

**GROUND WATER RESOURCES  
OF THE  
RICHGROVE AREA**

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**November 15, 1955**

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## GROUND WATER RESOURCES OF THE RICHGROVE AREA

### Introduction

This report has been prepared at the request of the Rag Gulch Water District for the purpose of analyzing and evaluating the ground water resources of the Richgrove area. While the Rag Gulch Water District has access to secondary waters from the Kern-Friant Canal, and its members have in the past secured ground water from relatively shallow sources, present trends of water demand for agriculture in this area make it apparent that additional reserves should be sought and evaluated. While numerous exploratory oil wells have been drilled in the southern part of the Richgrove area in past years, only recently have the possibilities of deeper ground water sources been recognized. The first water well to produce agricultural water from deeper sands was the H. M. Holloway, Inc. Water Well #1 in Section 8-T25S-27E, which was converted to water well use from an exploratory oil well drilled by the Western Gulf Oil Company. Within the past year six water wells have been drilled or deepened to new potential water sands in the area. While this number of wells to the new water source are not sufficient to fully evaluate all aspects of

the deeper water resource, the general performance and conditions can be delineated and the problems and method of development can be closely defined.

Exploratory oil wells drilled in the area indicate that other potential reservoirs may exist in this region.

It is the purpose of this report to set forth all presently known conditions and problems of the new deeper water reservoir and to delineate the possibilities of other ground water sources.

The area covered by this report is contained within Township 24 South, Range 27 East; the easterly portion of Township 24 South, Range 26 East; the westerly portion of Township 24 South, Range 28 East; and the northerly portion of Township 25 South, Range 27 East. The greatest density of water wells and exploratory oil wells have been drilled in the southerly portion of Township 24 South, Range 27 East and northerly portion of Township 25 South, Range 27 East, and therefore the best control of subsurface water conditions is obtained in this area. However, sufficient wells have been drilled in the remaining area to generally interpret subsurface conditions throughout the area considered. It should be pointed out, however, that the area has experienced to date a rather sparse and unplanned water development program as compared to many areas in the State which have been reported on by such agencies as the United States Geological Survey, the United States Bureau of Reclamation and the State Division of Water Resources.

## Geology

Stratigraphy - A thorough knowledge of the stratigraphy of the area is particularly important in evaluating ground water resources because most of the formations described hereafter extend continuously over the entire area. By the recognition of a particular sand formation and variations in its character and water content, a well planned and orderly exploitation of its water resources can be obtained.

The geologic section in the area is composed of the following readily recognized stratigraphic units (for reference see attached cross section):

### Surface sands and gravels.

Kern River Formation - The Kern River Series consists of a continental or land-laid section of sands, gravels and clays approximately 1800' thick in the westerly area, thinning to less than 700' in thickness on the east margin of Township 24 South, Range 27 East. The sands contained in this section are lenticular and discontinuous and for this reason are not highly conductive to ground water over large areas. This section has been extensively drilled for water and at the present time may be considered to be economically depleted in the south portion of Township 24 South, Range 27 East and the northwesterly portion of Township 25 South, Range 27 East.

Chanac-Santa Margarita sands - From the standpoint of water resources these two sands are essentially a single unit within

the area covered by this report. This sand section is mostly marine in character in the western part of Townships 24 and 25, South, Range 27 East and gradually grades to land-laid sands eastward. It exists as a 400-420' thick body of porous and permeable sand extending continuously over the west portion of Townships 24 and 25 South, Range 27 East, thinning to about 200' in thickness in the central region of the townships. As the sand grades eastward into continental deposition, the sandy phase becomes lenticular and less porous and permeable, and grades upward into and is indistinguishable from the overlying Kern River section.

The attached cross section shows that in Section 33-25S-27E and eastward a 70' thick sand develops at the base of the main Santa Margarita sand and to the east becomes the most porous sand of this section. This lower sand is well developed east of a line from the center of Section 13-25S-27E through the center of Section 28-24S-27E.

Round Mountain silt - The Round Mountain silt is an impervious siltstone and shale section approximately 200' thick in the western area. This siltstone extends continuously over the entire area, but thins eastward to about 60' in thickness on the east side of Townships 24 and 25 South, Range 27 East. It is an effective barrier to water between the Chanac-Santa Margarita sands and the Oloese sand below.

Olcese sand - The Olcese sand section is present throughout the district, but not everywhere as a continuous sand body. West of Section 8-25S-27E and to the northwest the Olcese is a solid sand body nearly 300' thick with good porosity and permeability. East of Section 8 the lower 200' of the Olcese becomes lenticular and the lenticular sands are less porous and permeable than the sands to the west. The upper 100' of the Olcese extends as a continuous sand body from the west margin of Townships 24 and 25 South, Range 27 East to the central area of the townships. Eastward the entire Olcese section is composed of lenticular sands and silts, the sands having generally somewhat less porosity and permeability than to the west. At the east margin of the townships the total thickness of the section is about 250'.

Freeman-Jewett silt - Below the Olcese sand lies the Freeman-Jewett silt which in the western area is about 350' thick. In this area it is an impervious silt and an effective water barrier. The Freeman-Jewett section thins continuously to the east and is about 100' thick in the east margin of Townships 24 and 25 South, Range 27 East. In Section 34-24S-27E and eastward, the Freeman-Jewett silt becomes essentially a solid sand phase which is nearly indistinguishable from the Pyramid Hills sand lying below. In the eastern portion of Townships 24 and 25 South, Range 27 East the Freeman-Jewett

section is a good potential water source.

Pyramid Hills-Vedder sands - These sands may be treated as a single unit in considering their water potential, although the Vedder sand does not extend to the east margin of the area. The Pyramid Hills sand is a porous and permeable sand varying in thickness from 100' to 150' and extending continuously over the entire area. The Vedder sand is a porous and permeable sand extending over the entire area west of an irregular line from the center of Section 13-25S-27E to the northeast corner of Section 22-24S-27E. It thickens from this east margin westward to a sand body over 400' thick along the west margin of the townships. From the apparent similarity of water character in the two sands as evidenced by electric log interpretation, it appears that the two sands are pressure-connected to the east and possibly along some zones of faulting. It is for this reason that it is believed that they may be treated as a single water source.

Walker - Below the Pyramid Hills-Vedder sands lies the Walker formation. In this area it exists as a land-laid deposit composed principally of a shaly silt with some lenticular sand stringers. In most of the district this section is essentially impervious to water. The thickness of the Walker varies erratically throughout the area from 30 or 40' to nearly 200'.

Basement - Basement is encountered directly below the Walker, and is principally a granite or granodiorite in the western area, and usually a slate in the eastern area.

Structure - The regional structure is a west-dipping monocline with a general direction of dip of S 70-80° W. The dip on the top of the Round Mountain silt (the base of the Santa Margarita sand) is approximately 300' per mile. The dip on the top of the Pyramid Hills sand is approximately 400' per mile. Numerous faults exist in the area with a principal north northeast trend. One major fault cuts the area with a northwest trend.

The attached map shows subsea structural contours on the top of the Round Mountain silt (equivalent to the base of the Santa Margarita sand). The map also shows the principal faults which can be presently delineated in the area. Control for the location and trend of these faults was interpreted from subsurface and seismic data and aerial photography. It appears that some of the faulting may be caused by compaction slumping, in that in some instances the faults appear to decrease or die out with depth. The effect of faulting on ground water movement in the area is not presently known, but it is probable that the faults with larger displacements, such as the one trending northwest from Section 35-24S-27E, have a pronounced effect on the movement of ground water. With a planned development of the Chano-Santa Margarita sand, the movement of ground water relative to faulting can be determined and future wells can be so located as

to take advantage of this knowledge.

#### Ground Water Sources

The ground water sources of this district are herein considered under two classifications: (A) Those formations or sands which are known to produce adequate quantities of water suitable for agricultural purposes; and (B) those formations or sands which would appear to be potential sources for agricultural water, but whose capacity to produce and whose water qualities have not yet been established.

Formations which are known to be capable of producing agricultural water are:

1. The Kern River formation
2. The Chanac-Santa Margarita sands.

Formations which are believed to be potential sources for agricultural water are:

1. The Olcese sand
2. The Pyramid Hills-Vedder sands.

The characteristics of each of the above sources are described in the following text.

#### Kern River Formation

This formation has been the principal water source in the region for many years. In the northwestern part of Township 25 South, Range 27 East, extensive exploitation of these sands has depleted them to a considerable extent. To the north, where fewer wells have been

drilled, additional minor resources could be developed at depths of less than 1200'. However, because the sands are lenticular and the section does not contain large reserves, it appears economically advisable to drill the additional 1000' required to produce water from the Chanac-Santa Margarita sand.

In the east half of the township the sands are less porous and permeable to the extent that no adequate reserves could be developed from the Kern River formation in this area.

To the west of Township 24 South, Range 27 East, the Kern River formation contains more sands and these sands are fairly porous and permeable. Better water well performance and reserves can be obtained in this area.

#### Chanac-Santa Margarita Sands

Sand characteristics - The general character of this sand has been discussed under "stratigraphy" above.

The upper portion of the Chanac sands are non-marine or lenticular in character. As a result, each well drilled in the area will encounter different sand conditions in this interval and whether or not these sands are left open to production will depend on their development in that particular well. Because these sands are not pressure connected throughout the area, it is unlikely that they can effect any serious thieving from the main sand bodies underlying them which are open to the same well bore.

The main Chanac-Santa Margarita sand body is best developed along the west line of Townships 24 and 25 South, Range 27 East and is a continuous sand along this area. It can be fully penetrated in this area by wells 2200-2400' deep. About two miles east of this line the upper half of the sand becomes lenticular and less permeable and porous, and eastward from this trend only the lower 150 to 200' of sand extends as a continuous body.

Water source and movement - Water source and movement are usually determined from well data. While an insufficient number of wells have been drilled to the Chanac-Santa Margarita sands to measure pressure gradients and water movement, there is sufficient evidence at hand to deduce the source and general movement of water in these sands.

The Chanac-Santa Margarita sands extend continuously over the entire area (confined above and below by impervious silts and shales) and rise eastward and grade into sandy formations which are exposed in a relatively topographically high region. These conditions are suitable to the filling and replenishment of the sands by surface waters.

There is evidence that a saline-fresh water contact exists along a margin running through Sections 8, 7 and 18-25S-27E. The deep Setrakian well drilled to the upper portion of the Chanac-Santa Margarita sand in Section 1-25S-26E encountered salt water in these sands. The lower half of the sand in the Pandol well in Section 18-25S-27E appears to be slightly saline on the electric log, and this increase in salinity was confirmed by laboratory test of sidewall

samples. All wells to the east contain fresh water in the Chanac-Santa Margarita sand.

Since these sands in this area were originally deposited as marine sands, they at one time contained salt water. The fact that they are now filled with fresh water is evidence that ground water movement has occurred. It can be reasoned that in the topographically higher area to the east, rainfall and stream seepage have fed fresh water into these sands at a sufficient elevation to exert a westward hydraulic gradient in the sands. These waters have moved downstructure and flushed the saline waters westward.

The saline-fresh water contact in the area of Sections 6, 7 and 18 probably represents the west margin of such flushing of the Chanac-Santa Margarita sands. It should be pointed out, however, that there has not been a sufficient number of wells drilled immediately to the north and west of this locality to closely delineate this condition. Several exploratory oil wells drilled seven to ten miles to the northwest in Township 24 South, Range 26 East and Township 23 South, Range 25 East indicate that this saline-fresh water contact extends generally to the north-northwest from Section 18-25S-27E.

Extreme caution should be exercised in the location and drilling of Chanac-Santa Margarita wells to the north and west from Section 18 to avoid the drilling of wells with a harmful salt content.

While it is known that the general movement of ground water is to the west, localized effects due to faulting are at present unknown.

Because the Kern River formation is composed principally of lenticular sands and therefore does not freely conduct water or pressure changes over any extensive area, the performance of the many wells drilled into this section does not readily measure pressure or water movement barriers. Therefore, no knowledge as to the presence and location of faulting nor its effect on ground water movement can be gained from the performance of these wells.

Although the Chanac-Santa Margarita sands are quite permeable and extend over the entire area and therefore are capable of readily transmitting pressure changes or indicating the presence of pressure barriers, only a few wells have been drilled in a short period of time and no planned fluid level data have been obtained from these wells. As a result, the effect of faulting on ground water movement in these sands is not presently known. With a planned program for obtaining fluid level readings and water withdrawals, the degree to which faulting affects ground water movement can be determined. This knowledge would be of considerable value in determining the best areas for water withdrawal.

Quality of water - Chemical analyses of water samples from only four Chanac-Santa Margarita wells have been obtained to date. While this represents a limited amount of data, some important problems of water quality are revealed.

The samples confirm the presence of the saline-fresh water margin in the area of the Pandol well in Section 18-25S-27E. The

Pandol well has a theoretical NaCl content of 606 p.p.m compared to 27, 152 and 187 p.p.m for the other three wells, one located to the north and the other two to the east.

Examination of the samples shows that in addition to the westward increase in salinity, there appears to be a westward increase in boron content. Both the Pandol well and the Zaninovich well in Section 8-25S-27E tested 0.9 p.p.m of boron, while the Holloway well in Section 8-25S-27E tested 0.55 p.p.m and the Thomas well in Section 32-24S-27E tested 0.15 p.p.m. It appears that as much consideration should be given to the critical boron content margin of these sands as to the saline margin. The precise effect of boron content on different crops in the area is not readily determined. Subsoil drainage is probably the most important factor affecting the build-up of harmful amounts of boron in the soil. Where drainage is good, it is possible that a boron content of 1.5 p.p.m could be tolerated for an indefinite period of time by tolerant crops. Probably for the development of safe water resources wells should be so located and confined in this area that the boron content is less than 0.8 p.p.m wherever practicable.

Generally, the other characteristics of the water are favorable for agricultural purposes, except that the water, like most other ground water in the San Joaquin Valley, is somewhat too soft for the maintenance of good soil texture.

Water reserves - Several methods exist by which the water resources of an area can be estimated, but all which are quantitatively reliable

depend on well performance data. Since development of the Chanac-Santa Margarita has only recently been initiated and there is no historical background of well performance, the writer attempted without success to determine by two primary methods an approximation of the reserves and performance to be expected from these sands.

In the first method, considering the Chanac-Santa Margarita sand as an aquifer or conduit, an investigation of stream flow run-off in the White River was made. The principle of this method is that any stream flow loss or seepage in the area of porous formations connected to the Chanac-Santa Margarita sand would be a measure of the replenishment rate of the Chanac-Santa Margarita at depth. The United States Bureau of Reclamation has made stream flow measurements along the White River as follows:

<u>Year</u>	<u>Station</u>	<u>Location</u>	<u>Elevation</u>
1911-15	Near Hot Springs	--	5200'
1944-47	Ducor	Sec.27-24S-28E	680'
1944	Upper Station	Sec.27-24S-28E	680'
1943-47	South of Ducor	Sec. 4-24S-27E	500'
1943-47	Kern-Friant Canal	--	400'

The location of these stations was such that seepage losses between any two stations would not give a reliable indication of replenishment to the Chanac-Santa Margarita sand separately from other sands in the area. Therefore, no estimate of replenishment or recharge can be made by this method.

The second method was to attempt to estimate the amount of water that would have been withdrawn at the time the water standing

level in the area had been lowered some arbitrary amount such as one hundred feet. This method assumes that when the standing level has been lowered one hundred feet in the wells, that it will have been lowered one hundred feet in the source area to the east, providing no recharge takes place. If the volume of sand present in the source area lying within the one hundred feet interval of change is known, the volume of water produced by a one hundred foot drop in water level can be estimated. A thorough investigation of the source area revealed that no wells in which electric logs had been run have been drilled in the area. Without electric log data there is no way of estimating sand volume, and consequently of estimating water reserves by this method.

As a result, the more standard methods of estimating water supply by employing well performance data will have to be relied upon in the Richgrove area. It is strongly recommended that a program of methodical water level records be initiated immediately so a reliable interpretation of ground water supply from this source can be obtained at an early date.

#### Olcese Sand

The characteristics of Olcese sand development have previously been discussed under "Stratigraphy".

Based only on electric log interpretation, it appears that in the west area slight salinity might be encountered in the Olcese

sand. The bottom 100' interval has definite saline characteristics in the northwest area of Township 25 South, Range 27 East. The upper 100-150' of the Olcese appears to have excellent water possibilities throughout the area. Should the water characteristics of the Olcese prove satisfactory for agricultural purposes, it will prove to be an important water source for the area. Development in the area of Section 8-25S-27E to Section 19-24S-27E would require wells to 2800'. However, to the east in an area between Section 3-25S-27E and Section 16-24S-27E wells to only 1900-2000' would be required. The Olcese appears also to be a good source for water along the east margin of Townships 24 and 25 South, Range 27 East at depths of from 800' to 1200'.

In the central area of Townships 24 and 25 South, Range 27 East, the Olcese sands are an excellent potential water source to be developed at reasonable depths, provided water from this source is suitable for agricultural purposes.

#### Pyramid Hills-Vedder Sand

The general character of the Pyramid Hills-Vedder sands and the reason for their being considered as a unit is discussed above under "Stratigraphy".

The total Pyramid Hills-Vedder sand thickness in the northwest portion of Township 25 South, Range 27 East is nearly 600'. However, in this area the sand appears to contain definitely saline

water, according to electric log interpretation, and lies at excessive depths for present economic development as a ground water source.

Along a line from Section 10-25S-27E to Section 21-24S-27E the Pyramid Hills-Vedder sand could be penetrated by wells 2200-2400' deep. In this area electric log interpretation indicates that the contained waters should be fresh and suitable for agriculture purposes. Approximately 250' of solid sand section with good porosity and permeability is present.

Along the east margin of Township 24 South, Range 27 East the Pyramid Hills sand has excellent permeability and porosity characteristics. The sand is about 150' thick in this area and would be penetrated by wells 1400-1600' deep.

The Pyramid Hills-Vedder sand appears to offer excellent possibilities as a water source in the central area and east half of Townships 24 and 25 South, Range 27 East.

#### Future Development and Performance

In the Richgrove area there appear to be substantial ground water resources which have yet to be developed. The Chano-Santa Margarita sand has proved to yield good water wells with water suitable for agricultural purposes. The Olcese sand and the Pyramid Hills-Vedder sand in the eastern area should yield wells and resources of equivalent value.

The water reserves of the Chanao-Santa Margarita appear to be much larger than those of the shallower Kern River series in this area. Although an estimate of water supply to be derived from the Santa Margarita cannot be determined at this time, the initiation of a program of methodical water-level records will yield data by which an accurate estimate of future water supply can be made. Water levels are a function of pressure within the water sands and by interpretation of these pressures, which show pressure gradients, not only can the withdrawal and replenishment of the reservoir be estimated, but also the movement of the ground water. By a determination of the localized movement of ground water, the effect of certain types of faulting on this movement could be ascertained and wells could be so located with respect to faulting as to secure maximum performance and reserves.

The knowledge of ground water movement relative to withdrawal would be of particular value to those wells located near the saline-fresh water and boron boundary by indicating the effect of water withdrawal on the movement of this boundary.

In addition to the methodical recording of water levels, the annual withdrawal from each separate source to be developed should be known. This can be accomplished by estimates based on the power and fuel consumption of wells in this area. With a knowledge of the change in water level and the rate of withdrawal, the rate of replenishment of the various reservoir sands can be calculated, and the safe rate of

withdrawal from each can then be estimated. When an understanding of these functions is combined with an estimate of water withdrawal from the Kern-Friant Canal, the water resources and supply of the Richgrove district can be predicted for many years in advance. Toward this end, it is recommended that a program of water level records be initiated immediately.

Respectfully submitted,

November 15, 1956