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Pebble Beach,
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FOR

MONTEREY COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

COURTHOUSE BUILDING

SALINAS, CALIFORNIA 93901

REPORT ON CASTROVILLE IRRIGATION PROJECT DEEP TEST HOLE AND FRESHWATER BEARING STRATA BELOW THE 400 FOOT AQUIFER, SALINAS VALLEY, CALIFORNIA

by

RICHARD R. THORUP

Consulting Geologist
MONTEREY, CALIFORNIA

APRIL 20, 1976

64

OIL WATER

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April 20, 1976

Mr. Loran Bunte, Jr.
District Engineer
Monterey County FC
and WCD
Courthouse Building
Salinas, Ca. 93901

Dear Mr. Bunte:

REPORT ON CASTROVILLE IRRIGATION PROJECT DEEP TEST HOLE WITH RECOMMENDATIONS FOR FURTHER ACTION

Enclosed with this letter are ten copies of the above report for distribution to the Board of Supervisors, Flood Control Office, Dr. John Mann, and other participants and agencies.

My recommendation is that we transfer the direction of the project from the Castroville Service Area to the Marihart Ranch and that a well be drilled in proximity to the location of the C. A. "Lucky" Marihart No. 1 abandoned oil test well, said well to be drilled, cased, sampled, logged and test pumped. Details for this program should be assembled and reviewed singly and together by your office, Dr. Mann, and myself before drawing up specifications for bid. Anticipated perforated interval is 780 - 1500 feet. This interval will test the deep zone below the 400 foot aquifer.

Respectfully submitted,

Richard R. Thorup

Richard R. Thorup

Enc.

FOR

MONTEREY COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
COURTHOUSE BUILDING
SALINAS, CALIFORNIA 93901

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DEEP TEST HOLE AND FRESHWATER BEARING STRATA
BELOW THE 400 FOOT AQUIFER, SALINAS VALLEY, CALIFORNIA

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APPENDICES

ILLUSTRATIONS

TABLES

Page

FIGURES

PLATES

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April 20, 1976

REPORT ON CASTROVILLE IRRIGATION PROJECT DEEP TEST HOLE AND FRESHWATER BEARING STRATA BELOW THE 400 FOOT AQUIFER, SALINAS VALLEY, CALIFORNIA

PURPOSE

The purpose of this report is:

A. To evaluate the results of the deep test hole.

B. To determine the lateral and vertical boundaries of the freshwater bearing strata in the Salinas Valley between Monterey Bay and King City.

C. To estimate the volume of freshwater reserves below the 400 foot aquifer.

D. To determine the recharge area of the deep freshwater sands and gravels.

E. To provide water quality data from available water wells and Electric Log analysis.

F. To establish seawater intrusion in the deeper beds.

G. To evaluate the possibility of subsidence.

SCOPE

To achieve the purposes stated above, several lines of research were employed. They are listed below, not necessarily in the order they were accomplished.

A. Review literature.

B. Locate all deep wells, including abandoned oil test wells, in the area between King City and Monterey Bay.

C. Identify aquifers.

D. Construct geologic cross-sections to show regional geology.

E. Construct isopach maps of alluvium and of the Paso Robles Formation.

F. Construct structural contour map on the base of the Paso Robles Formation.

G. Confer with the United States Geological Survey and obtain subsurface data in Monterey Bay.

H. Secure a paleontology report for correlation of the strata in the project well with other known data.

I. Obtain porosity and permeability determinations from sidewall samples.

J. Analyze both the Electric Log and sidewall samples from the test hole.

K. Obtain a complete chemical analysis from deep water wells near the test site.

L. Compile pertinent geologic data on deep wells between Moss Landing and King City. This is contained in Table 1.

DRILLING CONTRACT AND OBJECTIVES

The Castroville Irrigation Project Test Hole was drilled for the Monterey County Flood Control and Water Conservation District by their consultant, Richard R. Thorup, Consulting Geologist, Monterey, California, under a contract submitted to and executed by the Board of Supervisors on January 19, 1976.

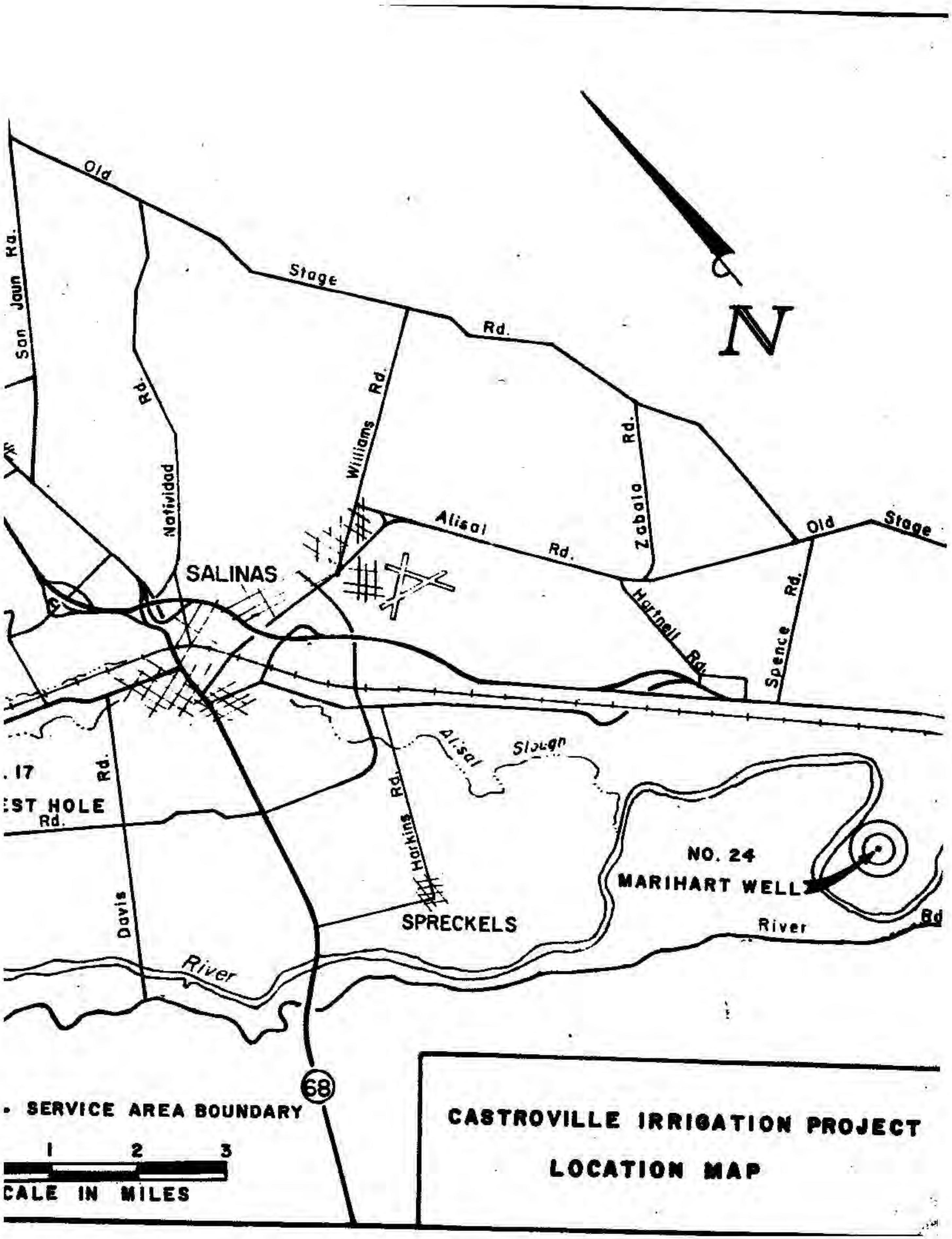
Location of the well on the Fontes Property was jointly selected by Mr. Thorup and Dr. John Mann, Consulting Geologist and Hydrologist from La Habra who represent several large landowners and growers in Zone 2 whose interests are vitally affected by the program developed under the direction of the County Flood Control Office.

The objectives of the test hole were to drill to the Monterey Shale and identify the geologic formations encountered in the hole. It was felt that this would make it possible to correlate the beds with the offshore work of the Geological Survey (H. G. Greene) and to help determine the geologic structure between Monterey Bay and South Monterey County. By obtaining an Electric Log and sidewall samples, it would be possible to analyze the water quality in the different aquifers.

The final report to the Monterey County Flood Control and Water Conservation District and Board of Supervisors would evaluate the overall potential as a site for a well field, summarize the results of the investigation and make recommendations for further action.

TABLE OF CONTENTS

Elkhorn Slough
Moro Cojo Slough
S.P.R.R.
101
Espinosa Rd.
MOSS LANDING
CASTROVILLE
1
Slough
Rd.
Tembladero
Reclamation
San Jon
Molero Rd.
Nashua Rd.
Alisal
Salinas
Cooper Rd.
PROJEC
Slough
Blanco
PACIFIC OCEAN
1
Reservation
MARINA



CASTROVILLE IRRIGATION PROJECT

LOCATION MAP

SUMMARY

The Project Test Hole was located in Section 22, Township 14 South, Rage 2 East in the Moro Cojo District of Monterey County. The 1715 foot test hole penetrated the Monterey Shale at 1677 feet. The formations encountered are:

INTERVAL (Feet)	DESCRIPTION
0-80	Salinas aquiclude (blue clay)
80-390	Alluvium (includes the 180 foot aquifer)
390-410	Clay
410-635	400 foot aquifer
635-675	Clay and thin sand streaks
675-1250	Deep aquifer
1250-1677	Pliocene sand (includes Santa Margarita formation)
1677-1715	Miocene Monterey Shale

Geologically, the strata are flat-lying and underlie most of the alluvial plain in this area. They extend horizontally beneath the bay and terminate at a large slump area, or fault on the south edge of Monterey Canyon.

An evaluation of the producing capability of the deep zone (675-1250) can only be made indirectly, since the well was not pump tested. The ability to produce groundwater is closely linked to grain size and total amount of

6

zone. Based on a comparison of the sand and gravel count between the test hole, the Marihart well, and the Tanimura well, a well producing from the deep aquifer would not be expected to yield in excess of 2000 gpm at the test hole locality.

		Sand and Gravel	Fine to Medium Sand	Aquifer
Project Test Hole	(15)	73'	242'	Deep
Marihart	(24)	370'	153'	Deep
Tanimura	(16)	192'	Minor	Alluvium

Well 16 is selected as a typical alluvium well. It is located about one-half mile south of the test hole and is perforated in the 180 and 400 foot aquifers. Alluvial wells produce between 2000 and 4000 gpm from a thick interval of loose sand and boulders.

The Marihart well can be seen to contain five times as much coarse material as the test well (see Appendix E).

CONCLUSIONS

Based on the information gained from drilling and evaluating the test hole, the conclusion is reached that in all probability this well site, and the Castroville area in general, cannot support a well field containing the size of wells required to economically fill the requirements of the project. A goal of around 3,000 gpm per well has been set as a requirement for a deep well, and it is anticipated that nine such wells will be needed to supply the project. The test hole location appears to fall short of this objective. No other location in the Service Area appears to have any better capability.

Rather than spend the considerable amount of money required to drill, complete and pump test a well at this location, or in this northern area, it is hereby recommended that a well be drilled, cased and pump tested at a location close to the Marihart well, and that, if this well is successful, a well field be established for the purpose of supplying the Castroville Project Service Area with groundwater from the deeper aquifer.

8

REVIEW OF SELECTED REFERENCES

The first comprehensive publications on the hydrology of the Salinas Valley were Bulletins 52 and 52-A, by the Department of Water Resources. These bulletins collected and analyzed large amounts of well data. This resulted in the formation of the concept of the Pressure Area and the adjoining hydrologic provinces which are in use today. The origins of the 180 and 400 foot aquifers can be found in this publication.

In 1960 the Monterey County Flood Control and Water Conservation District published a paper containing many geologic cross-sections and longitudinal sections. This paper investigated the upper 500 to 600 feet of the Salinas Valley aquifers. The complexity of the depositional pattern can be seen in the cross-section. As a result of this investigation, the hydrologic boundaries in the valley were locally refined.

John Manning (1963) outlined the hydrology of the Salinas Valley in an Association of American Petroleum Geologists guidebook on the Salinas Valley. He confined his paper to the existing aquifers, but makes mention that the Paso Robles Formation is one of the main water bearing units in the Salinas Basin. In the Upper Basin, according to Manning, it ranges in thickness up to 2,000 feet. The thickness in the Lower Basin is unknown, but believed to be substantial beneath the Salinas River. Manning placed the 400 foot aquifer in the Paso Robles Formation, as does this author.

The Monterey County Flood Control and Water Conservation District has, over the last several years, published annual reports on the hydrology, groundwater and climatology of Monterey County. These reports contain vast amounts of current hydrologic data, including water table levels, water quality and rainfall. In addition to the annual bulletins, the District has published many in-house and contracted reports on various problems, such as the Castroville seawater intrusion problem. The East Side has also been the subject of intensive study.

The Department of Water Resources published two reports on seawater intrusion in 1970 and 1973 respectively. Included in those reports are several interpretative cross-sections. Cross-sections D-D' and E-E' in their report show the complicated relationship between the Salinas aquiclude and the 180 and 400 foot aquifers. The Gabilan fault, which is shown to extend thru the Marina area, cannot be confirmed by present available well data. water well logs in the Marina area do not confirm the presence of this fault, nor has the seismic work by H. G. Greene confirmed its existence offshore.

The U.S. Geological Survey studies in Monterey Bay (Greene, 1973-74) shed considerable light on the geology of Monterey Bay and the Monterey Submarine Canyon.

Interpretative cross-sections, based on seismic work, showed the area offshore from Castroville to be flat-lying and unfaulted, except along the edge of the Monterey Canyon. Seismic picks on offshore formation boundaries did not, however, correlate too well with onshore data from nearby abandoned oil test wells. A soon to be published Ph.D. dissertation at Stanford may help to clarify the onshore-offshore relationships.

In the 1970 open file report (Green, et al.), the ocean floor outcrop of the 180 foot aquifer is outlined. The outcrop pattern is difficult to tie to onshore well data. This publication gives us a look at the Monterey Bay Fault Zone (called the Tolarcitos in this report) and the complexities of the Monterey Submarine Canyon geology. Greene's doctor's thesis is presently in the process of being assembled for publication (H. Greene, written communication) and will be an update of previously published materials. These publications are a valuable contribution to the Salinas Valley geology.

The U.S. Army Corps of Engineers published an informative report entitled "Hydrology of Fort Ord and Vicinity" in 1975, which, for the first time showed the location of Fort Ord wells, discussed the geology, well drilling history, water quality, seawater intrusion and tied this data with the adjacent portion of the Salinas Valley. The work was done largely by E. P. Kaiser, now retired. He firmly established the hydrology continuity of the Fort Ord - Marina area with the Salinas Valley and stated that his investigations produced no evidence of the presence of the so-called Gabilan fault in this area. He placed the 180 foot aquifer in the Aromas formation. Four test holes were drilled by the Army, south of Reservation Road, near East Garrison. Three of these wells were cased and pump tested. On the basis of those results, the Army has designated a well field area for development along the edge of the Salinas Valley, between Blanco Road and East Garrison. The present plans are to develop and pump the 400 foot aquifer for this well field. This, of course, will not assist the county in arresting seawater intrusion in the Castroville area. Efforts are being made to direct the Army's attention to the deeper aquifers in the area.

The new publications by the Department of Water Resources ("California's Groundwater, Bulletin 118" and "Seawater Intrusion in California, Bulletin 63-5") show by charts and maps the total groundwater resources of California and an overall picture of seawater intrusion along the entire coast. In Bulletin 118, page 42, the storage capacity for known aquifers in the Salinas Valley is given as 3,500,000 acre feet, with 1,300,000 acre feet of usable capacity. The 1972 estimated pumpage figure is 300,000 acre feet. The Department of Water Resources states there is <u>no further development potential</u>. The degree of geologic knowledge was listed in Bulletin 118 as being <u>moderate</u> for the coastal area, and <u>limited</u> for the inland area.

source of water supply for the Castroville Irrigation Project. In this report was a strong recommendation to drill a well near well No. 24 (C. A. "Lucky" Marihart #1) in Section 31 of Township 15 South, Range 4 East.

The writer stated that if the Committee wished to have a test hole drilled within the Castroville Project Service Area, the well should be located near the southern boundary of the service area, near the Salinas River. The final location of the drilled hole was about 3,000 feet southeast of the river location along Cooper Road.

REVIEW OF ILLUSTRATIONS

TABLE 1

Table 1 lists 47 wells, which have been selected for special study. These wells have been listed by number, name and location, starting with the most northerly and ending with the most southerly well. Of these wells, 25 are abandoned oil test wells and 22 are water wells. The Castroville Project Test Hole is No. 17 and the Marihart oil test well is No. 24.

PLATES

PLATE I is a geologic map showing the geology, the location of wells listed in Table 1, and six cross-section lines. The base map for illustrations in this report is the geologic map for the Monterey County Seismic Safety Element.

WELL #	NAME	SECTION #	WELL TYPE*	TOTAL DEPTH (Ft.)	SURFACE ELEVATION (Ft.)	DEPTH BELOW SEA LEVEL TO BASE OF FRESH WATER SANDS	DEPTH OF ALLUVIUM	FORMATION AT BOTTOM
	TOWNSHIP 12 SOUTH/RANGE 2 EAST							
1	Western Gulf Oil Co.	29	1	3195	181	--	--	Basement
2	Jergins Oil Co. Blohm No. 1	33	1	1922	413	--	--	Basement
3	Jergins Oil Co. Blohm No. 2	34	1	2168	75	--	--	Basement
	TOWNSHIP 13 SOUTH/RANGE 2 EAST							
4	Elba Oil Co. Capurro No. 1	6	1	4009	52	--	--	Basement
5	Bayside Oil Co. Vierra No. 1	7	1	7818	15	--	--	Miocene Non-marine
6	Kaiser Dolan No. 1 & 2	15	2	882	50	NR	230	**
7	PG&E Well No. 8	15	2	1014	50	NR	240	**
8	Moss Ldg Harbor Dist.	16	2	1014	55	NR	245	**
9	PG&E No. 7	17	2	745	20	NR	105	**
10	Texaco Pieri	19	1	3293	10	-1160	90	Basement
11	Kaiser Tate Well	20	2	812	15	NR	150	**
12	Texaco Davies No. 1	34	1	2218	70	-1110	200	Basement
	TOWNSHIP 14 SOUTH/RANGE 2 EAST							
13	Klute	9L2	2	640	10	NR	235	400
14	Rogers & Ferreira	12E1	2	848	45	NR	240	**
15	ARMSTRONG	18D	2	913	10	NR	240	**
16	Bordges	23H	2	600	30	NR	260	400
17	R. THORUP/FONTES NO. 1 CASTROVILLE PROJECT TEST HOLE	22K	2	1715	25	-1225	330	Miocene Shale
18	Tanimura	27D	2	495	30	NR	330	400
19	Marina County Water Dist.	30K	2	1060	105	NR		**
	TOWNSHIP 14 SOUTH/RANGE 3 EAST							
20	ALCO No. 5	26D	2	700	85	-695	45	Basement
21	Calif. Water & Serv. Co. Well No. C-26	31K	2	650	40	NR	205	400
	TOWNSHIP 15 SOUTH/RANGE 3 EAST							
22	Nestle	3M	2	1020	60	NR	190	**
23	Merrill Farms	18M2	2	904	55	NR	150	**

TABLE 1 -- page 1 of 2

WELL #	NAME	SECTION #	WELL TYPE*	TOTAL DEPTH (Ft.)	SURFACE ELEVATION (Ft.)	DEPTH BELOW SEA LEVEL TO BASE OF FRESH WATER SANDS	DEPTH OF ALLUVIUM	FORMATION AT BOTTOM
	TOWNSHIP 15 SOUTH/RANGE 4 EAST							
24	C. A. "LUCKY" MARIHART No. 1	31	1	2625	70	-1650	450	Miocene Non-Marine
	TOWNSHIP 16 SOUTH/RANGE 4 EAST							
25	Turri Brothers	2	2	1020	130	NR	175	**
	TOWNSHIP 17 SOUTH/RANGE 5 EAST							
26	Maestri	21	2	726	350	NR	262	**
	TOWNSHIP 18 SOUTH/RANGE 6 EAST							
27	Ferguson & Bosworth Pura No. 1	19	1	4258	698	-1820	FAN	Miocene
28	Humble Oil Capitol C-1	27	1	6100	370	-1730		Basement
29	Humble Oil Zabala No. 1	34	1	5954	386	-2240		Basement
	TOWNSHIP 19 SOUTH/RANGE 6 EAST							
30	W. W. Holmes	9	1	5800	368	-450	50	Miocene Non-Marine
31	Santa Fe Drlg.	11	1	4120	380	-1950	370	Miocene Non-Marine
	TOWNSHIP 19 SOUTH/RANGE 7 EAST							
32	Standard Rianda No. 1	5	1	1511	262	-638	215	Basement
33	Standard Kenner	8	1	2998	367	-1193	None	Basement
34	Terry Dryer Well	12	2	392	265	180	180	Basement
35	Standard - United Farms	14	1	1470	297	-608	240	Basement
36	Luard Marini No. 1	18	1	5007	397	-1203	300	Basement
37	Bandini Pet. Doud 82	19	1	3802	655	-1395	430	Miocene
38	Barron Kidd Spreckels	25	1	1349	279	-521	-521	Basement
39	Standard Oil Cowles	26	1	1771	327	-753	110	Basement
40	CCMO Salanco	35	1	2589	400	-850		Basement
	TOWNSHIP 19 SOUTH/RANGE 8 EAST							
41	Texaco Spreckels No. 1	31	2	1283	294	800	430	Basement
42	Spreckels Test Well	31	2	910	315	370	310	Basement
43	Tom Jones Spreckels-1	33	1	702	402	390		Basement
	TOWNSHIP 20 SOUTH/RANGE 8 EAST							
44	PG&E King City	5	2	1020	310	370	300	Miocene
45	Texaco E. King City	11	1	1545	470	Pliocene 350	None	Basement
46	Murdoch Oil Marion No. 1	9	1	5360	410	250		Miocene Non-Marine
47	Texaco Doud Core Hole No. 1	21	1	2343	317	520		Miocene Non-Marine

* - 1 = Abandoned oil test well
2 = Water well

-1110 - Subsea elevation

NR - Not reached

** - Older than 400 foot zone

TABLE 1,

15

PLATES 2 and 3 are isopach (thickness) maps of the alluvium and deep aquifers, respectively, showing the recharge area for each.

PLATE 4 is a structural contour map on the base of the Paso Robles Formation. It clearly shows the Salinas Valley synclinal axis and the rising of the structure toward King City.

PLATE 5 contains six simplified cross-sections. A-A' extends from Monterey Bay to King City through key control wells. B-B' shows the projection of the aquifers from onshore to their offshore termination along the south wall of the Monterey Canyon. Cross-sections C-C' through F-F' are transverse sections of the Salinas Valley, which illustrate the thickness of the Paso Robles formation and the recharge potential of the Paso Robles from the alluvium. This results from the fact that the alluvium rests unconformably on the upturned edge of the lower Paso Robles, thereby allowing groundwater to percolate into the Paso Robles sands and gravels from the alluvium.

CASTROVILLE IRRIGATION PROJECT WELL.--The site selected for the deep well was on the east side of Cooper Road, 1000 feet south of the southerly boundary of the Service Area. The well was spudded on March 4 and finished drilling at 1715 feet on March 7. The electric log was run on March 8, 1976.

Appendix C presents all of the field and laboratory data on the test hole. Included in the Appendix are: 1) the ditch sample and sidewall sample description by Darrel Shuck, assistant geologist; 2) the copy of the driller's log furnished by Salinas Valley Pump and Drill, Inc., of Salinas; 4) the sidewall sample analysis data; 5) the electrical log analysis of water quality, based on the sidewall sample porosity data and the electric log; 6) the paleontological summary on the lower 600 feet of the test hole.

GEOLOGICAL DISCUSSION OF THE STRATA.--The drilling of the test hole achieved the purpose for which it was drilled, which was to investigate and evaluate all of the sedimentary strata lying above the Monterey shale. The base of the freshwater sands was found at 1685 feet and drilling was terminated in Monterey shale of Upper Miocene Age at 1715 feet.

17

STRATIGRAPHIC SUMMARY.--

0-80	Salinas aquiclude, blue clay
80-390	180 foot aquifer, sand and gravel
390-410	Blue clay
410-635	400 foot aquifer, sand gravel and clay
635-675	Clay with thin sand streaks
675-1250	Deep aquifer, gravel streaks down to 1100 feet, sand and clay to 1250.
1250-1677	Pliocene sand, fine grained.
1677-1715	Monterey shale, Upper Miocene

DESCRIPTION OF WATER-BEARING FORMATIONS

ALLUVIAL DEPOSITS (QAL) occurring beneath the valley floor make up the most important underground reservoir in the Salinas Valley. They range in age from Upper Pleistocene to Recent. These are unconsolidated sediments of sand, gravel, silt and clay which were deposited by the Salinas River and its tributaries. They extend from Wunpost, south of San Ardo, to Moss Landing, a distance of 75 miles, and are present in the central valley. Shallow sediments lying in proximity to the Salinas River between River Road and Highway 101 receive direct recharge from the Salinas River as far north as Spence, near Chualar. This recharge percolates downward into the alluvium and underlying older coarse material. Northward from Spence, in an area extending from Salinas to Castroville, the shallow 180 and 400 foot aquifers are overlain by the Salinas aquiclude, consisting of about 100 feet of blue clay. This impervious layer forms the Pressure Area by sealing the underlying aquifers from direct recharge.

These two bodies of sand, gravel, clay and boulders, each about 200 feet thick, are the two most important sources of groundwater. To the south, where the thick clay cover disappears, the wells penetrate a continuous body of sand and gravel with minor clay interbeds.

Plate 2 shows the approximate extent and thickness of the alluvium. It ranges in thickness from zero to 450 feet. The 180 foot aquifer is considered in this report to be a part of the Aromas formation.

Alluvial fan material flanks the mountains on both sides of the Salinas Valley and extends to depths of nearly 1,000 feet.

Although individual wells pump from 1500 to 2000 gallons per minute from this material, the recharge within these semi-impervious strata does not keep pace with the withdrawals, so that a fairly severe drop in the water table has occurred. Long-range plans are being developed to overcome this problem.

West of the Salinas River the small amount of deep drilling which has been done has shown that these deposits are 800± feet deep. Well No. 27, which was drilled to 4250 feet, penetrated a thick section of interbedded sand, gravel and clay of the Paso Robles formation beneath the fan material. Farther north, on Pine Canyon Road, opposite Spreckels, fan deposits were found lying on basement at 900 feet, near the base of the Sierra de Salinas. In the intervening area, between Spreckels and Paraiso Springs, the practice has been to drill the wells near the river, along River Road, and pump the water from the alluvium up the slope of the fans for irrigation, rather than drill for deep aquifers.

THE PASO ROBLES FORMATION (MIDDLE AND LOWER PLEISTOCENE).--This formation is the second most important source of groundwater in the valley. It extends almost continuously from the Paso Robles Basin, where it is widely developed as an aquifer, to Monterey Bay, where it lies beneath the seawater.

The formation varies in thickness from 1800 feet west of Greenfield, 1300 feet at the Marihart Well (Well No. 24) and 840 feet thick at the Project Test Hole. Although no well information is available between Chualar and Greenfield (22 miles), there is every indication that the formation is thick below the course of the Salinas River. The gravity map (Figure 10) strongly supports this view. A noticeable gravity low parallels the mountains along the river all the way from Greenfield to Blanco.

The sands, gravels, and clays of the Paso Robles formation were laid down by the ancient Salinas River. These deposits often show a marked variation in thickness and grain size from one well location to another. In this report, the Paso Robles formation is divided into three members:

A. The 400 foot aquifer, at the top, 200 feet thick.

B. This member comprises the so-called 900 foot aquifer. It varies in thickness from 600 to 1200 feet and contains a series of interbedded sands and gravels that are marked on the Electric Log by high resistivities. In the Marihart well, the member contains five individual, substantial bodies of sand and gravel.

C. Lowermost 200 feet, sand and clay, lower resistivities and thinner beds, but still containing freshwater.

Member B is the only remaining substantial source of unused groundwater in the Salinas Valley. My calculations for this report indicate that nearly 11,000,000 acre-feet of fresh groundwater occur in this unit. About a dozen water wells now produce water from this interval in the northern Salinas Valley (see Table 1). The only well producing exclusively from this member is Well No. 15 at Lapis Landing.

Water quality analyses for several of these wells are included in this report in Table 2. The quality falls in the Class 1 category, with the exception of Well No. 23, which is high in iron and manganese, and Well No. 25.

In the King City area, a few wells are producing water for irrigation purposes from the deep zone and find good quality.

21

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In any reference, please quote Certified Analysis Number appearing hereon.

131540/670

Monterey County Flood Control
P.O. Box 930
Salinas, CA. 93901

April 8, 1976

CERTIFIED ANALYTICAL REPORT

MATERIAL: 6 water samples received March/April 1976
IDENRIFICATION: See below
REPORT: Quantitative chemical analysis is as follows expressed as milligrams per liter where not otherwise stated:

SEE TABLE 1 FOR WELL IDENTIFICATION

	23	15	13	18	25	16
Identification:	15S-3E-18MZ	14S-2E-18	14/2-9L2	14 27B/G	16/4-2Q3	14/2 10C
Conductivity (umhos/cm):	790	822	612	677	1516	613
pH value (units):	7.21	7.84	7.54	7.86	7.35	7.30
Bicarbonate (as $CaCO_3$):	182	168	158	172	276	170
Carbonate (as$CaCO_3$):	0	0	0	0	0	0
Sulfate (SO_4):	39	55	36	75	250	17
Chloride (Cl):	104	122	48	42	180	52
Fluoride (F):	0.1*	0.1*	0.1*	0.1*	0.1*	0.1*
Boron (B):	0.1*	0.1*	0.1*	0.1*	0.1*	0.1*
Calcium (Ca):	55	60	40	60	115	37
Magnesium (Mg):	15	20	13	18	74	11
Sodium (Na):	88	88	60	48	135	65
Potassium (K):	4	4	3	3	7	3
S.A.R.	1.9	1.8	1.5	1.2	2.4	1.5
Hardness (as $CaCO_3$):	199	232	154	224	591	137
NonCarb. Hardness("):	0	0	4	0	0	33
Alkalinity (as $CaCO_3$):	182	168	158	172	276	170
Nitrate-Nitrite(asN):	0.1*	0.3	0.6	0.3	11.4	0.7
Sodium % (Na):	49	45	46	32	33	51

The undersigned certifies that the above is a true and accurate report of the findings of this Laboratory.

* less than figure stated.

TABLE 2

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

1234 HIGHWAY 1

KEN GALLOWAY
KINGSLEY PACKER

408 724-5422

In any reference, please quote Certified Analysis Number appearing hereon.

131540/670

penetrates your problems!

Monterey County Flood Control
P.O. Box 930
Salinas, CA. 93901

April 8, 1976

CONTINUATION SHEET

CERTIFIED ANALYTICAL REPORT

MATERIAL: 6 water samples received March/April 1976
IDENTIFICATION: See below
REPORT: Quantitative chemical analysis is as follows expressed as micrograms per liter:

Note → SEE TABLE 1

Identification:	(23) 15S-3E-18M2	(15) 14S-2E-18	(13) 14/2-9L2	(18) 14/2 27B/G	(25) 16/4-2Q3	(16) 14/2 10C
Aluminum (Al):	10*	10*	10*	10*	10*	10*
Arsenic (As):	2	1	2	2	1	1
Beryllium (Be):	1*	1*	1*	1*	1*	1*
Cadmium (Cd):	1*	1*	1*	1*	1*	1*
Chromium (Cr):	1*	1*	1*	1*	1*	1*
Cobalt (Co):	1*	1*	1*	1*	1*	1*
Copper (Cu):	11	1*	7	6	8	7
Iron (Fe total):	6600	98	51	110	220	150
Lead (Pb):	5*	5*	5*	5*	5*	5*
Manganese (Mn):	440	5	1*	1*	8	5
Molybdenum (Mo):	9	9	7	5	4	6
Nickel (Ni):	3*	3*	3*	3*	3*	3*
Titanium (Ti):	10*	10*	10*	10*	10*	10*
Vanadium (V):	5*	5*	5*	5*	5*	5*
Zinc (Zn):	40	19	17	15	25	30

* less than figure stated:

The undersigned certifies that the above is a true and accurate report of the findings of this Laboratory.

[signature]

TABLE 2 -

R. THORUP

Elsewhere in South County, five wells in Hames Valley each produce between 3,000 and 4,000 gpm of high quality water and four wells in Jolon-Lockwood produce between 1,500 and 2,000 gpm. The water is suitable for all crops.

Plate No. 3 is an isopach (thickness) map of the net unused thickness of Paso Robles below the 400 foot (Member B). It covers an area of 200 square miles between King City and Moss Landing. Assuming an average thickness of 300 net feet, and a porosity of 28% (as determined by the sidewall samples) the amount of pore space in acre-feet available for groundwater is 10,752,000 acre-feet. This compares favorably with the figure of 12,000,000 acre-feet which appeared in my report to the Ad Hoc Committee. There, I used 500 feet for the net thickness and 20% for the porosity. The amount as calculated for this report is considered to be conservative.

RECHARGE

Recharge is available to the Paso Robles formation from the Salinas River in the King City area and from the Arroyo Seco River in the Arroyo Seco Cone, as shown on Plate 3, and Cross-Sections A-A', E-E', and F-F'. At King City, the lower beds rise in structure and are truncated by the alluvium. At Arroyo Seco, the Paso Robles formation dips to the east beneath the Arroyo Seco Cone, where the truncated, upturned edges are in contact with the alluvium.

Additional, but smaller recharge is believed to occur along the easterly edge of the Sierra de Salinas. The runoff from this side of the range disappears beneath the fans, which are barren of water. It is suspected this runoff works its way down into the upturned edges of the easterly dipping Paso Robles formation which underlies the fan.

PLIOCENE

Pliocene strata underlie at least 100 square miles of the Salinas Valley and can be found in outcrop in many places in Monterey Bay. The strata in the Project Well are 427 feet thick and consist of fossiliferous, fine to medium grained marine sand, deposited near shore but containing freshwater. The average permeability, as determined from six side wall samples, is 763 millidarcies, and the average porosity is 29.3%.

The quality of the water in the Project Well suggests it could be successfully co-mingled with the water in the Paso Robles. However, in wells 5 and 10, the freshwater - saltwater contact appears to be within the formation. This suggests seawater intrusion would spread vertically as well as horizontally, if overpumped near the coast.

This formation outcrops in the Corral de Tierra - Laguna Seca areas where wells produce 650 gpm of freshwater in the 700 ppm range. The water generally has to be treated for removal of iron and manganese. Yields are insufficient for large-scale irrigation or municipal use.

In the King City - Greenfield area the formation is not used for irrigation. Electric Logs indicate a brackish quality in many of the wells.

In summary, the Pliocene sand showed satisfactory quality and thickness, but relatively low permeability in the Project Test Hole. It might yield as much as 500 gallons per minute which could be commingled with water from the Paso Robles.

NON WATER BEARING FORMATIONS

These formations include Monterey shale (Tm) and basement rocks (Mu). Small quantities of water for domestic needs can frequently be found in these formations in areas of outcrop, but their subsurface capabilities for providing freshwater are nil.

26

STRUCTURE

The Salinas Valley is a long, narrow coastal valley trending northwest-southeast, terminating to the north in Monterey Bay, and extending southwards for 75 miles to Wunpost, 5 miles south of San Ardo. The Gabilan Range borders the easterly side and the Sierra de Salinas the westerly.

Sedimentary strata outcrop along the edges of the valley at the north and south ends, but are virtually absent in the central portion. Here, the bordering alluvial fans extend to the basement contact and cover the entire valley floor.

Surface exposure of older sedimentary rocks dip easterly into the valley north and south of the Arroyo Seco and form the westerly flank of a large syncline which extends from King City almost to the ocean, for a distance of 50 miles. The syncline is asymmetrical, as shown in the cross-sections and is underlain by a thick section of Paso Robles, and possibly older formations. Available geological data suggests that the basement is much deeper along the west side than the east. The older sediments are overlapped by younger deposits in this direction. Evidence for shallow basement on the east side can be found in numerous water well logs.

In the Monterey Bay area the seismic surveys

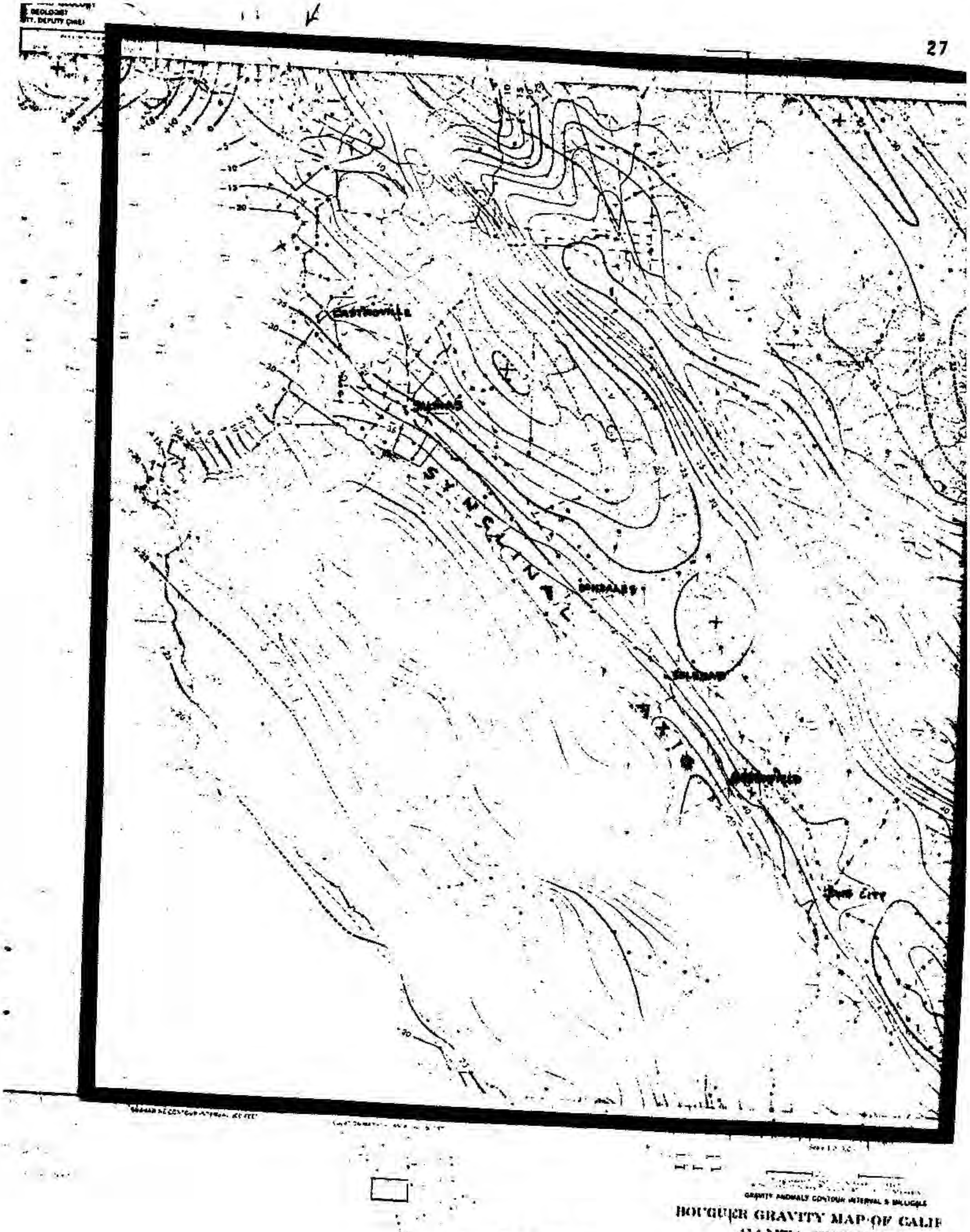
SYNCLINAL AXIS
CASTROVILLE
SALINAS
GONZALES
SOLEDAD
GRAVITY ANOMALY CONTOUR INTERVAL 5 MILLIGALS
BOUGUER GRAVITY MAP OF CALIF
SANTA CRUZ SHEET
ILATION BY CHARLES C. BISHOP AND RODGER H.

Figure 2.

undertaken by the USGS, under the supervision of H. G. Greene, show the geologic structure adjoining the coastline to be flat and relatively undisturbed.

The most prominent fault in proximity to the valley floor lies along the westerly edge at the base of the Sierra de Salinas Mountains. This steep scarp-like mountain front is bounded by the King City - Reliz fault. Tinsley (13) notes the presence of several small scarps in the vicinity of the mountain front, which suggest possible fairly recent movement. Seismic activity has also been recorded.

The fault as mapped by Dibble is a fault zone containing several branches. No evidence for faulting can be found north of Spreckels, though the extension of the Reliz - King City fault is shown on many maps as extending to Monterey Bay. The so-called Gabilan Fault of the D.W.R. (5, 6) is one such example.

If there is a branch of this fault system crossing the Salinas Valley, it does not appear to act as a barrier to the migration of groundwater.

SUBSIDENCE

Questions have been raised as to whether a withdrawal of groundwater for the Castroville Project will be apt to cause subsidence. My considered opinion is that it will not, for the reason that recharge will occur and replace the pumpage. This will be particularly true in the Marlhart area, where thick permeable sand and gravel beds occur and are fed from upstream recharge.

CONCLUSIONS

The Castroville Irrigation Project Test Hole produced the following results:

1. Freshwater, sands and gravels of the Paso Robles formation were found to be present to a depth of 1250 feet. Below this point, finer grained freshwater sands of marine origin occur to a depth of 1675 feet, where they rest on Monterey Shale.

2. By comparison with other aquifers and other areas, the test well area does not appear to have the necessary thickness of coarse material in the aquifers to be able to produce the large amount of water necessary for the project, particularly so at anticipated peak demands.

3. The drilling of the test hole at this location was done to see if the Service Area could provide groundwater from within its own borders from the deep zone to fulfill the requirements of the area. It is my opinion that although some irrigation wells will probably be developed from this zone in this area, the likelihood of a large enough capacity for a well field consisting of nine 3,000 gpm wells is not a reasonable expectation.

RECOMMENDATIONS

It is hereby recommended that no further test drilling be done in the Castroville area for the Castroville Irrigation Project. The project should be moved to the area in proximity to the Marihart No. 1, and a well be drilled, electrically logged, sidewall sampled, cased and test pumped. If the well capacity and water quality are acceptable, a well field should be developed and plans made to supply the Castroville area with water from the deep zone below the 400 foot aquifer.

Anticipated interval of perforation is 780 - 1500 feet and anticipated production is 3500 gpm.

Surface casing should be cemented to a depth of 780 feet, plus or minus, depending on the information gained from the electric log.

Details for the drilling and production should be carefully considered before incorporation into a set of specifications. Items such as type of rig, log, casing, perforation, tests, sidewall samples, etc., are all matters for consideration and concern, and should be decided by consultation between Dr. Mann, the Flood Control Office and Mr. Thorup.

Respectfully submitted,

Richard R. Thorup

Richard R. Thorup
Consulting Geologist
Monterey, California

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APPENDIX A

HISTORY AND BACKGROUND OF CASTROVILLE IRRIGATION PROJECT *by Monterey County F.C. & W.C.D.*

CASTROVILLE IRRIGATION PROJECT

Since the early 1940's the Castroville Area has been subjected to increasing sea-water intrusion of the underground aquifers due to heavy pumping overdrafts. The project, as proposed by the Monterey County Flood Control and Water Conservation District, was designed to alleviate the local overdraft condition by providing an alternate source of water supply to the irrigated lands near Castroville.

The project consists of a pipeline distribution system that would transport water from the Salinas River at a point near the community of Spreckels to the service area. The service area would extend from Monterey Bay to within 3.5 miles of the City of Salinas and include 9,100 acres. During certain dry periods when water is not available from the river, supplemental water would be drawn from a well field near the river intake.

In January of 1974 drafts of a loan application report and an environmental impact report for the Castroville Irrigation Project were completed and were circulated through the State Clearinghouse and all interested agencies for their review and comments. After the review period and the comments were received, the reports were to be finalized and submitted to the U.S. Bureau of Reclamation as a loan application report under Public Law 984. Under this law,

34

with approval of the application, the Bureau could furnish financing, a large portion interest free, for the project.

However, during this review process, opposition to the project arose due to the location of the well field in the Blanco-Spreckels Area. Fears were expressed that pumping from this well field would adversely affect the wells in this area. Other objections to the project were the point of diversion in the Salinas River and the route of transmission.

On July 1, 1975, the County Board of Supervisors appointed an Ad Hoc Committee to evaluate and study the project which had now become controversial. The Committee members were selected from each interested agency and group. Early in the Committee's work it was decided that the discussion should be broadened to consider the water problems of the entire valley since they are interrelated.

Immediate valley problems were identified and on September 19, 1975 the Committee considered eight alternative solutions presented by Sanford Koretsky of Koretsky King Associates. The alternatives included various ways and combinations to supply water to the Castroville and the East Side Areas. Insofar as the Castroville Area was considered, after due consideration the Committee chose the alternative which most closely agreed in scope with the original project plan.

It was thought by the Committee that the greatest single objection to the plan (the well field) could be removed by placing the wells in the Arroyo Seco Cone Area where there is a bountiful supply of water in an aquifer that is readily recharged. At subsequent public meetings, however, this alternative met considerable resistance. Landowners in the Arroyo Seco Area expressed the same fears as did those in the Blanco-Spreckels Area. It became obvious that alternative water supplies would have to be considered. One of the most promising was the possibility that a usable supply of water exists below the 400-foot aquifer in the Salinas Valley.

On November 28, 1975, Dr. John Mann, hydrogeologist, recommended to the Ad Hoc Committee that a deep test hole be drilled within or adjacent to the service area for the Castroville Project (Zone 6 of the Monterey County Flood Control and Water Conservation District). He further recommended that Mr. Richard Thorup be retained as hydrogeologist to oversee the sampling and logging of the hole. All pertinent information, including the information obtained from the deep test hole, would be studied to determine the best location for a production well. Based upon the performance of the production well the Castroville Irrigation Project would again be reevaluated to determine if water from the deep aquifer could be used totally or as a supplemental supply for the project.

36

SALINAS VALLEY SUB-AREAS

The original five sub-areas were delineated by the State Department of Water Resources for a Salinas Basin Investigation conducted in the late forties. These divisions of the Salinas Valley were made for study purposes and are not to be confused with sub-basins. All information indicates that they are hydrologically interconnected.

The Pressure Area extends southerly in a strip from Monterey Bay to Spence, covering a width of about 4-3/4 miles. The aquifers in this area are largely confined to clay layers. These clay layers effectively prevent percolation to the groundwater from direct precipitation or from the Salinas River Channel. The aquifers in the Pressure Area are supplied primarily by recharge from the upstream Forebay Area.

The East Side Area extends from the vicinity of Santa Rita to Gonzales, along the east side of the Salinas Valley, and is roughly bounded by the foothills of the Gabilan Mountains and Highway 101. The sources of groundwater replenishment are percolation from the small streams that flow from the Gabilan Range and percolation in the Salinas River. To a lesser degree, some recharge comes directly from rainfall.

The Forebay Area extends approximately from Spence