sediments. Subsurface inflow of ground water into Surprise Valley is possible from Duck Flat and Long Valley in Nevada. Exposures of Plocene-Pliestocene basalt flows may provide recharge along the southwestern portion of the valley.

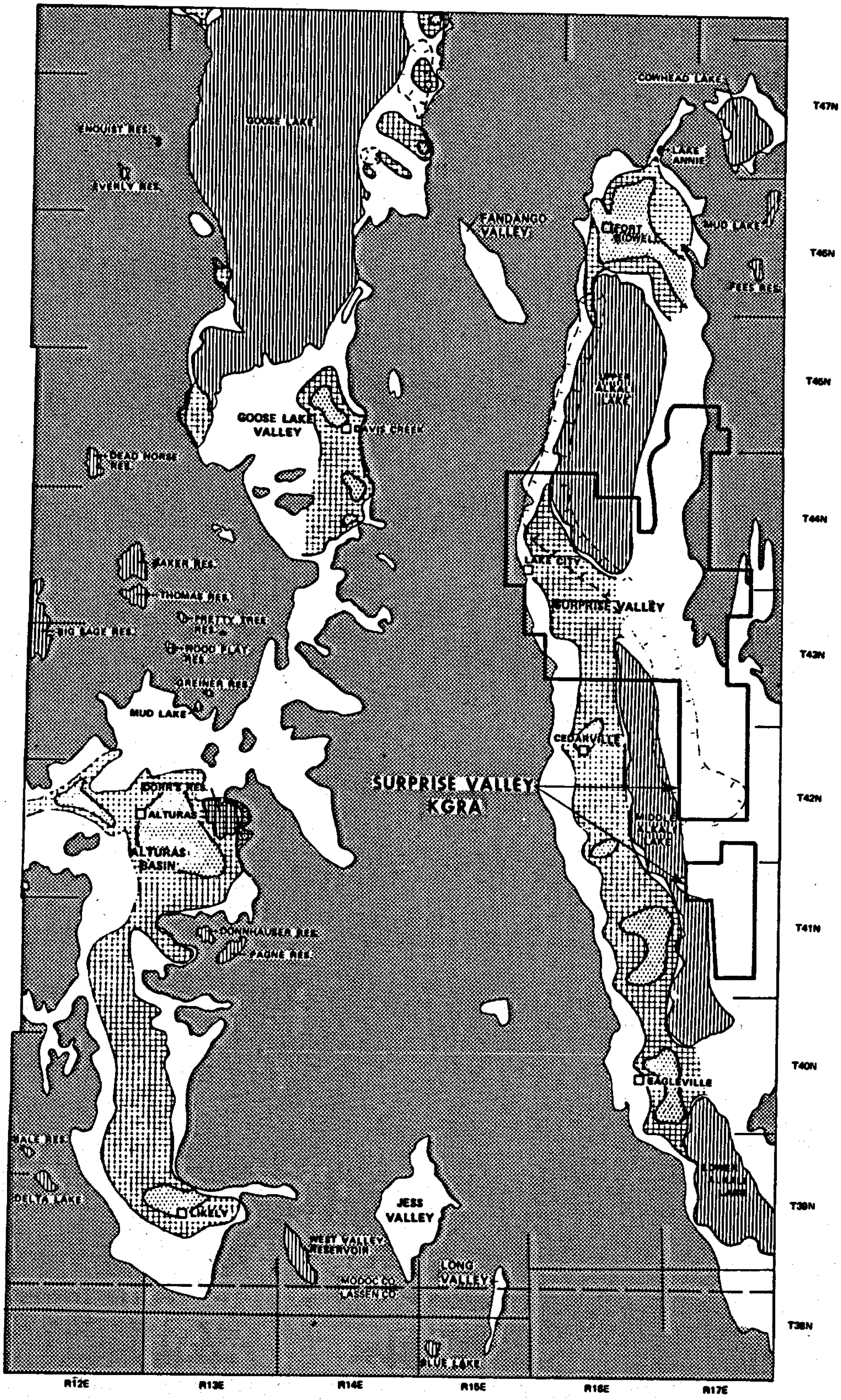
Shallow ground water under water table conditions overlies deeper, confined ground water throughout Surprise Valley; however, the limited thickness of the aquifer precludes development of large capacity wells. Along the northern, western and southwestern sides of the valley the piezometric head in the confined aquifer exceeds the land surface in many areas, and flowing wells can be constructed. Both the shallow and deeper confined ground water in Surprise Valley is moving toward the three alkali lakes, where discharge occurs in the form of evaporation.

Lakeward movement of ground water is probable along the western side of the valley, where contours of the piezometric surface are absent. Ground water divides separate the three lakes. The faults which underlie the valley floor provide paths for vertical circulation of water to the numerous hot springs in the Surprise Valley KGRA and may also transmit recharge to the deeper deposits of sediments.

Ground water in Surprise Valley is generally of good quality and is suitable for most uses. The water ranges from sodium bicarbonate to calcium bicarbonate in character. Figure VE-1 shows a water quality hazard area which has been delineated in the northwestern and control portion of the valley. In the area, highly mineralized thermal ground water occurs under artesian conditions, and it is generally unsuitable for agriculture or domestic use. The concentration of dissolved solids is greater than 1000 mg/l only in the northern end and eastern side of the hazard area (CDWR 1960).

Estimates of the ground water stored in the upper 400 feet of sediments in areas of Surprise Valley have been made on the basis of drillers' logs and logs of test wells. Estimates are available for four areas, which include the Ford Bidwell area, the Lake City to Eagleville area, the Bare Ranch area and the Sand Creek area. It is estimated that the upper 400 feet of sediments in these areas contain 4,000,000 acre-feet of ground water.

Reliable data on the yield of wells and hydraulic characteristics of the aquifer in Surprise Valley are limited. Appendix F presents information on the depth, discharge, drawdown specific capacity and saturated thickness for seven wells in Surprise Valley. The depth of the wells ranges from 184 to 390 feet and their yields range from 800 to 2800 gpm. The specific capacity of the wells, determined by dividing discharge by drawdown ranges from 17.7 to 186 gpm per foot. The available well data and geologic information were used to delineate two levels of areas within which high yield wells can be constructed.



AREAS OF GROUNDWATER DEVELOPMENT POTENTIAL AND HAZARDOUS WATER QUALITY IN THE VICINITY OF SURPRISE VALLEY KGRA

ZONE A – AREAS WITH POTENTIAL TO PRODUCE 500 GPM

ZONE B – AREAS WITH POTENTIAL TO PRODUCE 100 GPM

Figure VE-6

AREAS WITH HAZARDOUS WATER QUALITY

ADAPTED FROM: CALIFORNIA DEPARTMENT OF WATER RESOURCES NORTHEASTERN COUNTIES INVESTIGATION, BULLETIN 98, 1962.

0 5 10

SCALE IN MILES

These areas are shown in Figure VE-1. Well yields of at least 500 and 100 gpm can be developed within the A and B zones, respectively (Lorenz, pers. comm 1978). Experience has shown that both zones A and B are capable of sustaining pumping rates for in excess of the minimum values reported (Lorenz, pers. comm. 1978).

Alturas Basin

The Alturas Basin, located approximately 25 miles southwest of Surprise Valley, is comprised of the north/south trending valleys of the upper forks of the Pit River and the westward trending Warm Springs Valley. This discussion is limited to that portion of the basin comprised of the valleys of the upper forks of the Pit River and the Alturas area. The water bearing sediments which comprise the aquifer under the valley floors include basalts, the Alturas Formation , near-shore deposits of alluvium, and Recent valley alluvial sediments. The Alturas Formation consists of two 400-foot-thick sedimentary members comprised of ashy sandstone, diatomite and tuff beds, separated in most areas by a 50- to 250-foot thick tuff member. The formation crops out along the eastern, western and southern sides of the valleys. The sedimentary and basalt members are moderately to highly permeable. Along the northeastern side of the valleys up to 200 feet of moderately permeable alluvium of near shore deposits overlie the Alturas Formation and crop out on the valley margin. From Alturas to Likely, in the center of the valleys, the Alturas Formation is overlain by up to 50 feet of slightly to moderately permeable alluvium which comprise the Recent valley sediments.

Ground water in the aquifer under the valleys of the upper forks of the Pit River is under conditions ranging from unconfined to confined. The thickness of the aquifer has not been investigated extensively. Measured sections and well logs indicate the maximum thickness of the aquifer is probably 2000 to 3000 feet.

Recharge of the aquifer in the basin results from the infiltration of precipitation into permeable basalt flows in upland areas surrounding the basin. The recharge moves through the basalts to the aquifer. Additional recharge may infiltrate outcrops of the Alturas Formation along the margins of the valley, particularly where streams cross the out-crops.

Ground water moves toward the center of the valleys and along the central portion of the valleys. Near Alturas, ground water moves eastward into the Warm Springs Valley. Faults which occur along the margins of the valley and which cross it may provide paths for the movement of recharge and may locally modify the general pattern of ground water movement.

Ground water in the aquifer under the valleys of the upper forks of the Pit River is generally good and is suitable for most uses. No water quality hazard areas have been delineated in the valleys.

Based on well logs, the upper 800 feet of water bearing basalts and sediments under the valleys of the upper forks of the Pit River contain 6,700,000 acre-feet of ground water.

Reliable data on the yield of ground water to wells in the valleys of the upper forks of the Pit River are limited. The available data from two wells are shown in Appendix F. The maximum yield is 1000 gpm. The maximum specific capacity, defined as discharge per foot of drawdown, is 7.5 gpm per foot.

Appendix F summarizes information on the yield of wells and ground water storage in the upper fork valleys of Alturas basin.

Goose Lake Valley

Goose Lake Valley, located about 20 miles west of the Surprise Valley KGRA, is a north/south trending basin. Water-bearing basalts, and alluvium of the near-shore deposits and Recent valley sediments comprise an aquifer under the eastern and southeastern portions of the valley floor. Extensive lake deposits under the central portions of the valley floor are saturated but not sufficiently permeable to yield large quantities of water to wells. Small bodies of alluvium which occur along the eastern margin of the valley are generally too limited in size and recharge to sustain long term discharge of large quantities of water to wells. The moderately to highly permeable deposits capable of sustained large well yields include the basalts, alluvium of the near shore deposits and alluvial fans and intermediate alluvium of the Recent valley sediments. Ground water in these deposits are under conditions ranging from confined to unconfined. The confinement is provided by beds and lenses of low permeability sediments, intertongueing with lake deposits and displacement against low permeability materials along faults.

There have been no investigations of the thickness of the water bearing materials below the floor of Goose Lake Valley. On the basis of measured sections and well logs, the probable maximum thickness of these materials is 2000 to 3000 feet.

Recharge of the aquifer along the eastern side of Goose Lake Valley results from infiltration of precipitation into basalts in upland areas west of the valley and infiltration of stream flow into alluvium, particularly at the heads of alluvial fans. Recharge also occurs in the upland basalts and alluvium on the eastern side of the valley. Recharge from the upland basalts moves toward the alluvium which occurs on the margins of the valley.

Two aquifers, one shallow and unconfined and the second deeper and confined, occur in the northern and southern portions of the valley. Ground water movement is similar in both aquifers. Movement is toward the west into the lake deposits in the central part of the valley. A third aquifer containing confined water occurs in the southern portion of the valley, and it underlies the two upper aquifers. Water movement in this aquifer is also eastward toward the lake deposits in the center of the valley.

Ground water in Goose Lake Valley is generally of excellent quality and is suitable for most uses. Figure VE-1shows two water quality hazard areas delineated in the eastern side of the valley. Water in these areas contains concentrations of fluoride and boron, which are considered hazardous for irrigation and domestic uses. Appendix F shows the results of analyses of the quality of ground water in Goose Lake Valley. Based on well logs it is estimated that the upper 500 feet of water-bearing materials in the eastern Goose Lake Valley contain 1,000,000 acre-feet of ground water.

Reliable data on well yields in Goose Lake Valley are limited. The maximum well yields are about 2,500 gpm, with an average of 1,500 gpm (see Appendix F). Table VF-6 shows yield data from two wells in the valley. Figure VE-1 shows the locations of A and B areas in the valley where potential well yields of at least 500 and 100 gpm, respectively, have been estimated.

Well yields in both of these areas are capable of greatly exceeding the minimum estimates (Lorenz, pers. comm. 1978).

Appendix F summarizes information on the yield of wells and water storage in Goose Lake Valley.

APPENDIX F

TECHNICAL DATA

SELECTED GROUNDWATER QUALITY FOR SURPRISE VALLEY

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB		TEMP	FIELD LABORATORY PH	EC	MINERAL CONSTITUENTS IN CA	MG	NA	K	CO3	MILLIGRAMS PER LITER MILLIEQUIVALENTS PER LITER PERCENT REACTANCE VALUE HCO3	SO4	CL	NO3	MILLIGRAMS PER LITER B	F SIO2	TDS SUM	TH NCH	SAR
		SURPRISE VALLEY																	
08/14/75 0745	5050 5050	40N/16E-11G01 M	55.0F 12.8C	7.8 8.3	235 207	23 1.15 51	6.2 .51 22	13 .57 25	1.5 .04 2	0 .00	130 2.13 94	3.3 .07 3	1.4 .03 1	2.0 .03 1	.00	-- --	137 114	83 0	0.6
08/14/75 0815	5050 5050	40N/16E-36F01 M	57.0F 13.9C	7.1 8.3	406 304	--	--	--	--	0 .00	221 3.62 95	--	3.6 .10 3	6.2 .10 3	--	-- --		145	
08/14/75 0830	5050	40N/16E-36G01 M	55.0F 12.8C	7.2	325	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1450	5050	41N/16E-09A02 M	56.0F 13.3C	8.0	205	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1505	5050 5050	41N/16E-25C03 P	58.0F 14.4C	8.1 8.1	220 262	--	--	--	--	0 .00	82 1.34 88	--	6.1 .17 11	.6 .01 1	--	-- --		24	
08/14/75 0730	5050	41N/16E-35F01 M	76.0F 24.4C	7.0	150	--	--	--	--	--	--	--	--	--	--	-- --			
08/14/75 0930	5050 5050	42N/16E-04P01 M	59.0F 15.0C	7.2 8.5	320 296	20 1.00 44	9.0 .74 23	24 1.04 33	.7 .02 1	6.0 .20 6	156 2.56 81	11 .23 7	3.0 .08 3	5.0 .08 3	.00	-- --	190 183	107 0	1.0
08/13/75 1055	5050	42N/16E-05F01 P	56.0F 13.3C	7.9	320	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1230	5050	42N/16E-08E01 M	57.0F 13.9C	7.7	305	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1300	5050 5050	42N/16E-08M02 M	57.0F 13.9C	7.2 8.1	295 273	--	--	--	--	0 .00	165 2.70 94	--	1.6 .05 2	7.6 .12 4	--	-- --		119	
08/13/75 1345	5050	42N/16E-29D02 M	60.0F 15.9C	7.4	222	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1400	5050	42N/16E-29H01 M	52.0F 11.1C	7.1	195	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1410	5050	42N/16E-34F01 P	69.0F 20.5C	8.1	345	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1105	5050	43N/16E-09Q01 M	60.0F 15.9C	7.0	325	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1020	5050 5050	43N/16E-20A01 M	58.0F 14.4C	7.8 8.5	320 305	27 1.35 42	1.1 .09 3	41 1.78 55	1.1 .03 1	6.0 .20 6	176 2.88 86	6.9 .14 3	3.3 .09 3	5.0 .08 2	.10	-- --	193 176	72 0	2.1
08/13/75 1035	5050	43N/16E-32H01 M	76.0F 24.4C	8.1	320	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 1045	5050 5050	43N/16E-33M03 M	63.0F 17.2C	7.4 8.4	490 459	--	--	--	--	3.0 .10	253 4.15	--	6.6 .19	18.0 .29	--	-- --		192	
08/14/75 1030	5050 5050	43N/17E-20D01 M	65.0F 18.3C	8.2 8.4	645 610	--	--	--	--	4.0 .13	182 2.98	--	48 1.36	5.7 .09	--	-- --		20	
08/14/75 1010	5050	43N/17E-21J01 M	75.0F 23.9C	8.5	480	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 0950	5050	44N/16E-31B01 M	53.0F 11.7C	6.9	460	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 0905	5050 5050	45N/16E-17Q01 M	60.0F 15.5C	7.1 8.4	275 253	31 1.55 54	10 .82 29	10 .44 15	2.1 .05 2	3.0 .10 4	157 2.57 90	3.8 .08 3	2.5 .07 2	2.1 .03 1	.00	-- --	185 162	119 0	0.4
08/13/75 0920	5050	45N/16E-19Q01 M	64.0F 17.8C	7.9	320	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 0845	5050 5050	46N/16E-08H02 M	65.0F 18.3C	7.3 8.2	230 230	--	--	--	--	0 .00	114 1.87 89	--	4.8 .14 7	5.8 .09 4	--	-- --		87	
08/13/75 0750	5050	46N/16E-08H03 M	53.0F 11.7C	6.9	335	--	--	--	--	--	--	--	--	--	--	-- --			
08/13/75 0835	5050 5050	46N/16E-16H01 M	54.0F 12.2C	6.7 8.0	180 172	16 .80 45	5.4 .44 25	11 .48 27	2.1 .05 3	0 .00	99 1.62 91	9.5 .20 11	3.7 .10 5	3.1 .05 3	.00	-- --	107 95	62 0	0.6
08/13/75 0810	5050 5050	46N/16E-23B01 M	55.0F 12.8C	7.7 8.3	355 354	33 1.65 46	11 .90 25	20 .87 25	5.0 .13 4	0 .00	133 2.18 61	39 .81 23	20 .56 16	2.0 .03 1	.10	-- --	248 195	129 19	0.8

Source: California Department of Water Resources, Hydrologic Data: 1975, Vol. II Northeastern California, Bulletin No. 130-75

TABLE VF-2

SUMMARY OF YIELD CHARACTERISTICS OF SELECTED WELLS IN SURPRISE VALLEY

Well	Depth (Ft.)	Dis-charge (gpm)	Draw-down (Ft.)	Specific Capacity	Saturated Thickness (ft.)	Yield Factor X100	Average Permeability (Meinzer units)
40N/17E-18N1	390	1,900	35	54.4	382	14.1	282
40N/17E-19D4	327	2,400	39	61.7	319	19.3	386
40N/17E-31M1	293	1,800	30	60.0	285	21.0	420
41N/16E-14N1	330	2,800	15	186.0	322	58.0	1,160
42N/16E-5B1	280	1,350	18	75.0	272	27.6	552
42N/16E-17R1	335	2,250	25	90.0	327	27.5	550
44N/15E-24R1	184	800	45	17.7	178	9.9	199

Source: California Department of Water Resources, Northeastern Counties Groundwater Investigation, Appendix C, Geology , Bulletin 98, 1963

TABLE VF-3

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB		TEMP	FIELD LABORATORY PH	EC	MINERAL CONSTITUENTS IN CA	MG	NA	K	MILLIGRAMS PER LIFE MILLIEQUIVALENTS PER LITER PERCENT REACTANCE VALJE CO3	HCO3	SO4	CL	NO3	MILLIGRAMS PER LITEM B	F SIO2	TDS SUM	TH NCH	SAR
		ALTURAS BASIN																	
		39N/13E-06N01 M																	
08/14/75	5050		67.0F	7.2	225	--	--	--	--	0	118	--	4.8	2.6	--	--		48	
1430	5050		19.4C	8.1	217					.00	1.93		.14	.04		--			
											91		7	2					
		40N/12E-11F01 M																	
08/14/75	5050		68.0F	6.0	170	--	--	--	--	0	80	--	4.4	3.4	--	--		28	
1355	5050		20.0C	8.0	161					.00	1.31		.12	.05		--			
											89		8	3					
		40N/12E-25J01 M																	
08/14/75	5050		65.0F	7.3	520	--	--	--	--	--	--	--	--	--	--	--			
1410			18.3C													--			
		41N/13E-18P01 M																	
08/14/75	5050		66.0F	7.3	750	74	31	18	8.0	6.0	223	138	7.9	2.9	.00	--	484	313	
1315	5050		18.9C	8.4	653	3.69	2.55	.78	.20	.20	3.65	2.87	.22	.05		--	395	128	0.4
						51	35	11	3	3	52	41	3	1					
		42N/11E-19E01 M																	
08/12/75	5050		68.0F	7.6	470	--	--	--	--	0	244	--	6.7	.8	--	--		12	
1010	5050		20.0C	8.4	467					.00	4.00		.19	.00		--			
											95		5						
		42N/11E-24A01 M																	
08/12/75	5050		68.0F	7.3	218	--	--	--	--	--	--	--	--	--	--	--			
1030			20.0C													--			
		42N/12E-11J01 M																	
08/12/75	5050		64.0F	7.4	392	--	--	--	--	--	--	--	--	--	--	--			
1130			17.8C													--			
		42N/13E-31G01 M																	
08/.4/75	5050		61.0F	7.1	580	--	--	--	--	--	--	--	--	--	--	--			
1240			16.1C													--			
		42N/13E-32G01 M																	
08/14/75	5050		58.0F	7.4	360	--	--	--	--	--	--	--	--	--	--	--			
1255			14.4C													--			

Source: California Department of Water Resources, Hydrologic Data: 1975, Vol. II Northeastern California, Bulletin No. 130-75

Table VF-4

Summary of Yield Characteristics of Selected Wells in Alturas Ground Water Basin

Well	Depth (ft.)	Discharge (gpm)	Drawdown (ft.)	Specific Capacity	Saturated Thickness (ft.)	Yield Factor X100	Average Permeability (Meinzer units)
42N/13E-28Q1	808	1,000	170	5.9	788	0.75	15
42N/12E-24C1	500	600	80	7.5	370	2.03	40.6

Source: California Department of Water Resources, Northeastern Counties Groundwater Investigation, Appendix C, Geology, Bulletin 98, 1963

TABLE VF-5

SELECTED GROUNDWATER QUALITY FOR GOOSE LAKE VALLEY

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB		TEMP	FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR
		MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE													MILLIGRAMS PER LITER				
GOOSE LAKE VALLEY																			
		46N/14E-07K01 M																	
08/12/75	5050		57.0F	7.0	750	73	26	38	1.3	19	298	27	20	59.0	.10	--	460	291	
1235	5050		13.9C	8.6	673	3.64	2.14	1.65	.03	.63	4.88	.56	.56	.95		--	410	14	1.0
						49	29	22		8	64	7	7	13					
		45N/13E-12L01 M																	
08/12/75	5050		69.0F	7.3	340	--	--	--	--	--	--	--	--	--	--	--			
1310			20.5C													--			
		45N/14E-32L01 M																	
08/12/75	5050		72.0F	7.1	250	--	--	--	--	--	--	--	--	--	--	--			
1250			22.2C													--			
		46N/14E-32J01 M																	
08/12/75	5050		68.0F	6.8	205	--	--	--	--	0	87	--	9.6	4.9	--	--		60	
1450	5050		20.0C	8.0	193					.00	1.43		.27	.08		--			
											80		15	4					
		47N/13E-07Q01 M																	
08/12/75	5050		63.0F	7.5	235	--	--	--	--	--	--	--	--	--	--	--			
1400			17.2C													--			
		47N/14E-02H01 M																	
08/12/75	5050		64.0F	8.3	350	--	--	--	--	--	--	--	--	--	--	--			
1535			17.8C													--			
		47N/14E-14B02 M																	
08/12/75	5050		55.0F	6.8	185	--	--	--	--	--	--	--	--	--	--	--			
1510			12.8C													--			
		48N/14E-23K01 M																	
08/12/75	5050		56.0F	6.6	235	--	--	--	--	0	126	--	3.5	1.0	--	--		60	
1550	5050		13.3C	8.1	210					.00	2.07		.10	.02		--			
											95		5	1					

Source: California Department of Water Resources, Hydrologic Data: 1975, Vol. II Northeastern California, Bulletin No. 130-75

TABLE VF-6

Summary of Yield Characteristics of
Selected Wells in Goose Lake Valley

Well	Depth (ft.)	Discharge (gpm)	Drawdown (ft.)	Specific Capacity	Saturated thickness (ft.)	Yield factor X100	Average Permeability (Meinzer units)
45N/14E-18B1	450	2,510	87	28.9	422	6.85	120
45N/14E-19C1	222	260	104	2.5	216	1.16	20.3

Source: California Department of Water Resources, Northeastern Counties Groundwater Investigation, Appendix-C, Geology, Bulletin 98, 1963

APPENDIX G

PROCUREMENT SPECIFICATIONS

APPENDIX G

PROCUREMENT SPECIFICATIONS

1.0 INTRODUCTION

To fully assess the availability of water resources in an area, data must be available for both surface and ground water. Not only must the data be available, it must be site specific to the area for which the analysis is being performed. Surface water data are, for the most part, based on hydrologic studies performed by the USGS and California Department of Water Resources. the primary source of data were reports from varoius stream gauging stations located in the study area. Since there are annual variations in flow, historic data over a period of time are required to assess surface water characteristics.

Ground water data, however, do not show considerable annual variations, thus an inventory-type information (i.e. data as of a point in time) are required. The key aspects of ground water involve storage capacity and usable capacity. Storage capacity indicates the amount of ground water stored in the underlying aquifers. Developable usable capacity is recharge less current usage and natural discharge for a specific ground water basin. Unless both parameters are known, the amount of make-up water available from ground water sources cannot be estimated.

Since some data are available for each area, the procurement specifications have been designed to acquire only the specific information required. Acquisition of data relevant to estimating available make-up water in the specific area is the only information included in the procurement specifications. Potentially, proposals could be solicited to respond to the tasks contained in the procurement specifications.

2.0 GROUNDWATER PROCUREMENT

2.1 Water Use Inventory

The major objective of this portion of the statement of work is to determine the water usage in the identified aquifer areas. This determination should be based on a survey of water users in the aquifer area.

Statement of Work:

1. Based on local county, city, utility(ies), California Department of Water Resources and the California Division of Oil and Gas, official well records and land ownership maps for the aquifer area, determine:

   a. number of wells
   b. the location of each well
   c. annual usage for each well and current application
   d. annual variations in usage

2. For wells not recorded in any official record, individual well owner visits should be made to determine:

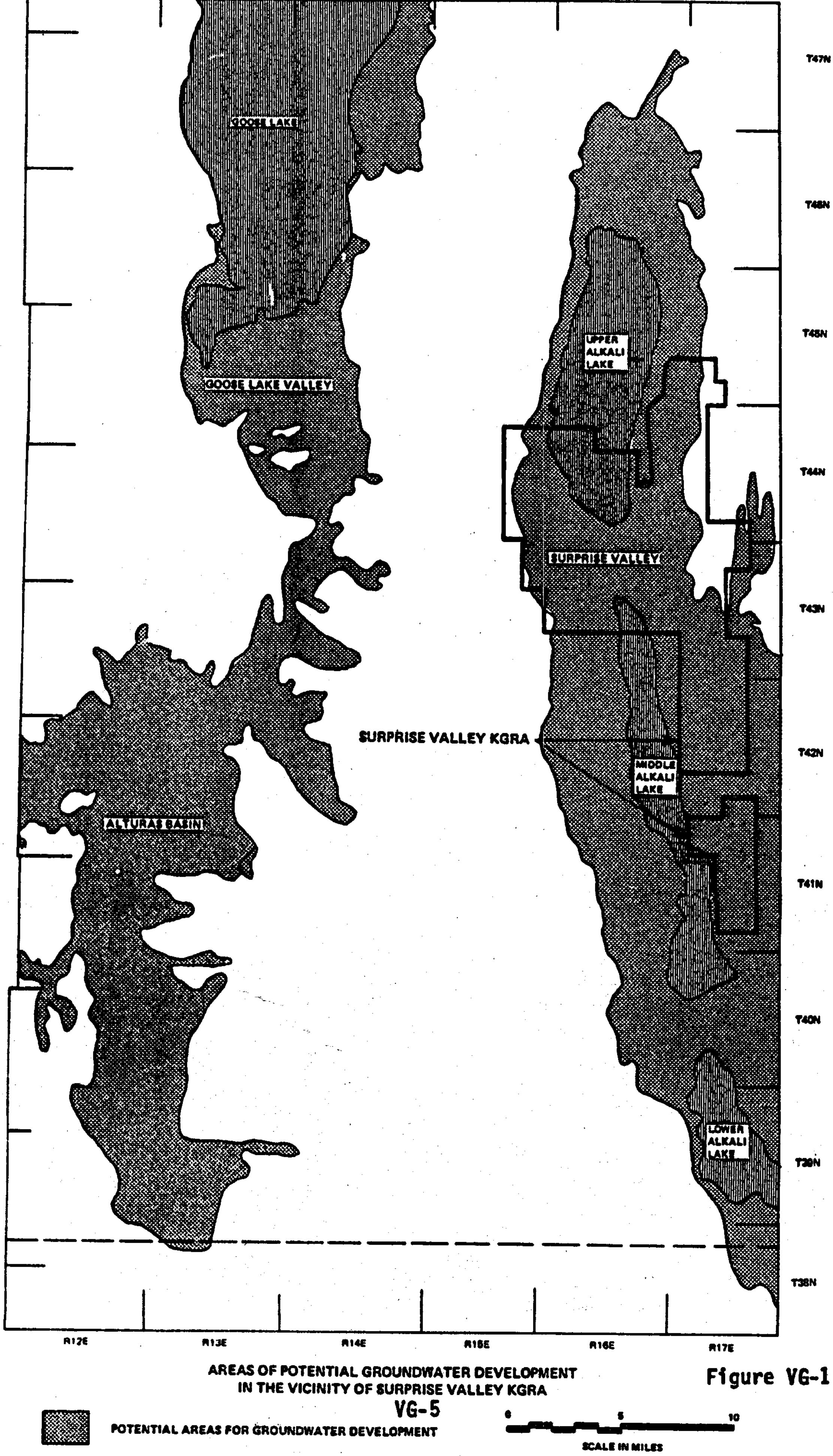
   a. number of wells
   b. the location of each well
   c. annual usage for each well and current application
   d. annual variations in usage

This survey should include all individual wells greater than four inches in diameter but should exclude windmills and stockwells. Municipal irrigation and industrial wells should be surveyed.

3. All of the data should be summarized to establish water usage for the aquifer area.

4. In addition to determination of water usage, the long-term annual recharge and inflow for the aquifer should be established. (Note, if possible, a 30-year historical period should be used to determine this long-term term.)

Figure VG-1 identifies the specific areas to be surveyed.



AREAS OF POTENTIAL GROUNDWATER DEVELOPMENT
IN THE VICINITY OF SURPRISE VALLEY KGRA

Figure VG-1

APPENDIX A

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APPENDIX A

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APPENDIX B

LITERATURE CROSS-REFERENCE

TOPICS	KEY WORDS	AUTHOR CDWR TITLE Northeastern Counties Groundwater Investigation REFERENCE NO. C5-GEN	AUTHOR CDWR TITLE Northeastern Counties Investigation REFERENCE NO. C2-GEN	AUTHOR USDA TITLE Water & Related Land Res.Cen.Lahontan B. REFERENCE NO. U1-GEN
GROUNDWATER	AQUICLUDE			
	AQUIFER	p.77 p.96 p.166	Table 25	III-39
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	BOUNDARY			
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	DISCHARGE			
	GEOHYDROLOGY			
	GRADIENT			
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	POTENTIOMETRIC			
	RECHARGE	p.83 p.102 p.172	Table 25	
	SEEPAGE			
	SPECIFIC CAPACITY			
	SPECIFIC YIELD			
	SPRING			
	STORAGE COEFFICIENT			
	TEMPERATURE			
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	UNCONFINED			
	WATER BUDGET			
	WATER DEMAND			
	WATER LEVEL			
	WATER QUALITY	p.92 p.109 p.179	p.63	
	WATER SUPPLY			
	WATER USE	p.88 p.106	Table 25	
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	WELL DEPTH			
	WELL LOGS			
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	GEOCHEMISTRY			
	GEOPHYSICAL LOGS			
	GEOTHERMAL			
	HAZARD			
	ISOPACH			
	JOINT			
	LINEATION			
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	CANAL			
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	DIVERSION			
	DRAW			
	EVAPORATION		p.149	III-46
	EXPORT			
	HYDROLOGY		p.22 p.51	
	IMPORT			
	INFLOW			
	IRRIGATION		p.109 p.149	Table 51,80; III-48
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	OUTFLOW			
	PRECIPITATION		p.52, Plate 3	
	RESERVOIR			Table 19
	RIVER			
	RUNOFF		p.54	III-35
	SEA			
	SEEPAGE			
	SPRING			
	STORAGE CAPACITY			Table 19
	TEMPERATURE			
	TRANSPIRATION			
	WATER BUDGET			
	WATER DEMAND		p.109 p.147	V-22
	WATER QUALITY		p.63	III-43
	WATER SUPPLY		p.54	III-35, V-20
	WATER USE		p.147	III-46
	COMMENTS			

APPENDIX C

SUMMARY OF VISITS

APPENDIX C

SUMMARY OF VISITS

The following is a list of persons, agencies, addresses and dates of visits and telephone contacts.

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Alturas, California 96101
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Telephone contact

APPENDIX D

SURFACE WATER DATA

APPENDIX D

SURFACE WATER DATA

Precipitation

Annual precipitation varies from approximately 40 inches at the extreme western portion of the Susan River drainage to less than 10 inches along the eastern portion of the Honey Lake basin (CDWR #58 1960). Precipitation generally decreases from west to east due to the rain shadow effect of the mountains to the west. Mean annual precipitation at the Susanville Airport is 14.5 inches (NOAA 1976). About three-fourths of the precipitation at the Susanville Airport occurs as snow from October through March. This is generally true throughout the basin.

Evaporation

The range for annual net evaporation from Honey Lake has been estimated as 10,000 to 200,000 acre-feet (BLM 1978). This large variation is due to the fact that Honey Lake is extremely shallow and its surface area varies considerably with an increase or decrease in volume of water. Since evaporation from a free water surface is directly related to surface area, it reflects a similar variation. Annual net evaporation from Honey Lake, based on the October 1, 1970 surface area, is estimated to be 66,300 acre-feet (USDA 1975).

The mean value for total pan evaporation from May through September, 1962-1976, at the Fleming Fish and Game location is 41.2 inches (CDWR #73-1 1974, NOAA 1975-1977).

Surface Water

The annual runoff discharged into Honey Lake was estimated to be 100,000 acre-feet. The lake surface evaporation varied from 10,000 acre-feet to 200,000 acre-feet annually. Honey Lake will change its surface area year after year, depending upon the amount of runoff discharged into the lake, the evaporation rate, and the precipitation falling over the lake surface.

Because the streams run nearly dry in summer, storage facilities and conduits are necessary to tap stream water for geothermal developments in Wendell-Amedee KGRA. Otherwise, the 300,000 acre-feet of Honey Lake water could be considered as cooling water. However, Honey Lake has 5,000 ppm dissolved solids.

APPENDIX E

GROUND WATER DATA

APPENDIX E

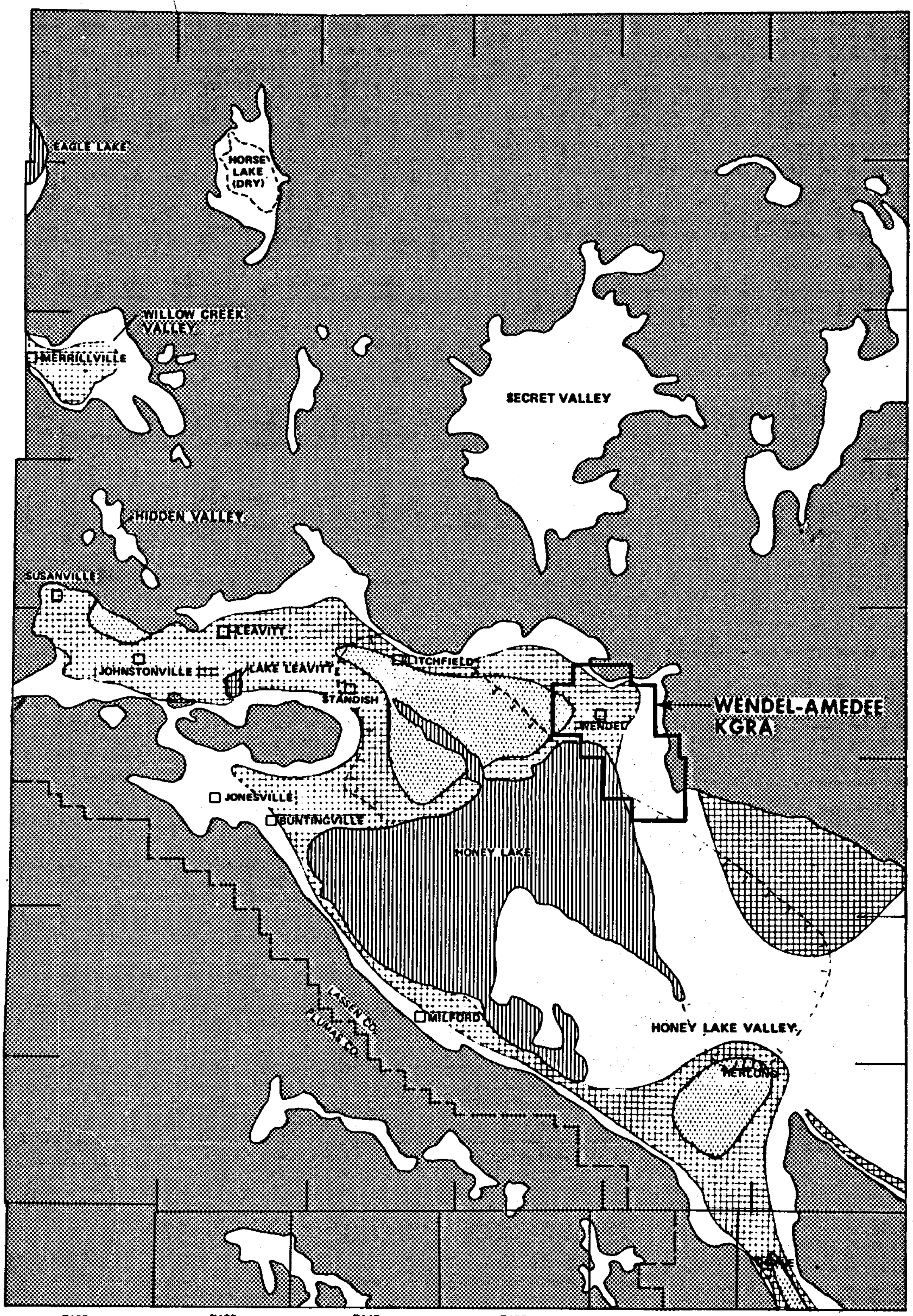
GROUND WATER DATA

Ground Water Hydrology

Honey Lake Valley

Honey Lake Valley is located within the KGRA, and Honey Lake is located therein. The California portion of the valley is about 45 miles in length and 10 to 15 miles in width, with an area of 490 square miles (CDWR). The valley is composed of up to 5000 feet of valley fill. The principal aquifer is the Lahonton Lake and near-shore deposits. These deposits consist of primarily unconsolidated to semi-consolidated gravel, sand, silts and clays. Thickness of these deposits is up to 700 feet in the central part of the valley. The near-shore deposits form a discontinuous belt around the edge of the valley and are coarser grained.

Alluvial fan deposits are generally good aquifers but are limited in their extent. They occur only along the periphery of the mountain ranges, with thicknesses up to 300 feet. The potential for ground water development in the Pleistocene basalt flows surrounding the valley is highly variable, due to their unpredictable permeabilities. Therefore, basalt flows are not mapped as water-bearing deposits on FigureVIE-1.Underlying the basin are up to 5000 feet of Pliocene Lake deposits. In general, these deposits are of low permeability and are not a major source of ground water. Recharge to the aquifers occurs by percolation of precipitation through Plio-pleistocene and Pleistocene basalts and in the near-shore and alluvial fan deposits. Recharge is also received from the Long Valley and Skedaddle Creeks, which are influent and contribute water to the underlying aquifers. Because Honey Lake Valley is a closed basin and there is no surface or



AREAS OF GROUNDWATER DEVELOPMENT POTENTIAL AND HAZARDOUS WATER QUALITY IN THE VICINITY OF WENDEL-AMEDEE KGRA

Figure VIE-1

ZONE A – AREAS WITH POTENTIAL TO PRODUCE > 500 GPM

ZONE B – AREAS WITH POTENTIAL TO PRODUCE > 100 GPM

- - - - AREA WITH HAZARDOUS WATER QUALITY

ADAPTED FROM: CALIFORNIA DEPARTMENT OF WATER RESOURCES, NORTHEASTERN COUNTIES GROUNDWATER INVESTIGATION, BULLETIN 98, 1962.

0 5 10
SCALE IN MILES

VIE-3

subsurface outflow, ground water movement is controlled by topography. The general direction of ground water movement is toward Honey Lake from all areas in the valley (see Figure VIE-5).

The present data indicates no fault barriers inhibiting ground water movement. Several faults in Honey Lake Valley act as conduits for the upward movement of mineralized thermal waters. Since the basin has interior drainage, the lower portion of the basin has poorer quality water. Figure VIE-1 shows the location of ground water areas which were found to be excessive in concentrations of boron, fluoride, nitrate and total dissolved solids. The range and numerical average of selected mineral constituents of 184 samples and 159 sources in Honey Lake Valley are shown on Table VIF-3. Ground water temperatures throughout this region generally range from 50°F to 80°F, with an average temperature of 57° for wells fewer than 100 feet deep (ERDA 1976), but the temperature has been observed as high as 205°F for shallow wells and springs near Wendell and Amedee Hot Springs (Mariner 1976).

Willow Creek Valley

Willow Creek Valley is about 17 miles northwest of the KGRA. It is a fault block basin with up to 1000 feet of valley fill sediments. It is roughly seven miles long and four mile wide with an area of approximately 20 square miles (CDWR #98). The Willow Creek ground water basin contains both unconfined and confined aquifers. The principle aquifers in the basin are the intermediate alluvium and alluvial fan deposits. These deposits consist of unconsolidated gravel, sand, silt, and clays up to 250 feet thick. These deposits are found mostly in the southwestern half of the valley. Bordering much of the valley are Plio-Pleistocene to recent basalt flows. These flows have a total thickness of up to 350 feet. Because the permeability of these deposits is highly variable, they were not mapped as water-bearing deposists on Figure VIE-1. These ba s form areas of ground water recharge as precipitation percolates laterally into the valleys. The recent basalts transmit water from Eagle Lake into Willow Creek Valley by subsurface flow. Ground water is not impaired by faulting in the valley, and the general direction of movement flow is southeast toward Willow Creek. Ground water in the valley is generally of excellent quality. Storage capacity of the aquifer is unknown with a maximum well yield in the valley of 1200 gpm (CDWR #118). Figure VIE-1 indicates one zone which should yield in excess of 100 gpm.

APPENDIX F

TECHNICAL DATA

TABLE VIF-1

MONTHLY DISTRIBUTION OF AVERAGE ANNUAL RUNOFF IN PERCENT
FOR SUSAN RIVER AND WILLOW CREEK

	Susan River At Susanville (USGS Sta.No.10356500)	Willow Creek Near Susanville (USGS Sta.No.10358500)
October	1.9	5.9
November	2.5	6.9
December	6.8	10.9
January	5.9	12.4
February	9.4	18.4
March	10.4	14.6
April	21.7	12.5
May	22.9	5.1
June	9.7	3.7
July	5.7	3.3
August	2.8	3.1
September	0.5	3.2

Source: USGS, California Streamflow Characteristics, Vol. 2, 1971

TABLE VIF-2

MONTHLY MEAN WATER TEMPERATURE
DURING JANUARY AND AUGUST
FOR
SUSAN RIVER, WILLOW CREEK, LONG VALLEY CREEK

Station	Mean Water Temperature (°C)	
	January	August
Susan River near Susanville, USGS Sta.No. 10356500	1	21
Willow Creek near Susanville, USGS Sta.No. 10358500	6	19
Long Valley Creek near Doyle, USGS Sta.No. 10354500	6	20

Source: USGS - WRD, 1971

TABLE VIF-3

SELECTED WATER QUALITY FOR
HONEY LAKE VALLEY

Constituent	Range	Average
Conductance (in micromhos at 25°C)	108-3240	513
Total dissolved solids, in ppm*	84-1790	362
Per cent sodium	7-97	51.3
Boron, in ppm	0.0-5.10	0.29
Fluoride, in ppm	0.0-4.4	0.5

Source: California Department of Water Resources, Division of Resources Planning, Water Quality Investigation, Honey Lake and Willow Creek Valleys.

TABLE VIF-4

SUMMARY OF YIELD CHARACTERISTICS OF SELECTED WELLS TAPPING THE LAHONTAN LAKE DEPOSITS IN HONEY LAKE VALLEY

Well	Depth (ft.)	Dis-charge (gpm)	Draw-down (ft.)	Specific Capacity	Saturated Thickness (ft.)	Yield Factor X100	Average Permeability (Meinzer units)
27N/16E-36Q1	590	700	12	58.2	563	10.4	182.0
27N/16E-36Q2	607	600	43	13.9	580	2.4	42.2
27N/17E-14L1	1,400	200	140	1.4	712	0.2	3.5
28N/14E-2H1	81	50	18	2.78	35	7.9	139.0
28N/17E-7N1	49	20	36	0.56	9	6.2	109.0
28N/17E-17B1	114	200	26	7.7	94	8.2	143.5
29N/12E-11J1	80	60	30	2.0	24	8.4	146.0
29N/12E-13E1	252	350	105	3.33	235	1.4	24.8
29N/13E-11N1	702	750	32	23.4	672	3.5	61.0
29N/15E-31A2	600	2,000	52	38.4	595	6.5	113.0

TABLE VIF-5

SUMMARY OF YIELD CHARACTERISTICS OF SELECTED WELLS TAPPING THE NEAR-SHORE DEPOSITS IN HONEY LAKE VALLEY

Well	Depth (ft.)	Dis-charge (gpm)	Draw-down (ft.)	Specific Capacity	Saturated Thickness (ft.)	Yield Factor X100	Average Permeability (Meinzer units)
26N/15E-3F1	505	750	124	6.0	245	2.46	43.1
26N/16E-3B2	108	16	8	2.0	28	7.2	125.0
27N/14E-16F1	32	20	4	5.0	12	41.6	728.0

Source: California Department of Water Resources, Northeastern Counties Groundwater Investigation, Appendix C, Geology, Bulletin No. 98 , 1963

TABLE VIF-6

SUMMARY OF YIELD CHARACTERISTICS OF SELECTED WELLS TAPPING THE PLEISTOCENE BASALT AND LAHONTAN LAKE DEPOSITS IN HONEY LAKE VALLEY

Well	Depth (ft.)	Discharge (gpm)	Drawdown (ft.)	Specific Capacity	Saturated Thickness (ft.)	Yield Factor X100	Average Permeability (Meinzer units)
27N/17E-27R1	605	850	35	24.2	473	5.1	90.1
29N/12E-3E4	317	2,200	85	25.9	305	8.5	149.0
29N/12E-3L2	307	1,500	60	25.0	294	8.5	149.0
30N/12E-33N2	400	1,200	100	12.0	370	3.2	56.9

TABLE VIF-7

SUMMARY OF YIELD CHARACTERISTICS OF SELECTED WELLS TAPPING THE ALLUVIAL FAN DEPOSITS IN HONEY LAKE VALLEY

Well	Depth (ft.)	Discharge (gpm)	Drawdown (ft.)	Specific Capacity	Saturated Thickness (ft.)	Yield Factor X100	Average Permeability (Meinzer units)
25N/17E-28E1	400	1,000	50	20.0	390	5.1	90.0
25N/17E-29A1	200	400	23	17.3	179	9.7	170.0

Source: California Department of Water Resources, Northeastern Counties Groundwater Investigation, Appendix C, Geology, Bulletin No. 98, 1963

APPENDIX G

PROCUREMENT SPECIFICATIONS

APPENDIX G

PROCUREMENT SPECIFICATIONS

1.0 INTRODUCTION

To fully assess the availability of water resources in an area, data must be available for both surface and ground water. Not only must the data be available, it must be site specific to the area for which the analysis is being performed. Surface water data are, for the most part, based on hydrologic studies performed by the USGS and California Department of Water Resources. the primary source of data were reports from varoius stream gauging stations located in the study area. Since there are annual variations in flow, historic data over a period of time are required to assess surface water characteristics.

Ground water data, however, do not show considerable annual variations, thus an inventory-type information (i.e. data as of a point in time) are required. The key aspects of ground water involve storage capacity and usable capacity. Storage capacity indicates the amount of ground water stored in the underlying aquifers. Developable usable capacity is recharge less current usage and natural discharge for a specific ground water basin. Unless both parameters are known, the amount of make-up water available from ground water sources cannot be estimated.

Since some data are available for each area, the procurement specifications have been designed to acquire only the specific information required. Acquisition of data relevant to estimating available make-up water in the specific area is the only information included in the procurement specifications. Potentially, proposals could be solicited to respond to the tasks contained in the procurement specifications.

2.0 GROUND WATER PROCUREMENT

2.1 Ground Water Exploration

The ground water exploration program will include drinking wells for geophysical logging and aquifer testing. Exploration wells will extend to a depth of 1000 feet. The number of wells should be approximately one well for every 10 square miles of surficial area in the two ground water basins. Therefore, this will require a total of two exploration wells for Willow Creek Valley, which has ground water potential (see Figure VIG-1). Honey Lake and Secret Valleys do not rquire analysis. The methods used in this program will conform to the standard methods and equipment. Figure VIG-2 shows the general parameters for collection of ground water data.

2.1.1 Drilling and Geophysical Logging

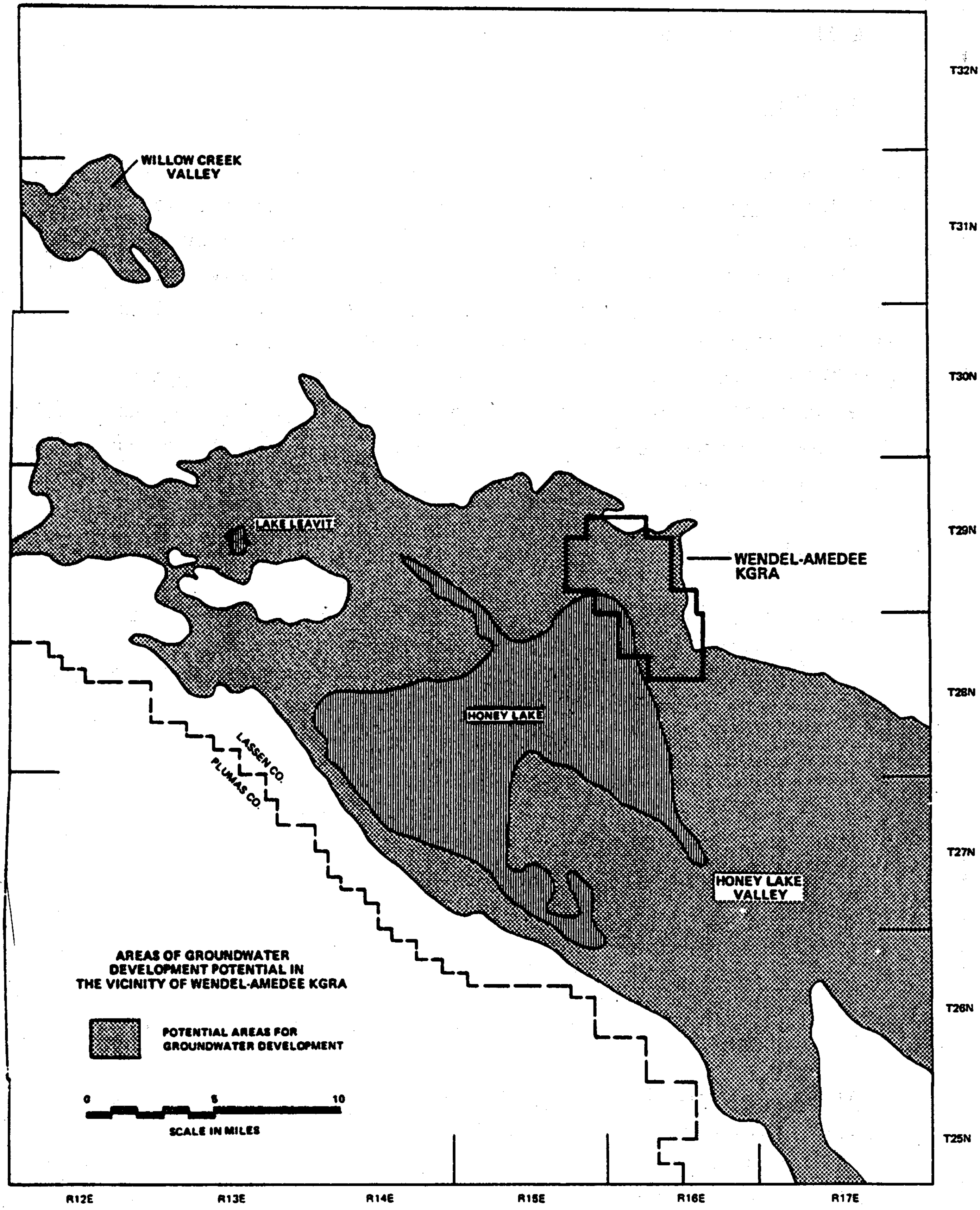
The program should consist of an exploration program which includes drilling and geophysical logging programs.

The drilling program should indicate:

a) Number and location of exploration wells
b) Water level data
c) Water quality, including temperature
d) Physical properties of the aquifer
e) Method used for drilling, including equipment to be used

The geophysical logging program should indicate measurements of:

a) Spontaneous electrical potential
b) Resistivity
c) Acoustic logs
d) Temperature logs



WILLOW CREEK VALLEY
LAKE LEAVIT
WENDEL-AMEDEE KGRA
HONEY LAKE
LASSEN CO.
PLUMAS CO.
HONEY LAKE VALLEY
AREAS OF GROUNDWATER DEVELOPMENT POTENTIAL IN THE VICINITY OF WENDEL-AMEDEE KGRA
POTENTIAL AREAS FOR GROUNDWATER DEVELOPMENT
0
5
10
SCALE IN MILES
T32N
T31N
T30N
T29N
T28N
T27N
T26N
T25N
R12E
R13E
R14E
R15E
R16E
R17E

Figure VIG-1

GENERAL GROUNDWATER EVALUATION PROCEDURE

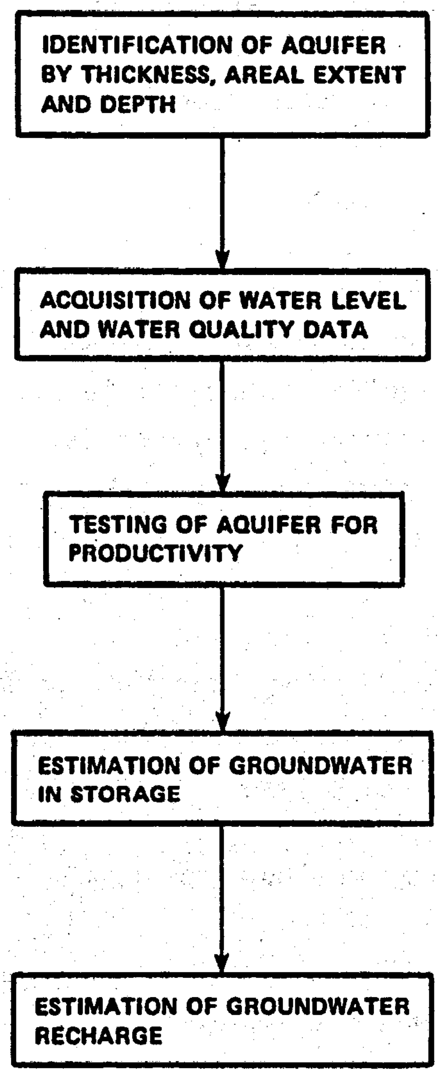


Figure VIG-2

Spontaneous electrical potential measurements should report: a) location of aquifer, b) thickness of aquifer and c) water quality.

Resistivity logs should indicate: a) water quality; b) porosity of formation, c) location of aquifer and d) salinity of pore fluid.

Acoustic logs should report porosity of formations.

For temperature logs, indicate temperature encountered with depths.

2.1.2 Aquifer Testing Program

The aquifer testing program should describe the pumping test to be accomplished. The program should delineate information from aquifers and the wells. The aquifer testing program should include pertinent information on the hydraulic characteristics of the aquifer. In addition, specific information from well tests should describe the following: a) yield, b) drawdown and c) specific capacity or discharge drawdown ratio.

A description of the methodology selected for each test, the equipment to be used, number of tests to be performed, site selection rationale and instrumentation to be used should be included for each test.

The aquifer testing program should specify:

a) Well design and construction technique selected
b) Well diameter to be employed
c) Well depth
d) Well screen length
e) Type of pump to be employed
f) Capacity of the pump
g) Rate of discharge and measurement technique to be employed

h) Length of time of the test period

i) Method of discharge disposal

j) Number and location of observation wells

Measurements of water depth should be conducted according to the following schedule:

TABLE 2.1

RANGE OF TIME INTERVALS BETWEEN WATER LEVEL MEASUREMENTS IN THE PUMPED WELL

Time Since Pumping Started	Time Intervals
0 - 5 minutes	0.5 minutes
5 - 60 minutes	5 minutes
60 - 120 minutes	20 minutes
120 - shut down of the pump	60 minutes

After the pumping test is completed and all information has been collected on well discharge, drawdowns in pumped well, regional trend of the water table, etc., the available data should be analyzed. This data processing should include: a) compilation of the data in the form of graphs, b) correction of the drawdown data for regional changes of the water level in the aquifer not induced by pumping, and for changes, if any, in barometric pressure during the test, and c) determination of the type of aquifer that has been pumped.

2.2 Water Use Inventory

The major objective of this portion of the statement of work is to determine the water usage in the identified aquifer areas. This determination should be based on a survey of water users in the aquifer area.

Statement of Work:

1. Based on local county, city, utility(ies), California Department of Water Resources and the California Division of Oil and Gas, official well records and land ownership maps for the aquifer area, determine:

   a. number of wells
   b. the location of each well
   c. annual usage for each well and current application
   d. annual variations in usage

2. For wells not recorded in any official record, individual well owner visits should be made to determine:

   a. number of wells
   b. the location of each well
   c. annual usage for each well and current application
   d. annual variations in usage

This survey should include all individual wells greater than four inches in diameter but should exclude windmills and stockwells. Municipal irrigation and industrial wells should be surveyed.

3. All of the data should be summarized to establish water usage for the aquifer area.

4. In addition to determination of water usage, the long-term annual recharge and inflow for the aquifer should be established. (Note, if possible, a 30-year historical period should be used to determine this long-term term.)

Honey Lake Valley and Willow Creek Valley are the only areas to be surveyed (see Figure VIG-1).

APPENDIX A
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APPENDIX A

BIBLIOGRAPHY LISTING

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APPENDIX B

LITERATURE CROSS-REFERENCE

TOPICS	KEY WORDS	AUTHOR CDWR TITLE Northeastern Counties Groundwater Investigation REFERENCE NO. C5-GEN	AUTHOR CDWR TITLE Northeastern Counties Investigation REFERENCE NO. C2-GEN	AUTHOR USDA TITLE Water & Related Land Res.Cen.Lahontan B. REFERENCE NO. U1-GEN
GROUNDWATER	AQUICLUDE			
	AQUIFER	p.77 p.96 p.166	Table 25	III-39
	AQUITARD			
	BOUNDARY			
	CONFINED		Table 25	
	DISCHARGE			
	GEOHYDROLOGY			
	GRADIENT			
	HYDRAULIC CONDUCTIVITY			
	INFLOW		Table 25	
	LEAKAGE			
	MOVEMENT	p.84 p.102 p.172	Table 25	
	OUTFLOW			
	PERMEABILITY	p.77 p.98 p.168		
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	POTENTIOMETRIC			
	RECHARGE	p.83 p.102 p.172	Table 25	
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	SPECIFIC CAPACITY			
	SPECIFIC YIELD			
	SPRING			
	STORAGE COEFFICIENT			
	TEMPERATURE			
	TRANSMISSIVITY			
	UNCONFINED			
	WATER BUDGET			
	WATER DEMAND			
	WATER LEVEL			
	WATER QUALITY	p.92 p.109 p.179	p.63	
	WATER SUPPLY			
	WATER USE	p.88 p.106	Table 25	
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	WELL DEPTH			
	WELL LOGS			
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	FAULT	p.82 p.102 p.169		
	FRACTURE			
	GEOCHEMISTRY			
	GEOPHYSICAL LOGS			
	GEOTHERMAL			
	HAZARD			
	ISOPACH			
	JOINT			
	LINEATION			
	POROSITY			
	SAND			
	SHALE			
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	CANAL			
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	DIVERSION			
	DRAW			
	EVAPORATION		p.149	III-46
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	HYDROLOGY		p.22 p.51	
	IMPORT			
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	IRRIGATION		p.109 p.149	Table 51,80; III-48
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	SEEPAGE			
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	STORAGE CAPACITY			Table 19
	TEMPERATURE			
	TRANSPIRATION			
	WATER BUDGET			
	WATER DEMAND		p.109 p.147	V-22
	WATER QUALITY		p.63	III-43
	WATER SUPPLY		p.54	III-35, V-20
	WATER USE		p.147	III-46
	COMMENTS			

APPENDIX C

SUMMARY OF VISITS

APPENDIX C

SUMMARY OF VISITS

The following is a list of persons, agencies, addresses and dates of visits and telephone contacts.

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APPENDIX D

SURFACE WATER DATA

APPENDIX D

SURFACE WATER DATA

The Medicine Lake watershed is bordered north and west by the Medicine Lake highland. The widespread basaltic flows north of the Glass Mountain KGRA which includes the lavas of the Lava National Monument, were discharged mostly from the north flank of the Medicine Lake highland. Mount Hoffman (7,913 feet), Glass Mountain (7,600 feet), Grouse Hill (7,650 feet), Lyon Peak (7,800 feet), and Red Shale Butte (7,800) are the highest peaks on the Medicine Lake highland. South of the Medicine Lake watershed is the Medicine Mountain (7,400 feet) and west is the Little Mount Hoffman (7,310 feet). The Medicine Lake watershed is a closed basin.

Precipitation

Annual precipitation is approximately 40-45 inches in the higher elevations in the vicinity of Medicine Lake. The annual precipitation decreases rapidly with decreasing elevation to the north, east and south to a range of 10 to 20 inches (CDWR #58 1960). The mean annual precipitation at Medicine Lake for the period 1967 through 1975 is 51.9 inches. The mean annual precipitation at Lava Beds National Monument for the period 1967 through 1977 is 14.6 inches. The normal annual precipitation at Tule Lake is 10.9 inches (NOAA 1967-1977).

Evaporation

There is no data available for evaporation in the vicinity of the Glass Mountain KGRA. The mean total evaporation from May through September at Tule Lake for the period 1967 through 1976 is 42 inches (NOAA 1967-1976). The mean annual net evaporation loss from Clear Lake Reservoir is 60,000 to 100,000 acre-feet (CDWR #83 1964).

APPENDIX E

GROUND WATER DATA

APPENDIX E

GROUND WATER DATA

General Geology

The Glass Mountain KGRA is located in the Medicine Lake Uplands, an eastward extension of the Cascade Range physiographic province. The province is characterized by recent volcanic activity. Modoc Plateau physiographic province which lies north, east and south of Medicine Lake Uplands is characterized by north to northwest trending valleys and ranges and broad areas inundated by basalt flows. The valley floors are underlain by water bearing sediment which accumulated on subsiding fault blocks. Butte Valley, Red Rock Valley and the Lower Klamath Valley are located in the vicinity of the Glass Mountain KGRA.

Butte Valley lies east of the Mahogany Mountain Ridge. Elevation ranges from about 4200 feet in the valley floor to 6255 feet at Mahogany Mountain. Redrock Valley, southeast of Mahogany Ridge, lies at an elevation of about 4350 feet. Sheep Mountain rises to 6210 feet between Butte Valley and Red Rock Valley. The Klamath Valley lies west of the Mahogany Mountain Ridge and is comprised of the Lower Klamath Lake and Tule Lake areas. These areas lie at elevations of about 4075 and 4040 feet respectively and are separated by a north trending ridge which rises to 5258 feet at Sheepy Peak.

The Glass Mountain KGRA is underlain for the most part by volcanic rocks of varying age which include rhyolite andesite, basalt and pyroclastics. Small bodies of glacial deposits and alluvium lie immediately adjacent to Medicine Lake.

Ground Water Hydrology

Ground water resources in the study area were considered in two groups: water bearing and non-water bearing stratigraphic units, as shown in FigureVIIE-2.Sedimentary rock units were classified as water bearing Igneous rocks in the study area are entirely of volcanic origin were classified as non-water bearing. Extensive bodies of sedimentary rocks overlie down faulted blocks beneath Butte Valley and the Lower Klamath Lake and Tule Lake areas of the Klamath River Valley. These comprise the principal aquifers in the study area. The smaller body of sedimentary rocks in the Red Rock Valley are not sufficiently permeable to yield large quantities of water to wells. The volcanic rocks in the upland areas which border the sedimentary rocks in the study area are not entirely non-water bearing. The younger volcanic rocks vary in permeability and water yielding capacity with location. The broad basalt flows comprise important recharge areas and locally in the uplands may yield significant quantities of water to wells. Where interbedded with sediments in the valleys, the basalts combine with the sediments to form the most productive aeas of the aquifers.

The following discussion describes ground water conditions in Butte Valley, Red Rock Valley, Tule Lake and Lower Klamath Lake areas.

Butte Valley

Butte Valley is a closed basin located about 20 miles northwest of the Glass Mountain KGRA covering an area of about 480 square miles. Water bearing rocks in Butte Valley consist of basalt, alluvial deposits and lake deposits. The lake deposits under the central and western portion of the valley are not sufficiently permeable to yield large quantities of water to wells. The moderately permeable lake deposits in the eastern part of the valley combined with basalt and alluvial deposits comprise the aquifer in Butte Valley. The lake deposits are at least 900 feet thick. The alluvial deposits consist of up to 350 feet of talus and alluvial fan deposits occurring on the margins of the valley and up to 60 feet of alluvium deposited in basins, stream channels, and playa lakes along the southeastern side of the valley. The talus deposits are highly permeable. The coarser alluvium deposited in basins and stream channels is moderately permeable. The alluvial fan and playa deposits have low permeability. The Butte Valley basalt which is interbedded with lake deposits and alluvium in the southern part of Butte Valley has high permeability and is the most productive rock unit in the valley (Wood 1960).

Ground water in Butte Valley is under conditions ranging from confined to water table. Confinement results from intertonqueing of more permeable basalt and alluvium with less permeable lake deposits. In the southwestern margin of the valley the piezometric surface is higher than the land surface and flowing wells can be constructed.

The thickness of the water bearing materials under Butte Valley is unknown. A well drilled near Dorris penetated 947 feet of lake deposits before encountering basalt. The thickest sediments probably occur under the west central part of the valley (Wood 1960).

Recharge of the aquifer in Butte Valley results from the infiltration of precipitation into the basalts on uplands surrounding the valley and infiltration of stream flows into alluvial deposits along the margins of the valley. Water infiltrating the upland basalts moves downward in fissures and permeable zones and laterally into the sediments in the valley.

In the southern part of the valley ground water is moving toward areas where discharge occurs through wells. In the northern part of the valley ground water is moving toward the Mahogany Ridge in the vicinity of Dorris. Ground water moves through the ridge into the saturated sediments under the L Klamath Lake area of the Lower Klamath Valley.

The quality of water in Butte Valley is generally adequate for most uses. There is high sodium content in the western portions of the valley near Meiss Lake and some high concentrations of arsenic in shallow wells in the vicinity of Davis Creek (CDWR #118). The contration of TDS in ground water ranges from 150 to 500 mg/l in most areas.

No estimate is available for the ground water storage capacity in Butte Valley.

Well yields up to 4100 gpm have been measured in Butte Valley and have an average of 2,000 gpm (CDWR #118). Wells penetrating the Butte Valley Basalt in the soutern portion of the valley tend to produce more water with less drawdown than those which penetrate lake deposits. Appendix F shows yield data for wells tapping the lake deposits in the eastern portion of Butte Valley and wells which also tap the Butte Valley Basalt.

Red Rock Valley

Red Rock Valley is located approximately 12 miles northwest of the Glass Mountain KGRA covering an area of about 20 square miles (Wood 1960). Water bearing materials in the valley include up to 120 feet of lake deposits and basalt. The lake deposits overlie the basalt and do not yield significant quantities of water to wells. The deeper basalts which underlie Red Rock Valley are permeable and capable of large well yields. The Butte Valley Basalt is above the water table in Red Rock Valley. Ground water in the deeper basalts are under confined condition. Confinement is provided by the overlying lake deposits which have much lower permeability.

Insufficient information is available to determine the amount of ground water stored in the valley or the general pattern of its movement. Recharge probably results from the deep percolation of precipitation which infiltrates upland basalt flows surrounding the valley and alluvium under the valley floor.

Data on the quality of ground water in Red Rock Valley is limited. The ground water from the lake deposits is generally of excellent quality.

Data on the yield of wells in Red Rock Valley is limited. No data is available for wells tapping the lake deposits. Wells yields range up to 1,500 gpm (Wood 1960).

Tule Lake Area

The Tule Lake area of the Klamath River Valley is located approximately 10 miles north of the Glass Mountain KGRA. Water bearing materials in the Tule Lake area include lake deposits and basalt. The lake deposits have low permeability and do not yield large quantities of water to wells. The basalt is highly permeable and capable of large yields. The basalt intertonques with the lake deposits in the southern part of the area and underlies the lake deposits throughout the area. In the Tule Lake area ground water in the basalt is confined by lake deposits. South of the area ground water in the volcanics is under water table conditions. Ground water in the lake deposits is under conditions ranging from confined to water table (Hotchkiss 1968).

The thickness of water bearing deposits in the Tule Lake area is not known. A deep well near Tule Lake penetrated 2207 feet of lake deposits before encountering the underlying basalt.

The principal sources of recharge in the Tule Lake area are infiltration of surface water from Tule Lake Sump and underflow from adjacent volcanic rocks. Some recharge may occur where streams cross permeable volcanic rocks (Hotchkiss 1968).

The quality of ground water in the Tule Lake area is generally good and adequate for most uses. Water from the lake deposits is of less quality than that in the basalts under the area and south of the area. Shallow wells in the Hatfield and Tule Lake area produce water having a

TDS of 962 to 1300 mg/l from the lake deposits. Water from the deep basalts underlying the lake deposits in the same area contain about 200 mg/l TDS. The quality of water in the volcanic rocks south of the lake deposits improves with increasing distance from the lake deposits. Near the southern margin of the lake deposits ground water contains about 600 mg/l TDS. Several miles south of the lake deposits ground water from volcanic rocks contains 150 to 266 mg/l TDS (Hotchkiss 1968). Appendix F shows analyses of ground water and yield from wells in the Tule Lake area.

Yield data for wells located in the Tule Lake area is limited. The available data are shown in Appendix F. Generally, the largest well yields are produced from basalts beneath the lake deposits and basalts east of the lake deposits. In the Hatfield and Tule Lake areas the basalts beneath the lake deposits produce 1200 to 2650 gpm at specific capacities of 16 to 62 gpm per foot of drawdown. The basalts west of the lake deposits produce up to 4000 gpm at specific capacities up to 250 gpm per foot of drawdown. By contrast the average yield of the lake deposits is 30 gpm at an average specific capacity of 2 gpm per foot of drawdown.

Lower Klamath Lake Area

The Lower Klamath Lake area of the Klamath River Valley is located approximately 13 miles northwest of the Glass Mountain KGRA. Insufficient information is available to accurately describe the water-bearing formations in the area. Due to similarity in geology with the Butte Valley to the west and the Tule Lake area to the east, water-bearing materials in the Lower Klamath Lake area would probably include alluvium, lake deposit and basalt under and south of the lake deposits.

Insufficient data are available to describe the thickness of the water bearing materials, the conditions in the aquifer, or the direction of ground water movement. If the area is similar to the Tule Lake area to the west, higher quality ground water should be available from basalts under and south of the lake deposits. Ground water is typically high in sodium and nitrate content (CDWR #118).

Maximum well yields in the Klamath River Valley are 4,000 gpm with an average of 1,000 gpm (CDWR #118).

Aquifer Characteristics

The term "aquifer" is applied to any water-bearing formation or rock unit that is capable of yielding an adequate water supply. The adjectives "excellent," "good," "fair," or "poor" may be used to denote the degree to which the yield from an aquifer is adequate, but they are not specific enough for a quantitative appraisal of an aquifer or for comparing one aquifer with another. To be more specific, the water-bearing ability of an aquifer may be expressed in terms of the aquifer's trasmissivity. Transmissivity is expressed as the rate of flow in gallons per day through a one-foot-wide vertical strip of the entire saturated thickness of the aquifer under a unit hydraulic gradient at the prevailing temperature of the water.

The water-bearing ability of an aquifer may also be expressed in terms of field hydraulic conductivity. As used in this report, the field hydraulic conductivity is the rate of flow in gallons per day that will occur through a one-foot-square cross-section of the aquifer under a unit hydraulic gradient. Generally, the horizontal hydraulic conductivity of an aquifer is greater than the vertical hydraulic conductivity.

This is especially true for alluvial materials because of size sorting and the alignment of platy and ellipsoidal grains that occurred during deposition of the material. The vertical hydraulic conductivity of some aquifers that consist of many different strata ranging from clay or silt to sand or gravel may be only hundredths or thousandths of the horizontal hydraulic conductivity.

Transmissivities commonly are computed from the results of controlled pumping tests. They also can be computed on the basis of the width of a vetical section through which ground water is moving at a known rate under a known hydraulic gradient, or on the basis of the specific capacity, which is the rate of yield per unit drawdown, of a well.

In water table aquifers, the changes in storage that result in changes in head are defined by the specific yield which is the percentage of water by volume that can be drained from a porous rock under gravity.

Aquifer characteristics can be determined by pump tests. All pump tests for this area are located in Butte Valley. These tests were conducted by the USGS. The results of these pump tests are shown in Appendix F.

APPENDIX F

TECHNICAL DATA

TABLE VIIF-1 *Summary of yield characteristics for wells tapping the lake deposits in the eastern half of Butte Valley*

Well	Yield (gpm)	Drawdown (feet)	Specific capacity (gpm per foot of drawdown)	Saturated thickness (feet)	Yield factor [1]
46/1W- 2F1	1, 500	100	15	280	5
2G1	1, 600	105	15	365	4
47/1E-29N1	2, 500	40	62	275	23
30R1	2, 500	50	50	300	17
31A1	3, 000	70	43	300	14
31J1	2, 000	47	42	300	14
47/1W-13P1	2, 000	58	34	140	24
23A1	970	62	16	114	14
23H1	1, 100	35	31	190	16
24C1	940	49	19	166	11
34Q1	1, 800	124	15	342	4
34R1	1, 400	100	14	272	5
34H1	1, 000	108	9	----------	----------

TABLE VIIF-2 *Summary of yield characteristics for wells tapping the lake deposits and Butte Valley basalt*

Well	Yield (gpm)	Drawdown (feet)	Specific capacity (gpm per foot of drawdown)	Saturated thickness (feet)	Yield factor [1]
45/2W- 1Q1	1, 400	7	200	45	444
3Q1	800	63	13	[2] 398	3
46/1E—6J1	3, 000	64	47	177	26
6N1	2, 600	68	38	176	22
7D1	1, 800	43	42	177	24
46/1W- 1G1	1, 100	[4] 70	[4] 16	190	[4] 8
12H1	1, 300	43	30	146	20
17B1	[4] 2, 000	7	[4] 300	40	[4] 750
17B2	[4] 4, 000	[4] 10	[4] 400	[4] 45	[4] 900
17G1	1, 500	[4] 22	[4] 68	----------	----------
18Q1	2, 000	16	125	76	164
18Q2	1, 900	6	317	60	528
19G1	1, 300	4	325	----------	----------
19H1	1, 700	20	85	----------	----------
20B1	1, 500	63	24	130	18
28D1	1, 600	34	47	----------	----------
28F1	2, 000	27	74	----------	----------
29G1	2, 000	30	67	74	90
31J1	1, 400	12	117	56	209
31J2	1, 100	1	1, 100	56	1, 960
46/2W-12Q1	1, 300	30	43	63	68
13A1	1, 900	36	53	86	62
25R1	1, 300	23	56	61	92
25R2	2, 500	14	179	83	215
36A1	975	30	32	----------	----------
36H1	4, 100	15	273	51	535
36L1	1, 000	1	1, 000	113	885

[1] Specific capacity divided by saturated thickness, times 100.

Source: P.R. Wood, 1960

TABLE VIIF-3

SELECTED GROUNDWATER QUALITY FOR TULE LAKE AREA

Number above line, milligrams per liter (mg/l); Number below line, milliequivalents per liter (me/l)

Well number	Date of collection	Depth of well (feet)	Water temperature (°C)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH
U.S. Public Health Service drinking-water standards (1962)					0.3							250	250		45		500					
45N/4E-28H1	7-26-62	725		44		7.3 / .36	4.0 / .33	25 / 1.09	1.8 / .05	90 / 1.48	0.0 / .00	2.0 / .04	12 / .34	0.1 / .01	0.9 / .01	0.3	141	34	0	60	182	7.7
45N/4E-28H1	8- 9-65	725			0.23	5.9 / .29	4.5 / .37	25.3 / 1.10	2.4 / .06	71.8 / 1.18	.0 / .00	.3 / .01	13.2 / .37	.4 / .02	.3 / .00		156	33.5				8.2
45N/4E-28H1	3- 2-66	725	13	49	.0	3.0 / .65	.9 / .07	26 / 1.13	1.8 / .05	89 / 1.46	.0 / .00	3.0 / .06	11 / .31	.3 / .02	.6 / .01	.3	150	36	0	59	185	7.8
45N/6E-28M1	11- 2-65	365	18	49	.0	23 / 1.15	10 / .85	45 / 1.96	7.7 / .20	216 / 3.54	.0 / .00	10 / .21	14 / .39	.3 / .02	.7 / .01	.0	266	100	0	47	396	8.1
46N/4E-15M1	10-29-64	47.6	11	62	7.6	72 / 3.59	48 / 3.93	101 / 4.39	14 / .36	324 / 5.31	8 / .27	246 / 5.12	34 / .96	.2 / .01	24 / .39	.1	800	376	97	36	1,190	8.4
46N/4E-18J1	7-26-62	225.7		56	.23	64 / 3.19	45 / 3.68	62 / 2.70	12 / .31	424 / 6.95	.0 / .00	97 / 2.02	4.4 / .12	.2 / .01	12 / .19	.1	562	344	0	27	868	7.2
46N/4E-18J1	10-30-64	225.7		56	1.5	72 / 3.59	50 / 4.09	60 / 2.61	9.1 / .23	450 / 7.28	.0 / .00	113 / 2.35	26 / .73	.2 / .01	14 / .23	.1	638	384	15	25	976	8.2
46N/4E-18J1	8-20-65	225.7			1.24	66.6 / 3.31	50.3 / 4.14	53.0 / 2.31	14.5 / .37	357 / 5.85	.0 / .00	99.9 / 2.08	29.8 / .84	.3 / .02	15.7 / .25		632	372				7.4
46N/4E-18J1	6- 7-66	225.7		50	.12	74 / 3.69	47 / 3.83	61 / 2.65	13 / .33	438 / 7.18	.0	109 / 2.27	24 / .68	.4 / .02	15 / .24	.0	609	376	17	25	915	7.8
46N/5E-3P1	5- 6-66	48	13	15	.17	41 / 2.05	29 / 2.35	158 / 6.87	12 / .31	476 / 7.80	.0	158 / 2.89	14 / .39	.6 / .03	.8 / .01	.4	644	220	0	59	1,010	8.0
46N/5E-3P1	5- 8-66	136	14	23	b0.55	46 / 2.30	50 / 4.14	91 / 3.96	11 / .38	544 / 8.92	0 / .0	65 / 1.35	18 / .51	0.4 / .02	0.01	0.0	573	322	0	37	921	8.2
46N/5E-3P1	5- 9-66	172	14	21	a.20	30 / 1.50	46 / 3.82	119 / 5.18	10 / .26	464 / 7.60	22 / .73	69 / 1.44	16 / .45	.4 / .02	1.0	.0	562	266	0	48	896	8.6
46N/5E-3Q1	5- 2-66		14	45	a.16	13 / .65	15 / 1.23	120 / 5.22	12 / .31	328 / 5.38	0 / .0	73 / 1.52	10 / .28	1.4 / .07	.7 / .01	.4	452	94	0	70	665	7.8
46N/5E-9R1	5-12-66	155		27	b1.5	58 / 2.89	48 / 3.91	88 / 3.83	15 / .38	464 / 7.60	0 / .0	120 / 2.50	18 / .51	.4 / .02	.5 / .01	.2	604	340	0	35	942	7.8
46N/5E-10D1	11-10-65		12	26	.0	46 / 2.30	27 / 2.22	66 / 2.87	13 / .33	368 / 6.03	0 / .0	43 / .90	15 / .42	.3 / .02	140 / .23	.0	431	226	0	37	700	7.8
46N/5E-19M1	5-27-66	107		32	a.20	67 / 3.34	49 / 4.02	99 / 4.31	11 / .28	414 / 6.79	0 / .0	206 / 4.29	26 / .73	.5 / .03	.1 / .00	.0	695	368	29	36	1,030	8.0
46N/5E-20F1	5-11-66	45	13	44	b.35	70 / 3.49	35 / 2.91	86 / 3.74	15 / .38	372 / 6.10	0 / .0	190 / 3.96	21 / .59	.4 / .02	11 / .18	.0	655	320	15	36	988	7.6

Source: California Department of Water Resources, Hydrologic Data: 1975, Vol. I Bulletin No. 130-75

TABLE VIIF-4

YIELD CHARACTERISTICS OF WELLS
IN THE TULE LAKE AREA

Well	Depth (ft)	Discharge (gpm)	Specific Capacity (gpm ft)
44/6 - 16P1	271	15	
45/4 - 28H1	758	11.5	38
45/6 - 17Q1	250	2100	52.5
- 28M1	385	850	
46/4 - 15M1	48	24	2.4
- 18J1	226	12	
46/5 - 3P1	173	58	19
46/6 - 5L1	190	4000	250
- 8E1	215	2200	137.5
47/4 - 6F1	123	30	
47/5 - 1H1	1000	20	0.66
- 1K1	119	500	7.5
- 1K2	131	1050	
47/6 - 6C1	450	1200	
- 6F1	711	2000	
- 7G1	594	1150	
- 30B1	117	1000	
- 30C1	140	3500	
- 30K1	61	25	2.7
- 30L1	275	40	13.3
48/4 - 16P3	1200	2650	
- 35L1	2676	1200	
- 35L2	2676	1200	
48/5 - 14Q1	155	30	
- 33A1	33	50	
- 36H1	110	10	
- 36K1	66	30	
48/6 - 31L1	251	30	
- 31M1	438	1200	

Source: Hotchkiss, 1968

TABLE VIIF-5
PUMP TEST DATA FOR BUTTE VALLEY

Well Location	Depth (feet)	Average Discharge (gpm)	Transmissivity (gpd/ft)	Hydraulic Conductivity (gpd/ft^2)
47/1w - 23A1	194	950	26,000	160
- 24C1	190	1000	38,000	230
- 23H1	210	900	24,000	--

Source: McClleland, 1965

NOTE: All test wells tap lake deposits in the vicinity of Dorris in Butte Valley

APPENDIX G

PROCUREMENT SPECIFICATIONS

APPENDIX G

PROCUREMENT SPECIFICATIONS

1.0 INTRODUCTION

To fully assess the availability of water resources in an area, data must be available for both surface and ground water. Not only must the data be available, it must be site specific to the area for which the analysis is being performed. Surface water data are, for the most part, based on hydrologic studies performed by the USGS and California Department of Water Resources. the primary source of data were reports from varoius stream gauging stations located in the study area. Since there are annual variations in flow, historic data over a period of time are required to assess surface water characteristics.

Ground water data, however, do not show considerable annual variations, thus an inventory-type information (i.e. data as of a point in time) are required. The key aspects of ground water involve storage capacity and usable capacity. Storage capacity indicates the amount of ground water stored in the underlying aquifers. Developable usable capacity is recharge less current usage and natural discharge for a specific ground water basin. Unless both parameters are known, the amount of make-up water available from ground water sources cannot be estimated.

Since some data are available for each area, the procurement specifications have been designed to acquire only the specific information required. Acquisition of data relevant to estimating available make-up water in the specific area is the only information included in the procurement specifications. Potentially, proposals could be solicited to respond to the tasks contained in the procurement specifications.

2.0 GROUND WATER PROCUREMENT

2.1 Ground Water Exploration

The ground water exploration program will include drinking wells for geophysical logging and aquifer testing. Exploraton wells will extend to a depth of 1000 feet. The number of wells should be approximately one well for every 10 square miles of surficial area in the two ground water basins. Therefore, this will require a total of 122 exploration wells for the various basins which have ground water potential (see Figure VIIG-1). Table VIIG-1 is a summary of these potential areas number of exploration wells required. The methods used in this program will conform to the standard methods and equipment.Figure VIIG-2 shows the general parameters for collection of ground water data.

The groundwater procurement program generally will require: physical definition of the aquifer, water level data within the productive aquifer, water quality measurements, information on hydraulic properties, estimation of groundwater in-storage and estimation of groundwater recharge.Figure VIIG-2 shows the general parameters for collection of groundwater data.

2.1.1 Drilling and Geophysical Logging

The program should consist of an exploration program which includes drilling and geophysical logging programs.

The drilling program should indicate:

a) Number and location of exploration wells
b) Water level data
c) Water quality, including temperature
d) Physical properties of the aquifer
e) Method used for drilling, including equipment to be used

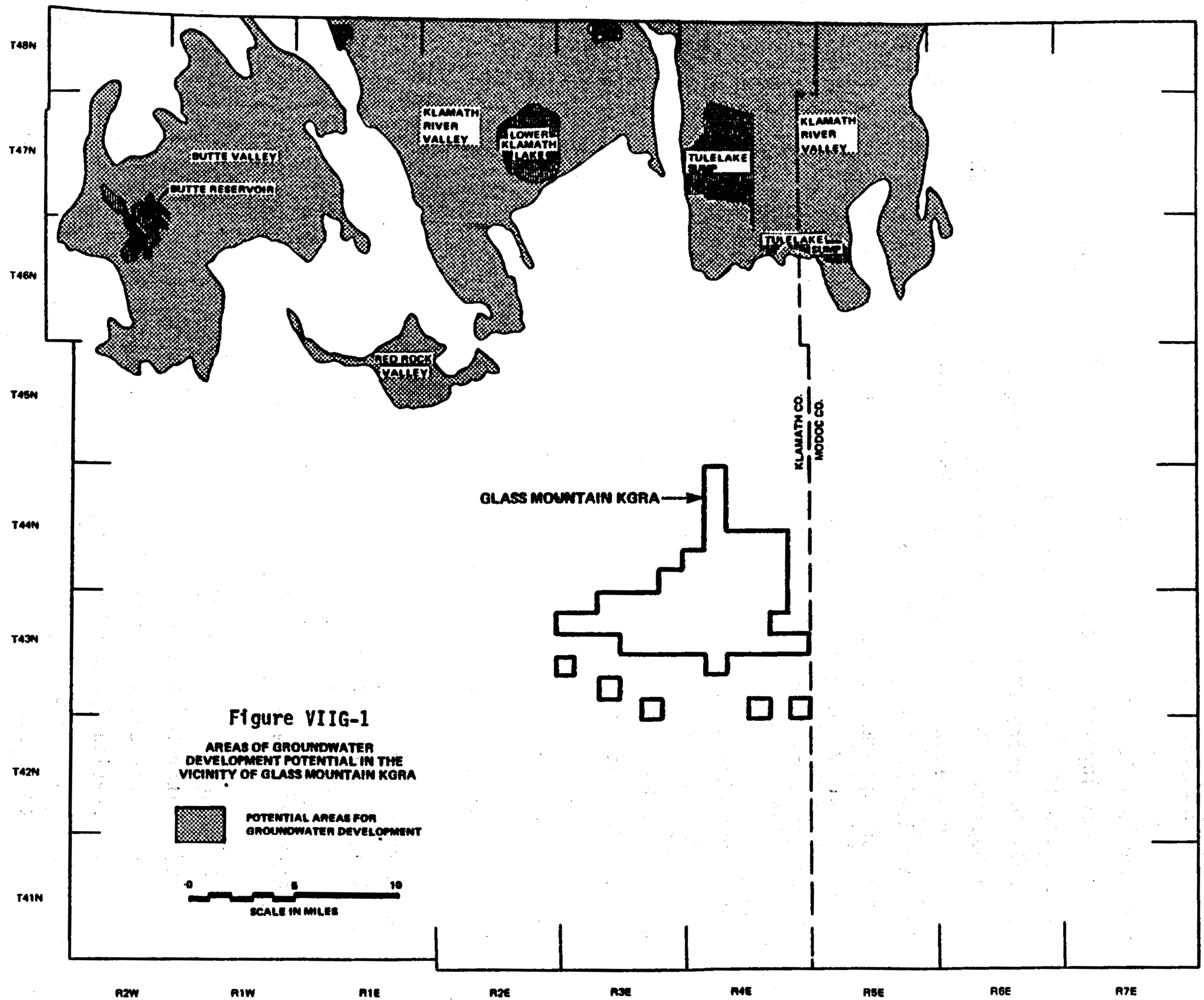

Figure VIIG-1

AREAS OF GROUNDWATER DEVELOPMENT POTENTIAL IN THE VICINITY OF GLASS MOUNTAIN KGRA

TABLE VIIG-1

Basin Name		Number of Exploration Wells Required
Tule Lake Area and Lower Klamath Lake		72
Butte Valley		48
Red Rock		2
	Total	122

2.2 Water Use Inventory

The major objective of this portion of the statement of work is to determine the water usage in the identified aquifer areas. This determination should be based on a survey of water users in the aquifer area.

Statement of Work:

1. Based on local county, city, utility(ies), California Department of Water Resources and the California Division of Oil and Gas, official well records and land ownership maps for the aquifer area, determine:

   a. number of wells
   b. the location of each well
   c. annual usage for each well
   d. annual variations in usage

2. For wells not recorded in any official record, individual well owner visits should be made to determine:

   a. number of wells
   b. the location of each well
   c. annual usage for each well
   d. annual variations in usage

GENERAL GROUNDWATER EVALUATION PROCEDURE

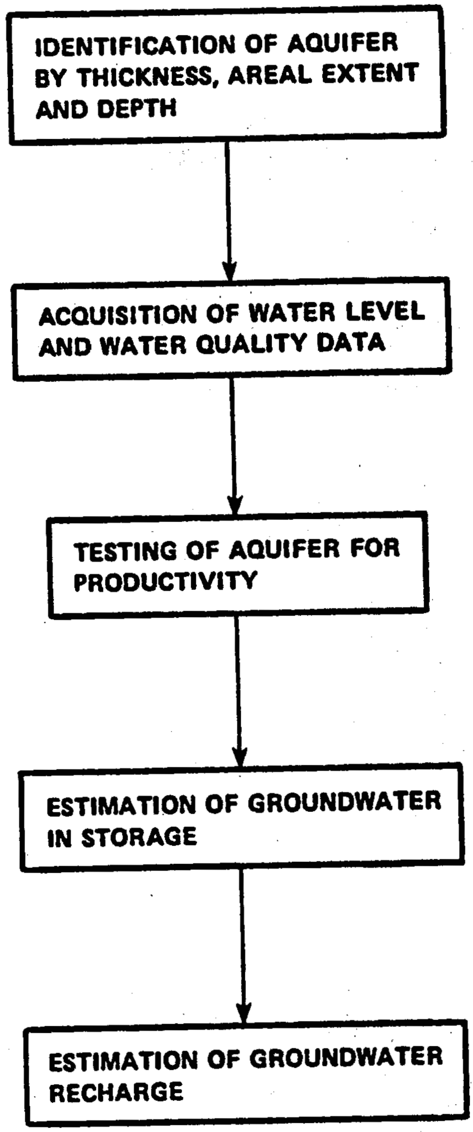

Figure VIIG-2

The geophysical logging program should indicate measurements of:

a) Spontaneous electrical potential
b) Resistivity
c) Acoustic logs
d) Temperature logs

Spontaneous electrical potential measurements should report: a) location of aquifer, b) thickness of aquifer and c) water quality.

Resistivity logs should indicate: a) water quality; b) porosity of formation, c) location of aquifer and d) salinity of pore fluid.

Acoustic logs should report porosity of formations.

For temperature logs, indicate temperature encountered with depths.

2.1.2 Aquifer Testing Program

The aquifer testing program should describe the pumping test to be accomplished. The program should delineate information from aquifers and the wells. The aquifer testing program should include pertinent information on the hydraulic characteristics of the aquifer. In addition, specific information from well tests should describe the following: a) yield, b) drawdown and c) specific capacity or discharge drawdown ratio.

A description of the methodology selected for each test, the equipment to be used, number of tests to be performed, site selection rationale and instrumentation to be used should be included for each test.

The aquifer testing program should specify:

a) Well design and construction technique selected
b) Well diameter to be employed
c) Well depth
d) Well screen length
e) Type of pump to be employed
f) Capacity of the pump
g) Rate of discharge and measurement technique to be employed
h) Length of time of the test period
i) Method of discharge disposal
j) Number and location of observation wells

Measurements of water depth should be conducted according to the following schedule:

TABLE 2.1

RANGE OF TIME INTERVALS BETWEEN WATER LEVEL MEASUREMENTS IN THE PUMPED WELL

Time Since Pumping Started	Time Intervals
0 - 5 minutes	0.5 minutes
5 - 60 minutes	5 minutes
60 - 120 minutes	20 minutes
120 - shut down of the pump	60 minutes

After the pumping test is completed and all information has been collected on well discharge, drawdowns in pumped well, regional trend of the water table, etc., the available data should be analyzed. This data processing should include: a) compilation of the data in the form of graphs, b) correction of the drawdown data for regional changes of the water level in the aquifer not induced by pumping, and for changes, if any, in barometric pressure during the test, and c) determination of the type of aquifer that has been pumped.

This survey should include all individual wells greater than four inches in diameter but should exclude windmills and stockwells. Municipal irrigation and industrial wells should be surveyed.

3. All of the data should be summarized to establish water usage for the aquifer area.

4. In addition to determination of water usage, the long-term annual recharge and inflow for the aquifer should be established. (Note, if possible, a 30-year historical period should be used to determine this long-term term.)

Figure VIIG-1 indicates the specific areas to be surveyed.

APPENDIX A

BIBLIOGRAPHY LISTING

APPENDIX A

BIBLIOGRAPHY LISTING

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APPENDIX B

LITERATURE CROSS-REFERENCE

TOPICS	KEY WORDS	AUTHOR CDWR TITLE Northeastern Counties Groundwater Investigation REFERENCE NO. C5-GEN	AUTHOR CDWR TITLE Northeastern Counties Investigation REFERENCE NO. C2-GEN	AUTHOR USDA TITLE Water & Related Land Res.Cen.Lahontan B. REFERENCE NO. U1-GEN
GROUNDWATER	AQUICLUDE			
	AQUIFER	p.77 p.96 p.166	Table 25	III-39
	AQUITARD			
	BOUNDARY			
	CONFINED		Table 25	
	DISCHARGE			
	GEOHYDROLOGY			
	GRADIENT			
	HYDRAULIC CONDUCTIVITY			
	INFLOW		Table 25	
	LEAKAGE			
	MOVEMENT	p.84 p.102 p.172	Table 25	
	OUTFLOW			
	PERMEABILITY	p.77 p.98 p.168		
	PIEZOMETRIC			
	POTENTIOMETRIC			
	RECHARGE	p.83 p.102 p.172	Table 25	
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	SPECIFIC CAPACITY			
	SPECIFIC YIELD			
	SPRING			
	STORAGE COEFFICIENT			
	TEMPERATURE			
	TRANSMISSIVITY			
	UNCONFINED			
	WATER BUDGET			
	WATER DEMAND			
	WATER LEVEL			
	WATER QUALITY	p.92 p.109 p.179	p.63	
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	WATER USE	p.88 p.106	Table 25	
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	ISOPACH			
	JOINT			
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	POROSITY			
	SAND			
	SHALE			
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	DIVERSION			
	DRAW			
	EVAPORATION		p.149	III-46
	EXPORT			
	HYDROLOGY		p.22 p.51	
	IMPORT			
	INFLOW			
	IRRIGATION		p.109 p.149	Table 51,80; III-48
	LAKE			Table 19
	OUTFLOW			
	PRECIPITATION		p.52, Plate 3	
	RESERVOIR			Table 19
	RIVER			
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APPENDIX C

SUMMARY OF VISITS

APPENDIX C

SUMMARY OF VISITS

The following is a list of persons, agencies, addresses and dates of visits and telephone contacts.

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APPENDIX D

SURFACE WATER DATA

APPENDIX D

SURFACE WATER DATA

The climate of the Lassen KGRA is generally governed by the air masses that originate in the Pacific Ocean. Altitude, however, causes some variations in the climate. Annual precipitation is 80 inches at Lassen Peak and 30 inches over Lake Almanor. Much of the precipitation falls in the form of snow, although rain occurs sometimes. Heavy snowfall is the usual winter feature of the southern Cascades at elevation above 5,000 feet. The northerly and westward movement of the prevailing Pacific High pressure ridge during the summer results in a practically rainless period during these months, except for local thunderstorms.

Temperature, wind, and humidity are similarly influenced by the movement of the Pacific air masses and the topography of the northeastern California. Warm, dry summers characterize the northeastern counties. In the winter, temperatures are low in the mountains and plateaus, with readings of -30°F at times. The mountain valley and plateau areas are usually frost-free from June until September, but in many locations frosts may occur in any month of the year.

Normal annual precipitation varies from approximately 60 inches in the extreme northwestern portion to less than 30 inches in the eastern portion of the drainage (CDWR #58 1960). The mean annual precipitation at Chester is 34.3 inches. Slightly more than 80% of the precipitation at Chester occurs as snow from October through March (NOAA 1976).

No data is available for evaporation pans within the vicinity of the watershed. The average net annual reservoir evaporation for the North Fork Feather River basin from its headwaters to Oroville has been estimated to be 2.2 feet (CDWR #59-2 1960). The maximum surface areas of Mountain Meadows Reservoir and Lake Almanor are 5,800 and 28,260 acres, respectively (CDWR #17-76 1977). Based on these figures, annual net evaporatin from Mountain Meadows resevoir and Lake Almanor are 12,800 and 62,200 acre-feet, respectively.

Annual precipitation varies from slightly more than 60 inches for the northern area to approximately 40 inches for the southern area (CDWR #58 1960). The mean annual precipitation at Mineral is 54.5 inches. Slightly more than 80% of the annual precipitation occurs as snow from October through March (NOAA 1976).

APPENDIX F

TECHNICAL DATA

TABLE VIIIF-1

MONTHLY DISTRIBUTION OF ANNUAL DISCHARGE
FOR THE 1906 WATER YEAR
AT NORTH FORK FEATHER RIVER ABOVE PRATTVILLE GAGING STATION

Month	Discharge (acre-feet)	Percent of Annual Discharge
October	20,800	4.45
November	19,800	4.24
December	20,000	4.28
January	27,200	5.82
February	30,700	6.57
March	41,100	8.80
April	54,900	11.76
May	83,600	17.90
June	71,400	15.29
July	44,900	9.61
August	29,000	6.21
September	24,000	5.14
Annual Total	467,000	

Source: USGS - WRD, Sacramento, 1978

TABLE VIIIF-2

MONTHLY DISTRIBUTION OF AVERAGE ANNUAL DISCHARGE IN PERCENT
BATTLE CREEK, MILL CREEK AND DEER CREEK BASINS

	Battle Creek below Coleman Fish Hatchery near Cottonwood, Sta.#11376550	Mill Creek near Los Molinos, Sta.#11383500	Deer Creek near Vina, Sta.#11383500	Deer Creek below Slate Creek near Deer Creek Meadows, Sta.#11382550
October	5.56	3.58	2.81	5.40
November	6.84	4.87	5.82	5.27
December	10.48	10.12	9.24	12.66
January	11.39	10.75	10.96	8.38
February	11.67	13.36	16.95	11.00
March	9.24	11.19	14.63	9.17
April	11.99	13.08	15.81	16.10
May	10.64	12.79	10.34	13.25
June	8.07	9.31	5.29	7.19
July	5.39	4.82	3.02	4.44
August	4.38	3.21	2.59	3.73
September	4.34	2.92	2.56	3.42

Source: USGS, California Streamflow Characteristics, Vol.2, 1971

APPENDIX G

PROCUREMENT SPECIFICATIONS

APPENDIX G

PROCUREMENT SPECIFICATIONS

1.0 INTRODUCTION

To fully assess the availability of water resources in an area, data must be available for both surface and ground water. Not only must the data be available, it must be site specific to the area for which the analysis is being performed. Surface water data are, for the most part, based on hydrologic studies performed by the USGS and California Department of Water Resources. the primary source of data were reports from varoius stream gauging stations located in the study area. Since there are annual variations in flow, historic data over a period of time are required to assess surface water characteristics.

Ground water data, however, do not show considerable annual variations, thus an inventory-type information (i.e. data as of a point in time) are required. The key aspects of ground water involve storage capacity and usable capacity. Storage capacity indicates the amount of ground water stored in the underlying aquifers. Developable usable capacity is recharge less current usage and natural discharge for a specific ground water basin. Unless both parameters are known, the amount of make-up water available from ground water sources cannot be estimated.

Since some data are available for each area, the procurement specifications have been designed to acquire only the specific information required. Acquisition of data relevant to estimating available make-up water in the specific area is the only information included in the procurement specifications. Potentially, proposals could be solicited to respond to the tasks contained in the procurement specifications.

2.0 GROUNDWATER PROCUREMENT

2.1 Water Use Inventory

The major objective of this portion of the statement of work is to determine the water usage in the identified aquifer areas. This determination should be based on a survey of water users in the aquifer area.

Statement of Work:

1. Based on local county, city, utility(ies), California Department of Water Resources and the California Division of Oil and Gas, official well records and land ownership maps for the aquifer area, determine:

    a. number of wells
    b. the location of each well
    c. annual usage for each well and current application
    d. annual variations in usage

2. For wells not recorded in any official record, individual well owner visits should be made to determine:

    a. number of wells
    b. the location of each well
    c. annual usage for each well and current application
    d. annual variations in usage

This survey should include all individual wells greater than four inches in diameter but should exclude windmills and stockwells. Municipal irrigation and industrial wells should be surveyed.

3. All of the data should be summarized to establish water usage for the aquifer area.

4. In addition to determination of water usage, the long-term annual recharge and inflow for the aquifer should be established. (Note, if possible, a 30-year historical period should be used to determine this long-term term.)

Figure VIIIG-1 identifies the specific areas to be surveyed.

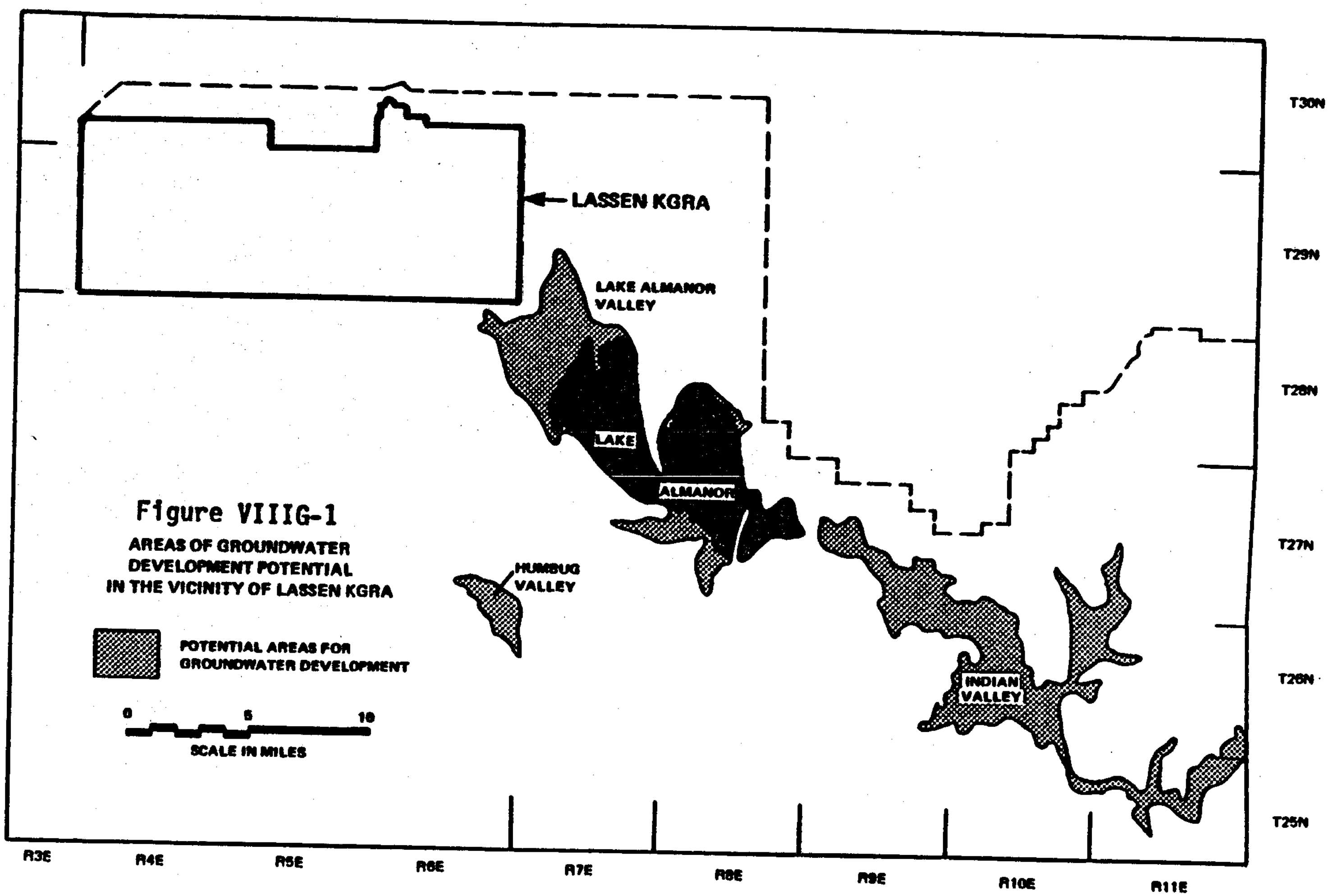

Figure VIIIG-1
AREAS OF GROUNDWATER DEVELOPMENT POTENTIAL IN THE VICINITY OF LASSEN KGRA

APPENDIX A
BIBLIOGRAPHY LISTING

APPENDIX A

BIBLIOGRAPHY LISTING

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APPENDIX A

SAMPLE PROBLEM

APPENDIX A

SAMPLE PROBLEM

1.0 INTRODUCTION

Utilizing Curves X-8 and X-9

Say an Imperial Valley situation is to be defined; specifically at the Salton Sea - Hypothetical data follow:

Basic Reservoir Data

Reservoir temperature - 350°C
Estimated field capacity - 1,200 MWe

Cooling Water Data

Availability rate 65,000 acre-ft/year
Solids Contents 2,500 ppm

Problem Solution

Water availability - $\frac{65,000}{1200}$ = 54.2 acre-ft/MWe years

1.1 Example - 1000 ppm water solids content

At a resource temperature of 350°C, a solids content of 1000 ppm, and a water availbility level of 54.2 acre-ft/MW-year, Figure X-9 would indicate that these would be sufficient water to furnish cooling water make-up requirements for a mix of about 83% binary plants and 17% flash plants. Thus, for example theses could be twenty (20), 50 MW binary polants and four (4), 50 MW flash plants. The total MW output would be:

Binary:	20 x 50 =	1000 MWe
Flash:	4 x 50 =	200 MWe
	Total =	1200 MWe

1.1.2 2500 ppm Water Solids Content

From Figure X-8, at a solids content of 1000 ppm and reservoir temperature of 350°C water make-up requirements are 24.2 lb/hr-KW. While at 2500 ppm, the valve is 48 lb/hr-KW, equivalent to a prorate factor of (48/24.2) or 2.0.

Thus, a new curve can be developed using Figure X-9 to indicate water requirements at 350°C and 2500 ppm. The permissible plan mix for a water available value of 54.2 AF/MWe would be about 42% binary plants and 58% non-binary plants. A typical breakdown could be:

10 Binary plants at 50 MW each	=	500 MWe
14 Flash plants at 50 MW each	=	700 MWe
Total	=	1200 MWe

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