STATE OF OREGON

WATER RESOURCES DEPARTMENT

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GROUNDWATER AVAILABILITY IN THE POWELL BUTTES AREA, CENTRAL OREGON

By

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CONCLUSIONS

Although the groundwater resource is somewhat limited naturally in the Powell Buttes area, there does not appear to be any serious groundwater supply problem as a result of current development. Based on water level measurements from 1981 to 1986 and comparison of measured water levels with those reported by drillers, there does not appear to be any significant groundwater level decline in the area.

The top of the regional groundwater system is at approximately 2700 feet elevation in the Powell Buttes area. (Land surface elevation on the Buttes ranges from about 3200 to over 5200 feet.)

Any aquifer in the Powell Buttes area producing from above approximately 2700 feet elevation should be considered to have only local recharge, which is limited. Therefore such aquifers should not be relied upon to support large scale development.

Wells drilled to depths below approximately 2700 feet elevation have the potential of obtaining a large supply of water from the regional groundwater system. Finding sufficient permeability, however, has proven difficult. Since most development has occurred at surface elevations ranging from 3200 to 3700 feet, well depths required to tap the regional groundwater system would have minimum depths ranging from 500 to 1000 feet.

Upper water bearing zones in deeper wells (penetrating to below 2700 feet elevation) should be cased and sealed off to prevent drainage of perched aquifers by water flowing down-hole to lower aquifers.

Semi-annual groundwater level monitoring should be continued in the Powell Buttes area to track any problems which may develop in the perched aquifers.

There does not currently appear to be any reason to consider the Powell Buttes area for Critical Groundwater Area designation.

INTRODUCTION

In November of 1980, Crook County requested that the Oregon Water Resources Department conduct a hydrologic investigation of the Powell Buttes area in Central Oregon to determine if it should be considered for Critical Groundwater Area designation. The county's request was in response to a petition from property owners on the north flank of Powell Buttes who had experienced a variety of well problems and were concerned about potential additional stress on the groundwater supply by proposed development. In response to the request, the Water Resources Department held an informational meeting in January 1981 to present the current knowledge of the groundwater conditions in the area and to gather additional information from property owners in the area. It was determined by the Department that an investigation into groundwater conditions and possible water level declines was appropriate, and a study was initiated. This report represents the culmination of the investigation.

The investigation started with the locating of wells in the area, and the establishment of a network of observation wells to monitor water level changes with time. Data from the network were used to create a water level map. The geologic aspects of the groundwater system in the area were studied through published reports and well log information with minor field reconnaissance. Climatological information was reviewed with regard to its effect on groundwater recharge. Water use was estimated from water well reports and water rights records.

The report summarizes the general geography and geology of the Powell Buttes area, summarizes the groundwater occurrence in the major geologic units, and presents an interpretation of the regional and local groundwater systems. This report was generated primarily as an internal document of the Water Resources Department for the purpose of summarizing current knowledge of the area. Therefore, the technical level of the material contained herein was not targeted for a particular audience and varies somewhat between sections as a function of the type and amount of information available. It is hoped, however, that the information is presented in such a manner that it will be useful to land use planners, as well as informative to residents of the Powell Buttes area.

ACKNOWLEDGMENTS

This report is the culmination of the time and effort of many individuals. Fred Lissner established the network of observation wells. Lauren Forcella collected much of the water level data and compiled other information, including water use and well data. Duane Clark, Assistant Watermaster for District 11, collected most of the water level data. Very useful critical reviews of this report were provided by Fred Lissner, Donn Miller, Ralph Patt, and Bob Main of the Oregon Water Resources Department, and Larry Chitwood of the Deschutes National Forest. The friendliness and enthusiasm of the landowners in the Powell Buttes area is greatly appreciated.

GEOGRAPHY

Powell Buttes are a cluster of isolated volcanic hills located in Central Oregon about 20 miles northeast of Bend and 10 miles southwest of Prineville (Figure 1). The Buttes and surrounding alluvial apron comprise approximately 50 square miles and rise to an elevation of 5225 feet, approximately 2000 feet above the adjacent basin floor. Powell Buttes are situated in the northern part of a broad relatively flat part of the Deschutes River basin, between the Cascade Range and Ochoco Mountains. Over the last several million years, this basin has received a thick accumulation of volcanic and sedimentary material, much of which has been derived from the Cascade Range to the west.

Land cover in the area is typical of the Central Oregon high desert: grassland with sagebrush, other low shrubbery and juniper trees. Powell Buttes and their alluvial apron have traditionally not been cultivated but have been used for grazing. The basin floor adjacent to Powell Buttes is used for either grazing or irrigated agriculture, depending on soil conditions. Much of the ground in the area is covered with relatively young basalt flows and is unsuitable for cultivation. The area north and east of Powell Buttes, east of the Dry River and west of Grass Butte, is largely irrigated. Irrigation water is mostly from the Central Oregon Canal. Relatively little groundwater is used for irrigation.

The elevation of the Deschutes basin around Powell Buttes ranges from 3200 to 3500 feet and slopes gently north to northwest. Powell Buttes rise to a height of 5225 feet, about 2000 feet above the adjacent basin floor. The major surface stream in the area is the Crooked River, which runs northward a few miles east of the Buttes, and flows generally westward, north of the Buttes. There are no perennial surface streams on or in the immediate vicinity of Powell Buttes. Several ephemeral streams flow off the Buttes and typically disappear into the surrounding alluvial fans. A major ephemeral stream, known as the Dry River, flows northward along the western edge of Powell Buttes. The dominant surface water feature in the immediate vicinity is the Central Oregon Canal, which carries water diverted from the Deschutes River near Bend. The canal ends near the Crooked River north of Powell Buttes.

The Powell Buttes area is high desert. Because of the rain-shadowing effect of the Cascade Range, the area does not benefit from the moisture and moderated temperatures provided western Oregon by the onshore flow of marine air. Therefore, the area is typically dry, with cold winters and hot summers. The closest meteorological stations are Redmond, Prineville, and Grizzly. Data from these stations are summarized in Table 1. Average annual precipitation is 10.5 inches at Prineville, 8.54 inches at Redmond Airport, and 13.2 inches at Grizzly (period of record 1951-1980). Data presented by Johnsgard (1963) indicates that most of the precipitation occurs at times of the year when enough potential for evaporation exists that only a very small amount of this water is available for groundwater recharge.

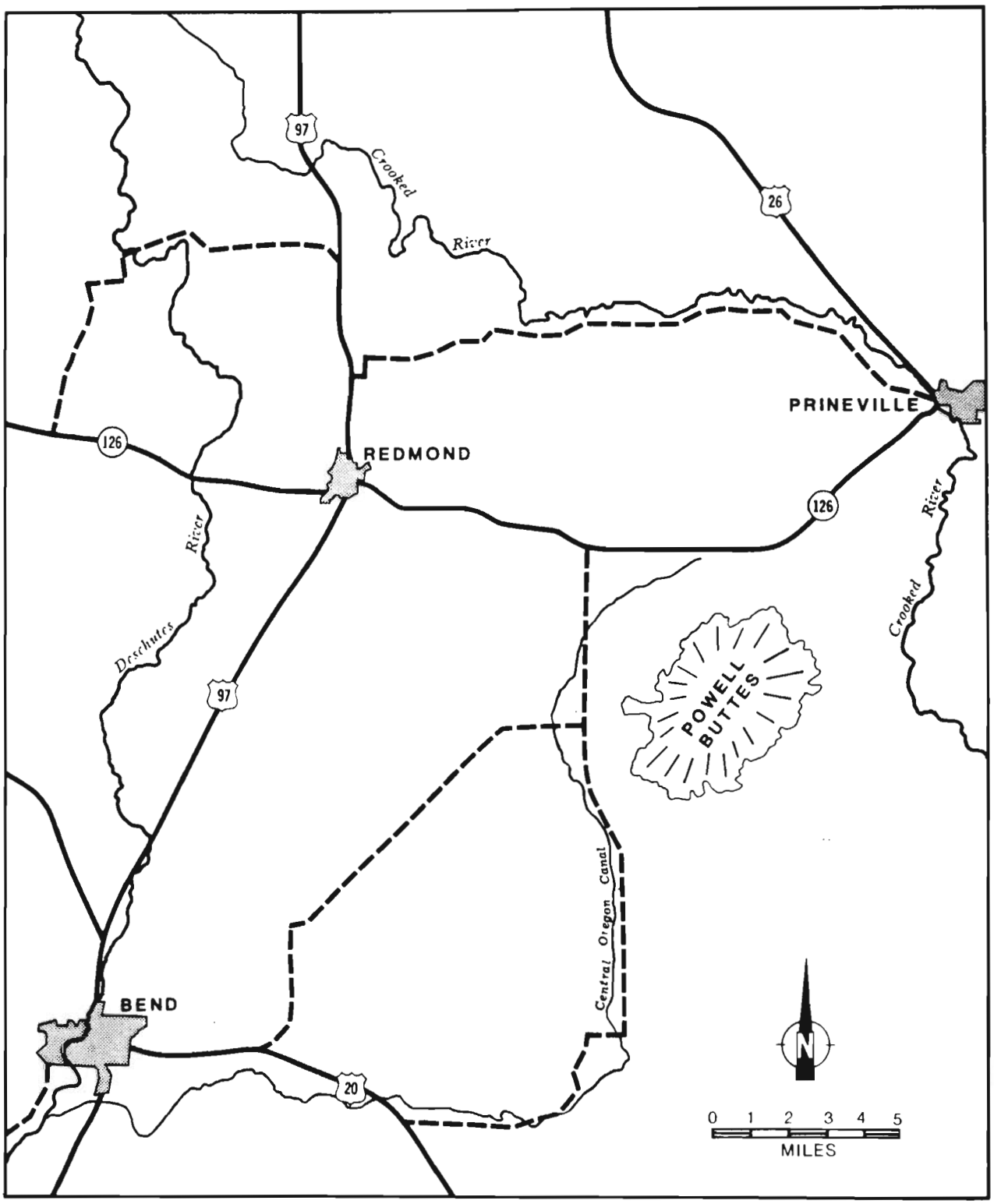

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Figure 1. LOCATION MAP OF THE POWELL BUTTES AREA

GEOLOGY

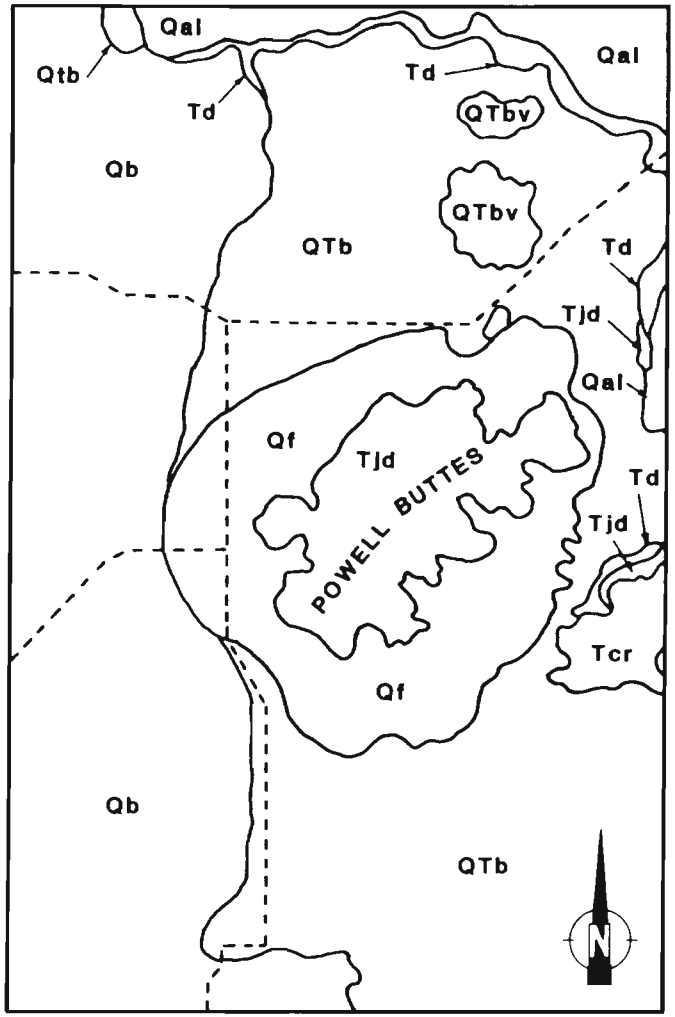
Powell Buttes and the surrounding area, like much of Central Oregon, consist chiefly of volcanic rocks and volcanic sediments. Powell Buttes are the eroded remnants of a complex silicic eruptive center thought to represent a source for many tuffs of the John Day Formation (Weidenheim, 1981; Swanson, 1969). The area around Powell Buttes is dominated by volcanic sediments and interbedded lavas and ash flow tuffs of the Deschutes Foundation. The geology of this part of Central Oregon has been studied by Russell (1905), Stearns (1931), Williams (1957), Sceva (1960, 1968), Wells and Peck (1961), Robinson and Price (1963), Swanson (1969), Walker (1977), Robinson and Stensland (1979), Brown and others (1981), Weidenheim (1981), Robinson and others (1984) and Smith (1985). Figure 2 is a simplified geologic map of the area, and Figure 3 is a schematic geologic cross section.

Powell Buttes comprises the oldest rock units exposed in the area, which are considered to be part of the John Day Formation of Oligocene to early Miocene age. Powell Buttes are a complex predominantly silicic volcanic pile consisting of domes and flows varying in composition from rhyolite and dacite to basaltic andesite, as well as epiclastic volcanic sediments, air-fall tuffs, ash-flow tuffs, and conglomerates (Weidenheim, 1981). This volcanic eruptive center is thought to represent the source for part of the John Day Formation tuffs, which occur over a large part of Central Oregon.

The John Day Formation lies unconformably on the Clarno Formation of late Eocene to early Oligocene age. The Clarno Formation is not exposed in the Powell Buttes Area, but undoubtedly occurs at depth. The Clarno Formation is described in adjacent areas by Swanson (1969) and includes predominantly andesitic flows and breccias, tuffs, mudflows, and other volcaniclastic debris, as well as numerous small intrusions. Brown and others (1981) encountered rock tentatively identified as Clarno Formation at a depth of 787 feet in the geothermal gradient hole "DOGAMI-Powell Buttes No. 1" (T16S, R14E, Sec 16 aba) on the west flank of the buttes.

Unconformably overlying the John Day Formation is the Columbia River Basalt of middle Miocene age. The Columbia River Basalt consists of a series of individual basalt flows 10 to 100 feet thick, with interbedded flow breccias and local sedimentary interbeds. The basalt occurs north and east of Powell Buttes, and is reported to be in excess of 800 feet thick in the Crooked River Canyon below Prineville Dam (Swanson, 1969). The Columbia River Basalt has a fairly limited occurrence in this study area, and is not considered an important aquifer here.

The most important unit in terms of groundwater in the study area is the Deschutes Formation of late Miocene to early Pliocene age. This Formation in the Powell Buttes area is primarily stratified volcanic sandstone, siltstone, and claystone, which is variably cemented and derived from waterlain reworked ash and tuffs (Swanson, 1969). Interstratified locally are deposits of fluvial gravels, conglomerate, and thin basalt flows. The Deschutes Formation was deposited unconformably on the eroded hills and valleys of the pre-existing volcanic rocks, so its thickness is quite variable. Swanson (1969)



KEY

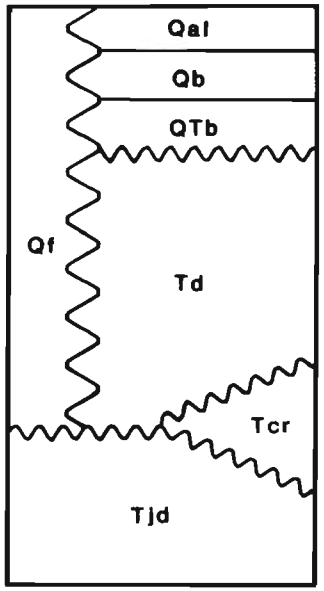
Qal	ALLUVIAL DEPOSITS IN THE CROOKED RIVER VALLEY
Qf	ALLUVIAL FAN DEPOSITS AROUND POWELL BUTTES
Qb	QUATERNARY BASALT FLOWS
QTb	QUATERNARY-TERTIARY BASALT FLOWS
QTbv	ERUPTIVE VENT DEPOSITS OF QTb
Td	DESCHUTES FORMATION AND EQUIVALENT VOLCANIC AND SEDIMENTARY DEPOSITS
Tcr	FLOWS OF THE COLUMBIA RIVER BASALT GROUP
Tjd	JOHN DAY FORMATION

GEOLOGIC CONTACTS

MAJOR ROADS

Geology from Swanson (1969) and Williams (1957)

See text for ages and descriptions of geologic units.



STRATIGRAPHIC RELATIONSHIP OF GEOLOGIC UNITS

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Figure 2. GEOLOGIC MAP OF THE POWELL BUTTES AREA

TABLE 1

SUMMARY OF CLIMATOLOGICAL DATA (1951-1980)

Prineville, Oregon

	Mean Temperatures			Mean Precip.
	Daily Max.	Daily Min.	Monthly Mean	
January	42.4	21.2	31.8	1.29
February	48.8	25.3	37.1	.83
March	53.3	25.1	39.2	.74
April	60.6	27.7	44.2	.63
May	68.8	34.6	51.8	1.10
June	76.6	40.3	58.5	1.04
July	86.4	42.5	64.5	.25
August	84.0	41.0	62.5	.57
September	77.7	35.2	56.5	.45
October	66.1	29.2	47.7	.77
November	51.5	44..4	38.7	1.41
December	44.4	22.7	33.6	1.42
Year	63.4	30.9	47.2	10.50

Redmond, Oregon

	Mean Temperatures			Mean Precip.
	Daily Max.	Daily Min.	Monthly Mean	
January	40.5	20.8	30.7	1.22
February	46.8	25.1	36.0	.70
March	51.5	25.4	38.5	.64
April	58.7	28.5	43.6	.46
May	66.7	35.0	50.9	.90
June	75.5	41.9	58.7	.83
July	85.5	46.6	66.1	.29
August	82.7	45.5	66.1	.57
September	75.5	39.3	57.5	.37
October	63.9	32.2	48.1	.55
November	49.5	26.9	38.2	1.04
December	43.0	23.1	33.1	1.06
Year	61.7	32.5	47.1	8.54

Grizzly, Oregon

	Mean Temperatures			Mean Precip.
	Daily Max.	Daily Min.	Monthly Mean	
January	39.7	21.4	30.6	1.60
February	44.9	25.2	35.0	1.06
March	48.6	25.0	36.8	1.07
April	55.7	27.6	41.7	.92
May	63.7	33.4	48.6	1.51
June	72.5	39.4	56.0	1.19
July	82.2	43.2	62.7	.28
August	79.9	42.6	61.3	.65
September	72.9	38.1	55.5	.69
October	61.7	32.3	47.0	.95
November	48.3	27.4	37.9	1.57
December	42.4	23.9	33.1	1.63
Year	59.4	31.6	45.5	13.12

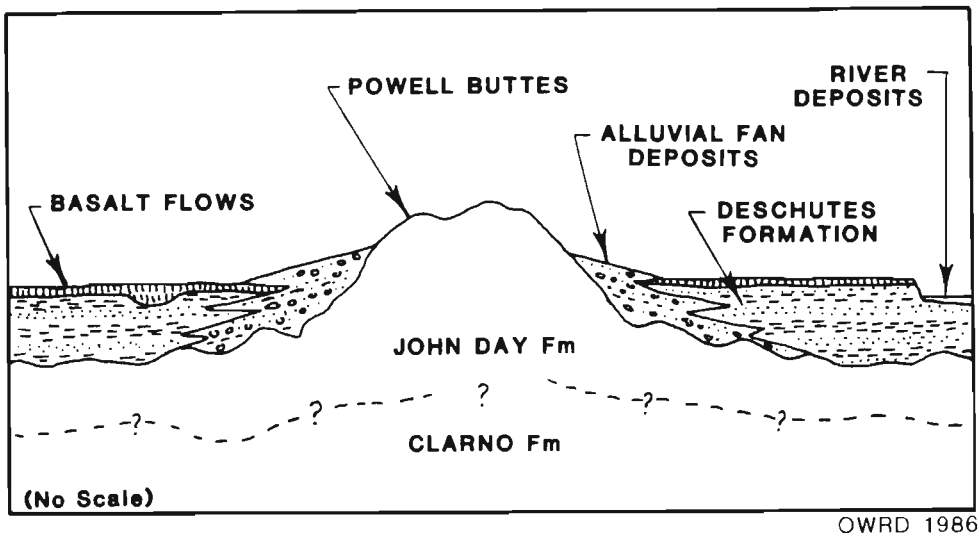

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Figure 3. SCHEMATIC GEOLOGIC CROSS SECTION OF THE POWELL BUTTES AREA

reports that it can be in excess of 300 feet thick south of the Crooked River in the Powell Buttes area. The base of the Deschutes Formation is tentatively placed 787 feet below the land surface in the lithologic log presented by Brown and others (1981) for DOGAMI-Powell Buttes No. 1. Sterns (1931) mentions a thickness of Deschutes Formation in excess of 1000 feet in the Deschutes River Canyon.

In the Powell Buttes area, the Deschutes Formation is covered by a layer of basalt, averaging about 150 feet thick. The basalt includes two major sequences. The older series (QTb of Figure 2), thought to be of Pliocene age, is described by Swanson (1969) as largely diktytaxitic olivine basalt, with single flows 10 to 30 feet thick. They are poorly columnar, with brecciated lower portions and rubbly, oxidized, scoriacious upper surfaces. The flows are somewhat eroded, but major flow features are still visible. This unit is generally less than 100 feet thick in the Powell Buttes area. Williams (1957) reports these basalts erupted from the Cascades; however, Swanson (1969) indicates that there are local sources for some of these flows. Swanson considers Grass Butte and Myers Butte, which are small eruptive centers north of Powell Buttes, to be vents which produced some of this lava.

The second lava series (Qb of Figure 2) is younger and occurs to the west and northwest of Powell Buttes. This unit is described by Swanson (1969) as a "... thin flow of diktytaxitic, non-porphyritic, olivine-bearing basalt." This basalt is considered of Pleistocene age. Williams (1957) reports that this lava erupted from fissures near the base of Newberry Volcano.

Alluvial fan deposits surrounding Powell Buttes are another important geologic unit. These thick deposits represent the accumulation of clastic material which has eroded from the Buttes during the last several million years. This material interfingers with the Deschutes Formation and probably extends to the base of the Deschutes Formation. This ancient alluvial debris could technically be considered part of the Deschutes Formation since the Deschutes Formation probably includes some clastic debris from non-Cascadian sources on its periphery. However, because this material appears to be texturally distinct and has an identifiable source, it is considered separately for this study.

GROUNDWATER

Previous Work

No groundwater studies dealing specifically with the Powell Buttes area have been published to date. There are, however, a few groundwater reports which include the larger region around Powell Buttes or deal with nearby areas.

Stearns (1931) reported on an eight-township area along the Deschutes and Crooked Rivers north of Redmond. This area does not include Powell Buttes, however, many of the major geologic units discussed occur in both areas. Sceva (1960) summarizes the groundwater resources of the entire Deschutes River Basin and provides information on the regional groundwater flow through the Powell Buttes area. Robinson and Price (1963) discuss groundwater in the Prineville area and, while their report does not include the Powell Buttes area, it deals with many of the same geologic units. Sceva (1968) addresses the groundwater in a large part of the Central Deschutes Basin as it relates to sub-surface disposal of liquid waste.

Groundwater Occurrence in the Powell Buttes Area

Groundwater conditions in the Powell Buttes area are variable and complex. The occurrence of groundwater is a function of many factors including the permeability and porosity of each geologic unit, and the location of that unit within the hydrologic system. Numerous aquifers have been developed in the Powell Buttes area. These various aquifers will support different levels of development.

Groundwater can occur in either local or regional flow systems. The type of flow system in which groundwater occurs has important implications for development potential. Local flow systems develop at relatively shallow depths and include relatively small areas. Local flow systems typically rely on local precipitation for recharge. In dry areas, local precipitation may not provide adequate recharge to sustain even modest development. Local groundwater flow systems may include perched aquifers. Perched aquifers can develop where downward percolation of water is impeded by a geologic layer with low permeability. The water which can no longer move downward saturates the porous materials above the low permeability layer creating an aquifer. Perched aquifers can be of limited volume and easily depleted.

Regional flow systems, on the other hand, include deep groundwater which may flow for many tens or even hundreds of miles underground. Regional groundwater flow systems receive recharge over very large areas. Even modest recharge over a very large area can represent a tremendous volume of water. Aquifers which produce water from within a regional flow system are likely to represent a reliable long-term supply of water if properly managed.

The best information currently available on the regional groundwater system in the

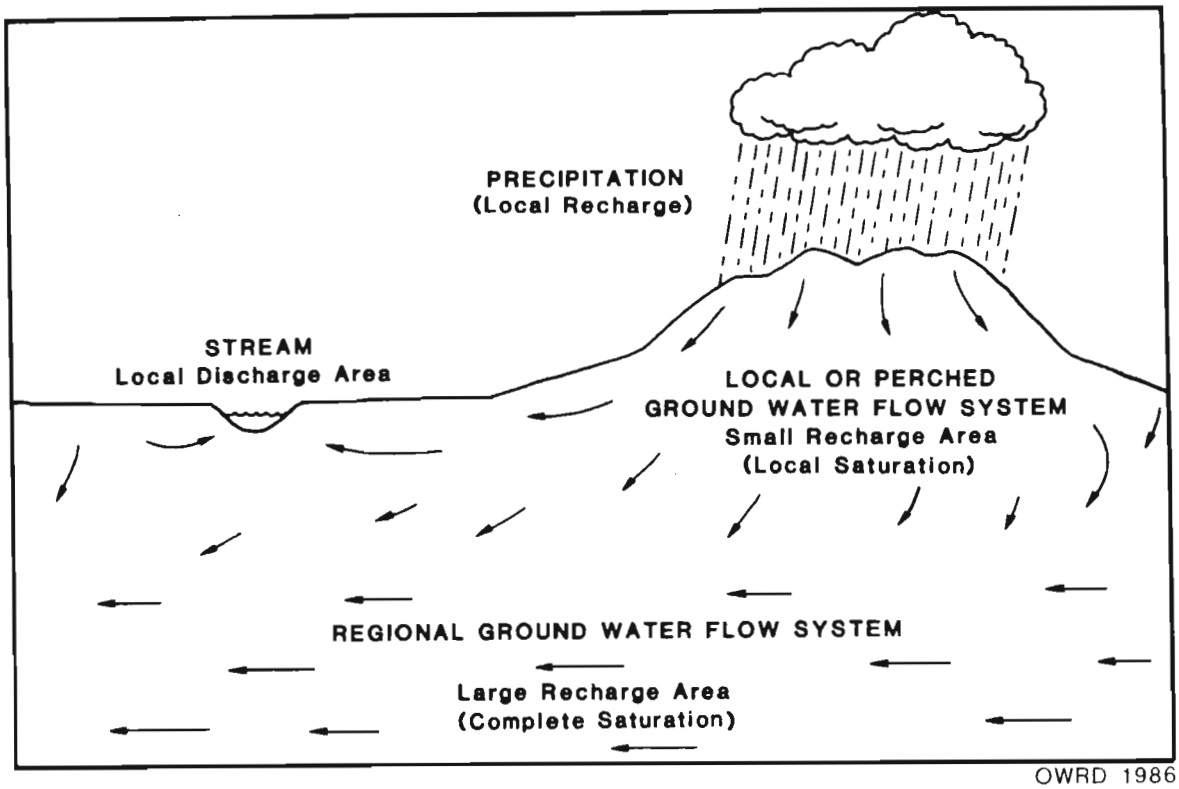


Figure 4. CONCEPTUAL DIAGRAM SHOWING LOCAL VERSUS REGIONAL GROUND WATER FLOW SYSTEMS

Deschutes Basin is provided by Sceva (1960, 1968). He has mapped the approximate surface of the regional groundwater system in the Bend, Redmond, and Madras areas, based on numerous water level measurements in deep wells. This surface slopes gently northward, roughly paralleling elevations of the Deschutes River valley. The level of the regional groundwater system (henceforth loosely referred to as the regional water table) is at an approximate elevation of 3000 feet in the vicinity of Bend and approximately 2800 feet near Tumalo.

The regional water table occurs at an elevation of approximately 2700 feet between Cline Falls and Smith Rocks, north of Redmond. If Sceva's water levels are projected several miles east, the regional water table should occur somewhere between 2700 and 2800 feet elevation in the Powell Buttes area. This figure agrees reasonably well with water levels measured in deeper wells in the basin floor around Powell Buttes. Measurements in this area indicate water level elevations range from 2730 to 2750 feet. The water level in one geothermal gradient hole is reported to be at 2673 feet elevation (Brown and others, 1981). The regional water table can be expected to be slightly higher to the south of the Buttes and lower to the north.

Farther north in the basin, the regional water table continues to slope northward. In the area of the confluence of the Deschutes and Crooked Rivers, a detailed water table map is provided by Stearns (1931) which generally agrees with Sceva's (1968) map of the Madras area. Along the Crooked River just west of Juniper Butte, the elevation of the regional water table is approximately 2000 feet. It is in this area that the regional water table coincides with the river level and numerous large springs occur, including Crooked River Springs and Opal Springs. These springs represent a major discharge point for the regional groundwater system.

MAJOR HYDROGEOLOGIC UNITS

In the following sections, groundwater characteristics of the major hydrorogeologic units in the study area are discussed. The sections start with Powell Buttes themselves and progress outward. Refer to Figure 2 for a map of the major geologic units as well as their stratigraphic relationships.

John Day Formation on Powell Buttes

Weidenheim (1981) shows that the John Day Formation on Powell Buttes consists primarily of rhyolite and dacite flows, rhyolite domes with minor basaltic andesite flows, volcaniclastic deposits and intrusions. Rhyolite and dacite flows have the potential to be highly and irregularly fractured. Such fractures may render the rock quite permeable. However, water movement could be impeded in these units by structural barriers, such as faults, or by interbeds of non-permeable material such as devitrified tuffs or fine-grained volcanic sediments.

Very few water well reports are on record with the Water Resources Department for wells drilled into the John Day Formation on Powell Buttes proper. Reports for wells drilled into the John Day Formation indicate complexly interstratified volcanic flows and sediments as expected. Most of the wells encounter water, but production rates are generally very low, ranging from less than 5 to 15 gpm. One well (16S/14E, 15dd) which is over 1000 feet deep and penetrates the John Day Formation produces only 5 gallons per minute. This suggests that permeability in the John Day Formation is generally quite low in the area.

The presence of numerous springs on Powell Buttes, particularly on the eastern portions, indicates some groundwater is present in the John Day Formation. The existence of the springs also suggests that there are hydrologic barriers present locally which impede the downward movement of water and divert it to the surface. The John Day Formation on Powell Buttes probably includes a number of perched aquifers. These aquifers are probably not extensive and likely have small storage. Recharge for such isolated perched aquifers is local and therefore extremely limited.

Alluvial Fan Deposits Surrounding Powell Buttes

Alluvial fan deposits around Powell Buttes are one of the more widely used sources of groundwater in the area. South and east of the Central Oregon Irrigation Canal, they represent the main source of groundwater. Alluvial fan deposits are typically crudely stratified and slope away from their source. The texture and lithology of these deposits can vary widely; however, they are typically poorly sorted, inhomogeneous, and laterally discontinuous. The permeability of such deposits varies from extremely poor to good and depends on such things as particle size, sorting and clay content. Information on the lithology of alluvial deposits around Powell Buttes was obtained from water well reports and from the descriptions of drill cuttings from geothermal gradient holes drilled by the Oregon Department of Geology and Mineral Industries.

Lithologic descriptions from water well reports for wells drilled in alluvial fans around the Buttes indicate interbedded rocks variously described by drillers as (in decreasing abundance) sandstone, claystone, clay, sand conglomerate, gravel, boulders, lava, hard rock, and broken rock. No direct correlation of lithologic descriptions between wells can be made due to variations in interpretation and nomenclature used by drillers, as well as inhomogeneity in the stratigraphy.

The general lithology of the alluvilal fans as suggested by well logs consists of fine-grained volcanically-derived sediments with local lenses of coarser clastic material and occasional lava flows.

More consistent descriptions of the subsurface close to Powell Buttes are provided for the geothermal gradient holes drilled by the Oregon Department of Geology and Mineral Industries (DOGAMI, unpublished data). These descriptions also indicate that the alluvial deposits surrounding the Buttes consist chiefly of fine-grained volcanic sediments, with occasional coarser clastic material and local lava flows. Material described as "talus" occurs as deep as 700 feet in DOGAMI-Powell Buttes No. 1.

Above the regional groundwater system alluvial fan deposits are locally saturated. This groundwater above the regional groundwater system represents a local flow system which is recharged by precipitation in the Powell Buttes area. The coarser or better sorted materials are permeable, allowing water movement and providing storage, and the fine-grained or poorly sorted materials form confining layers. Fractured lava flows may also serve as aquifers. The size, thickness, and hydraulic properties of these aquifers are highly variable. The lithology as described on water well reports suggests that fine-grained material of low permeability dominates.

Because the fine-grained "clay" and "claystone" materials are so dominant in the alluvial slopes of Powell Buttes, saturated zones within them are likely to be of limited volume and permeability. Since these aquifers represent local flow systems which occur above the regional water table, their only source of recharge is from the Buttes. Low precipitation and high evaporation in the area leave only a very small amount of water available for recharge.

Groundwater in the Deschutes Formation North of Powell Buttes

North and northwest of Powell Buttes, beyond the alluvial slopes, groundwater production is primarily in the Deschutes Formation. Lithologic information has been obtained from water well reports, published geologic reports and field reconnaissance. As with the alluvial material, no detailed lithologic correlations can be made between wells due to differing interpretations and nomenclature used by drillers, as well as inhomogeneity in the geology. However, the nature of the sub-surface geology can be generalized.

The lithology of the Deschutes Formation is variously described in well logs as sandstone, sand conglomerate, lava, cinders, clay, cinder sand and pumice, in approximate decreasing order of abundance. Rock descriptions are similar to those of the alluvial

slopes with two notable differences: a lesser quantity of clay or claystone, and a greater quantity of lava and cinders. Most of the area north of the Buttes and south of the Crooked River is mantled by 150 to 200 feet of basalt; interbedded basalt flows are common.

Inter-layering of permeable coarse sediments or fractured lava with fine-grained material of low permeability has resulted in perched aquifers above the regional water table. The regional water table is probably at an elevation between approximately 2600 and 2700 feet north of Powell Buttes. A number of fairly shallow wells north of the Buttes have static water levels above 2900 feet elevation, which is about 200 feet above the regional water table, suggesting the presence of a perched aquifer. Perched aquifers in this area have the potential to be more widespread and provide more storage than those under the alluvial slopes of the Buttes. Natural recharge to the perched aquifers is limited by low available precipitation. Infiltration of irrigation water and canal leakage provides a relatively large amount of artificial recharge to the perched aquifers.

THERMAL WATER

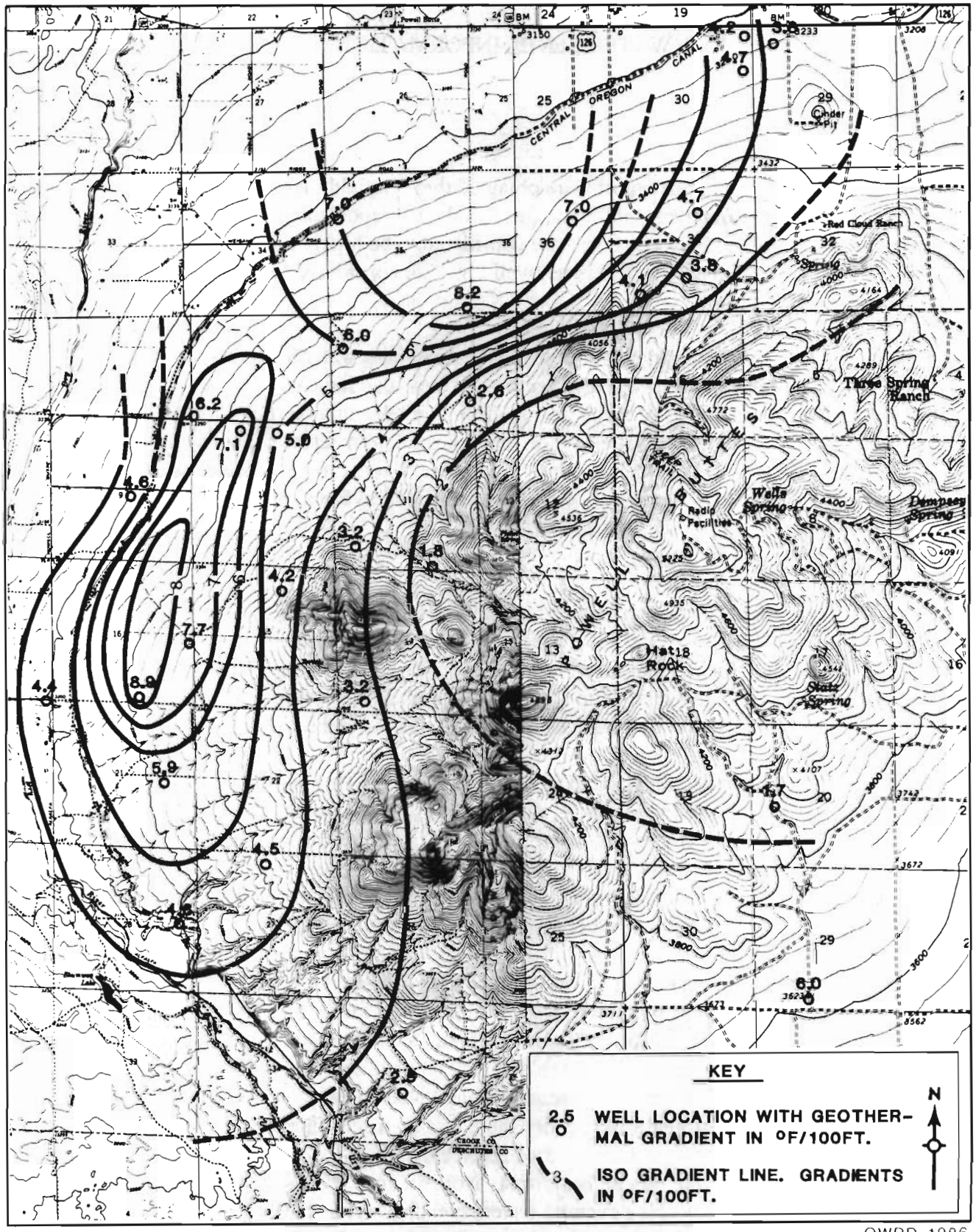
On the west and north alluvial slopes of Powell Buttes, a number of the deeper wells produce warm water ranging up to 96°F. Figure 5 is a geothermal gradient map and shows the areas of elevated subsurface temperature. The Oregon Department of Geology and Mineral Industries (DOGAMI) conducted an investigation into the geothermal resource potential of the Powell Buttes area. The results have been reported by Brown and others (1980) and Priest and others (1981). The study included the drilling of several geothermal gradient holes for heat flow determinations, chemical analyses of spring and well water for chemical geothermometry calculations, and compilation and interpretation of geologic and geophysical information. The DOGAMI investigation resulted in two possible models to explain the presence of the warm water.

The first model suggests that the juxtaposition of two rock types of strongly contrasting thermal conductivities may be causing a thermal refraction effect, locally increasing the already higher-than-average heat flow of the region. The two rock types involved are the silicic lavas of the John Day Formation and the interbedded volcanic sediments and flows of the Deschutes Formation. The warm groundwater would then be receiving heat by virtue of the localized area of high heat flow.

The second model suggests some structural or stratigraphic aspect of the geology is diverting deeper, warmer regional groundwater upward to the elevation at which it is encountered in wells. It is normal for water in the deeper parts of regional flow regimes to have elevated temperatures. This upward diversion of deep groundwater may be due to a fault. It is more likely, however, the large mass of low permeability John Day Formation forming Powell Buttes is diverting water upward. This second model, which is simple and is consistent with current geologic and hydrologic knowledge, is preferred by this investigator.

Geothermometric analysis of the chemistry of water from warm wells indicates that the water was in chemical equilibrium at the sampled temperature. This suggests that the water has not recently been at higher temperatures in the ground but is probably close to its maximum temperature. The highest temperature encountered in the area is 135°F which was measured at the bottom of the 1500 foot well DOGAMI Powell Buttes No. 1.

There is no evidence to suggest that the warm water represents outflow from some deeper, hotter geothermal system. It appears as if the warm water is a local phenomenon of the regional groundwater system. This resource probably has potential for small-scale direct uses such as space heating, but there does not appear to be any significant potential for higher temperature applications such as electricity generation.



OWRD 1986

Scale - 1:62500

1 1/2 0 1 2

Miles

FIGURE 5. GEOTHERMAL GRADIENT MAP OF THE POWELL BUTTES AREA
Data from Brown and Others (1980)

WATER LEVEL INFORMATION

Reliability and Utility

Water level data used in this report were obtained through field measurement by Oregon Water Resources Department personnel, from published reports, and from water well reports. Actual measured water levels are considered to be highly reliable, and levels in published reports and water well reports (well logs) are considered to be generally reliable.

Two major types of information are provided by examining water level data. First, water level information displayed over large geographic areas can indicate directions of groundwater flow and areas of recharge and discharge. A common method of displaying such information is a water level elevation map. Secondly, measuring the water level in a single well over a period of time can show water level fluctuations and long-term trends. A graph of water level in a well over time is called a well hydrograph.

Water Levels and Groundwater Flow

A well which penetrates an aquifer or saturated rock will have some static water level. The elevation of the static water level is determined by the elevation and pressure in the aquifer or saturated rock at that location. The elevation of the water level is known as the "head." "Head" is always relative to some datum, such as sea level. The higher the elevation of the water level in a well, the higher the head is in the aquifer at that place.

Water moves from areas of high head to areas of low head. Head varies within an aquifer, and water moves within the aquifer accordingly. Head may vary between aquifers. If two such aquifers are connected, water will move from the one with higher head to the one with lower head. A water level elevation map of a given geographic area shows variations in head within aquifers and between aquifers and therefore indicates directions of groundwater flow. Regional water level highs generally indicate recharge areas.

Plate 1 (inside back cover) is a map showing water levels around the Powell Buttes area. The water levels form a well-defined mound generally corresponding to topography of the buttes. Water levels from 50 wells are represented on the map. The wells are of different depths and represent water levels of different aquifers or composit water levels from multiple aquifers. Some wells indicate water levels in perched aquifers; others may represent the regional groundwater. Since there was no discrimination between wells of different depths, the map is not an accurate representation of the head in the regional groundwater system in the Powell Butts area. Nor is it an accurate representation of heads in artesian aquifers. However, no water level data were omitted, all wells measured are represented, and the water level mound persists with no wells deviating significantly from it. This suggests that along with the presence of perched aquifers there is a local high in the regional groundwater system. This indicates that Powell Buttes are a local recharge area for the regional groundwater system.

There are at least two instances in the Powell Buttes area where head differences in between two perched aquifers or between a perched aquifer and the regional systems are demonstrated. Two wells belonging to Dale Hoskins in T15S, R15E, Section 30 which are 450 and 650 feet deep, are only a few hundred feet apart yet have water levels which differ by about 70 feet. The shallower well has the higher water level and, although it did not produce a useable amount of water, probably represents the head in a local flow system. The deeper well which has the lower water level represents head in either a deeper portion of a local flow system or the regional system.

Another example of head differences between aquifers is the Flock well in T15S, R14E, Section 35bc. This well was originally 447 feet deep with a static water level of about 406 feet. This level represented perched water. When the well was deepened to 597 feet, a zone of much lower head was encountered. The water level dropped to the bottom of the well, and the well essentially went dry. Both these instances indicate decreasing head with increasing well depth in the Powell Buttes area. This downward head gradient indicates groundwater recharged in the Powell Buttes area is moving downward toward the regional flow system.

Water level data collected as part of this investigation combined with the work of Stearns (1930), Sceva (1960, 1968) and Brown and others (1981) indicates that the water level (or head) of the regional groundwater system is between about 2670 and 2750 feet in the Powell Buttes area. Any aquifer above this elevation is relying on local recharge. Since local recharge is limited, such aquifers should not be relied upon for any large-scale production. Any aquifer producing water from below 2673 to 2750 feet, regardless of the water level in the well, has the potential for recharge from the regional groundwater system. Such aquifers have the potential to produce significant amounts of water on a long-term basis if sufficient permeability can be found.

Well Hydrographs

Well hydrographs show fluctuations in water level with time. Fluctuations can be broadly classified into two groups: natural and artificial. Natural water level fluctuations include the yearly rise and drop due to the annual cycle of recharge and discharge. Superimposed on this may be a gradual lowering or rising of water levels due to longer-term climatic changes. Water levels can be exceptionally low in response to dryer than normal years or exceptionally high in response to very wet years. There are varying lag times between climatic change and a corresponding change in water level.

Artificial changes in water level are usually in response to pumping. As a well is pumped, the water level in the well drops. This is known as drawdown. In addition, the water level will drop in the area surrounding the well. The effect on the water level surrounding the well decreases with increasing distance from the well. This results in a conical depression in the water level around a pumping well known as the "cone of depression." When pumping ceases, the water level recovers, approaching the original level after some time. When two wells in close proximity are simultaneously pumped and the cones of depression overlap, the lowering of the water level is additive. The

drawdown in both wells is increased, and more time is required for the recovery of the water level after pumping stops.

During periods of heavy water use, principally summer months, the water levels in some areas may not recover to their pre-pumping elevation for several weeks or months. This is called a seasonal pumping effect. If the average rate of groundwater withdrawal from an area exceeds the average recharge rate on a long-term basis, water levels will continually decline, never recovering to their pre-pumping levels. This condition is known as overdraft and can result in the eventual depletion of the groundwater reservoir.

Water levels were periodically monitored in 44 wells from the summer of 1981 to the summer of 1985. Hydrographs of these wells are presented in Appendix II. Water level measurements during this period in the Powell Buttes area do not indicate any long-term water level decline problems. In addition, no general pattern of decline is indicated by comparing current measured water levels with the original levels on drillers' logs.

RECHARGE

There is no way to easily measure or calculate groundwater recharge. Ultimately, all groundwater reservoirs are recharged by meteoric water (rain and snow). The deeper regional groundwater may travel long distances; therefore, recharge occurs over a very large area. Recharge to the regional groundwater system in the Powell Buttes area is probably from the upper Deschutes basin, including the high lava plains to the south. This area includes some large areas of high elevation and significant precipitation. The shallow, local groundwater flow systems, on the other hand, generally receive only local recharge from the immediate area, which may be small. Local flow systems on and near the flanks of Powell Buttes probably receive recharge from precipitation up on the Buttes. This area receives probably 10 to 14 inches of precipitation per year (see Table 1). Most of this is lost through runoff, evaporation, and transpiration by plants.

Johnsgard (1963) presents water balance information for many weather stations in Oregon, including Grizzly, Prineville, and Redmond, the three closest stations to Powell Buttes. The water balance is a method of analyzing climatological information and estimating moisture surpluses and deficits. Johnsgard estimated the potential evapotranspiration by the Thornthwaite and Mather method and compared it to average precipitation for each month to determine whether there is a moisture surplus or deficit for the area each month. The cumulative surplus or deficit was then calculated. For the three stations around the Powell Buttes area the cumulative moisture surplus in the spring ranges from 2.6 to 5.6 inches, and the cumulative moisture deficit in the fall ranges from 14.2 to 17.4 inches. The significance of these numbers is that most of the precipitation is lost to evaporation, transpiration and soil moisture and that only a small proportion is available for recharge. Some of this remaining portion is probably lost to runoff, leaving even less to percolate into the groundwater system. This information is qualitative and is provided only to give the reader an appreciation of the fact that only a very small portion of total precipitation is ever available for groundwater recharge. For a more detailed discussion on the water balance and the Thornthwaite and Mather method, the reader is referred to Johnsgard (1963) and Thornthwaite and Mather (1957).

ESTIMATED WATER USE AND WATER USE TRENDS

In 1983, the Oregon Water Resources Department estimated water use data for the area around Powell Buttes, including all of Townships 15S/14E, 15S/15E, 16S/14E, 16S/15E, and Sections 1 through 30 of Townships 17S/14E and 17S/15E. The estimated number of wells in the area was based on water well reports on file at the Water Resources Department and, therefore, does not include any wells constructed before 1955. The estimated groundwater pumpage in the area was based on assumptions of household usage and on water rights records. This information is not considered to be a precise inventory of wells and groundwater use but is presented to give the reader a feeling for amount of groundwater use and the pattern and timing of development. Total groundwater use in the study area was estimated to be approximately 2229 acre-feet per year as of 1983.

Figure 6 shows the increase in the number of wells on record from 1955 to 1983. Figure 7 displays the estimated annual groundwater use in the area as a function of time. It shows a greater than sixfold increase in groundwater use between 1977 and 1983. Much of this increase represents irrigation development.

There are approximately 329 domestic wells in the six-township area around Powell Buttes. Assuming the average household uses an average of 500 gallons per day, the total annual pumpage for this use would be 184 acre-feet. This accounts for about eight percent of the total groundwater use in the area. Since most of the dwellings in the area are on large lots, lawn and garden irrigation may be higher than average and the actual figure may be larger.

About 60 acre-feet per year, or three percent of the annual pumpage, is for public water supply. This includes one school well permitted for 0.06 cfs and one small private water district. This figure was calculated assuming that the school is diverting its full allocation and that the water district supplies 30 houses using 500 gallons per day each.

There are approximately 21 irrigation wells in the area with a total permitted diversion of 11.91 cfs. Assuming that 70 percent of the permitted diversion is being used and that there are 120 days of irrigation per year, the total irrigation use is an annual pumpage of 1984.3 acre-feet. This accounts for 83 percent of the total estimated groundwater use in the area.

FIGURE 6.

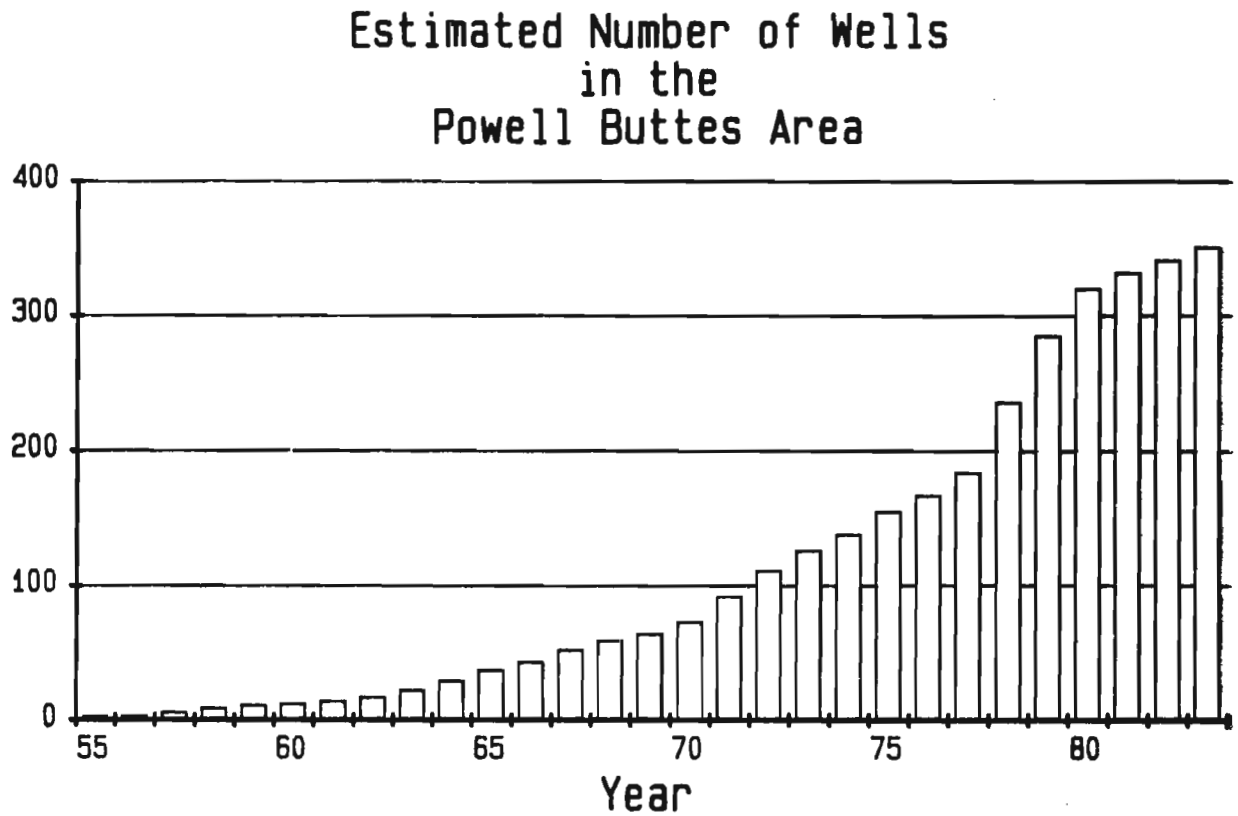
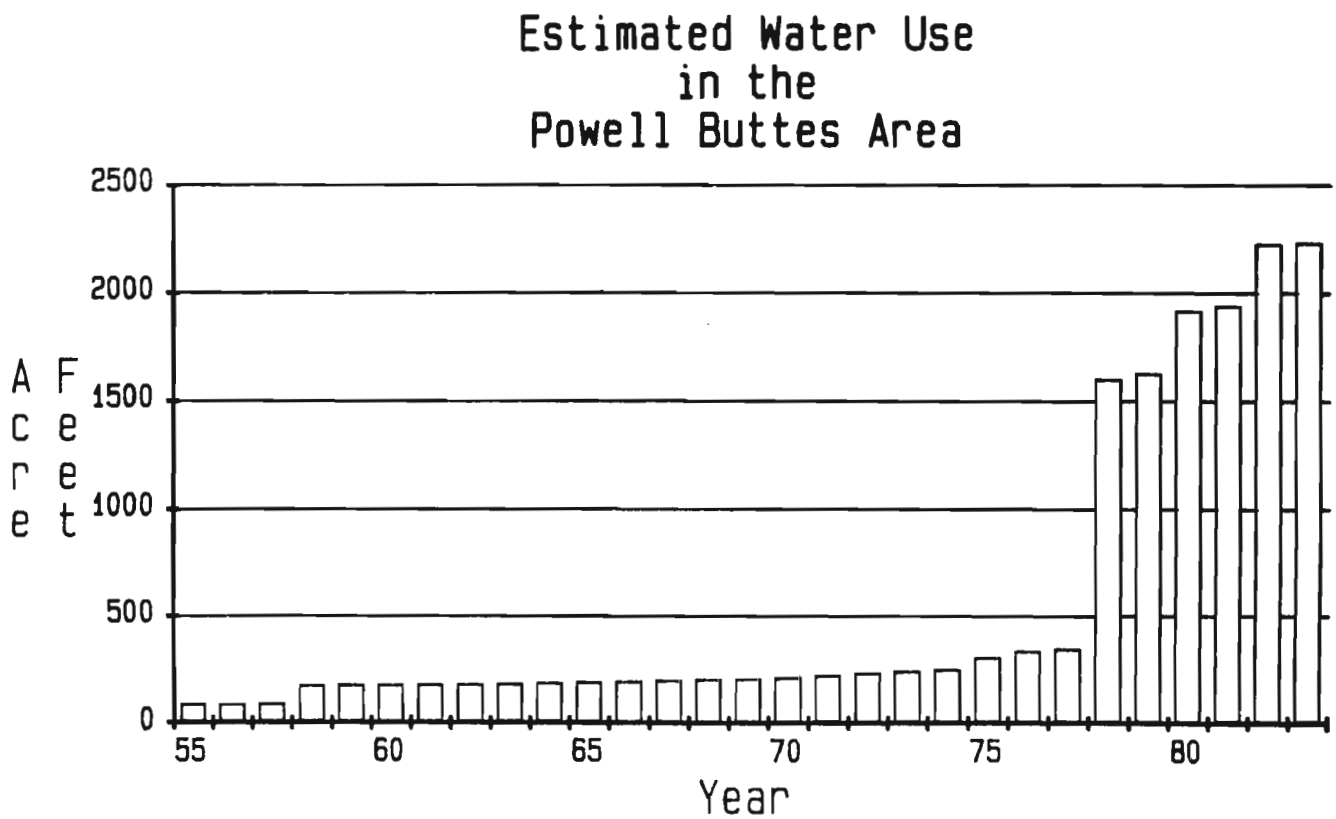


FIGURE 7.



WELL PROBLEMS

Starting in 1980, a general concern about the groundwater resource surfaced among landowners in the Powell Buttes area, particularly in Sections 29, 30, 31 and 32 of T15S, R15E. It appears that during the summer of that year, a number of people noticed problems with their wells for the first time. It is important to note that the winter and spring of 1980 had not been particularly dry.

The most common complaint was that there had been a decrease in well production rates or a decrease in the amount of water a well would produce before the water level was drawn down to the pump intake. This was generally reported in terms of the number of loads of wash which could be done in a day, or in the number of sprinklers which could be run for lawn and garden irrigation. A few people in the four-section area lowered pumps or deepened wells to solve problems.

Water well reports with original static water levels are available for ten of the wells measured in the summer of 1981 in the four-section area. These data are presented in Table 2 along with similar available data for all monitored wells. Six of the wells showed a drop in the water level from that indicated on the well log. Four wells showed a rise in the water level as compared to their logs. The drops in water levels range from 1 foot to 15 feet, with one of 96 feet. The rises in water level ranged from 37 to 57 feet, with one rise of 276 feet. There is no pattern present in these changes, and most can probably be attributed to inaccuracies in the original static water level reported or to natural seasonal fluctuations. The one significant apparent drop in water level (95.7 feet) in the Ferguson well may be due to depletion of a very limited-volume, perched aquifer. This depletion may have been due either to pumpage or down-hole drainage to an underlying aquifer with lower head being penetrated by the borehole. In any event, this is an isolated case and certainly is not indicative of an areawide trend.

TABLE 2

Differences Between Static Water Levels Measured Upon Well Completion and Levels Measured at Start of Monitoring

Name	Location	Orig. SWL	Date	SWL	Date	Change
Ross Curry	15S/14E/11bda	46 feet	5/79	40 feet	8/8	+6
Norman Curry	15S/14E/11bda	46 feet	3/80	40 feet	8/81	+6
Wampler & Werth	15S/14E/11dca	40 feet	3/79	51 feet	8/81	-11
Ray Priday	15S/14E/15dad	119 feet	8/77	95 feet	8/81	+23
Harold Mansfield	15S/14E/22abb	112 feet	12/71	109 feet	8/81	+3
Joe Kueser	15S/14E/22abb	251 feet	7/79	118 feet	8/81	+133
Robert Caraway	15S/14E/22abb	72 feet	6/78	99 feet	8/81	-27
Alan Rothenbucher	15S/14E/24ccc	236 feet	7/81	223 feet	8/81	+13
Dale Landrus	15S/14E/25db	325 feet	2/81	246 feet	7/81	-21
Don Copley	15S/14E/26ddd	290 feet	11/70	281 feet	8/81	+9
Jim McFarlane	15S/14E/34baa	418 feet	4/69	422 feet	7/81	-4
Rodney Johnson 1	15S/14E/35ddd	320 feet	12/75	303 feet	9/81	+17
Gruniger	15S/15E/11cac	414 feet	12/80	407 feet	7/81	+7
Robert Caudle	15S/15E/17bb	420 feet	12/79	370 feet	10/81	+50
Ben Koops	15S/15E/28ada	280 feet	2/68	275 feet	7/81	+5
*Paul Sampaulesi	15S/15E/29baa	255 feet	10/80	256 feet	7/81	-1
*Melvin Menge	15S/15E/29bc	237 feet	9/77	251 feet	7/81	-14
*Glen Ferguson	15S/15E/29bdb	135 feet	1/78	231 feet	7/81	-96
*Wilson	15S/15E/29bdd	102 feet	6/72	108 feet	7/81	-6
*Red Cloud C	15S/15E/29dcc	135 feet	6/71	78 feet	6/82	+57
*Dale Hoskins 1	15S/15E/30aad	615 feet	4/80	339 feet	7/81	+276
*Stanley Hushour	15S/15E/30adb	342 feet	6/79	305 feet	7/81	+37
*Larry Crawford	15S/15E/30dbb	370 feet	1/80	321 feet	7/81	+49
*Robert McCall	15S/15E/30ddd	215 feet	11/77	222 feet	7/81	-7
*Carl McDonald 2	15S/15E/31ada	200 feet	2/78	215 feet	7/81	-15
Don Howlett	16S/14E/2ccc	270 feet	5/80	272 feet	7/81	-2
Robert McCasland	16S/14E/9add	520 feet	1/70	497 feet	7/81	+23
Lloyd Mathers	16S/14E/11cca	263 feet	4/81	340 feet	10/81	+23
Alan Bovee	16S/14E/16cbb	484 feet	9/71	484 feet	7/81	0
Ray Shumway	16S/14E/28add	43 feet	1/80	348 feet	10/81	-5
Tony Palmer	17S/14E/13ad	10 feet	11/79	2 feet	7/81	+8
Richard Seaverson	17S/14E/24bba	15 feet	9/79	11 feet	7/81	+4
Charles Church	17S/15E/16cdb	680 feet	6/81	671 feet	7/81	-1

* Wells in four-section area of original concern.

Since there is no evidence of a general drop in water levels in the four-section area, any reduction in the performance of wells must have some other cause, of which there are several possiblities. When a decrease in well performance is noticed, it may be the result of a decrease in well efficiency. This means that there is a greater drawdown in the well for a given yield. If efficiency drops enough, the water level can be drawn down to the pump intake with normal pumping.

One of the major causes of reduced well efficiency is encrustation of mineral deposits in the well screen or perforations or in the rock materials of the well bore. Mineral encrustation impedes water flow into the well. Brown (1980) indicates that bicarbonate is probably the dominant anion in groundwater in the Powell Buttes area. This suggests that carbonate may be a common precipitate in wells. Reconditioning a well which has a serious encrustation problem can be a fairly major task. A typical method involves treating the well with concentrated hydrochloric acid. Another very common problem which can impede water flow into screens or perforations, or in the well bore, is the buildup of slime-producing bacteria. This is a fairly common problem, particularly in areas of iron-rich water. Bacterial growth can be controlled by periodic chlorination of wells. It is not known whether bacterial growth is a problem in wells in the Powell Buttes area. Well performance can be reduced by material failures in the well, such as a collapse of the casing, caving, and filling of uncased portions of the bore hole. These are the more common problems which can cause reduced well performance. Since these are unrelated to the groundwater resource, they should be investigated by individual well owners if reduced well production occurs.

Some individuals have speculated that the development of springs at Red Cloud Ranch was responsible for some of the well problems. This is unlikely, since springs are groundwater discharge points. Most of the water issuing from springs evaporates or evapotranspires. The remaining quantity available for recharge is very small. Loss of this quantity would have negligible effect on the aquifers at the locations where people are producing water.

With the information available, it is not clear whether problems actually developed in a number of wells in the summer of 1981 or whether the problems had been developing for several years and became apparent for the first time in 1981.

SUMMARY

The top of the regional groundwater system occurs at about 2700 feet in the Powell Buttes area. Most of the wells in the area are producing from aquifers above the regional groundwater system. The amount of water which can be produced continuously from these aquifers is limited because they rely on local recharge, which is very low. While individual wells within these aquifers may yield amounts of water entirely suitable for domestic use, the capacity of the aquifers to sustain a large number of wells is limited. In addition, since most of these aquifers are relatively shallow with recharge coming from local precipitation, they are sensitive to climatic variations. Water levels may drop in response to dry years. Many, if not most, of these shallow aquifers are perched. A number of perched aquifers may occur one on top of another, and deeper wells may interconnect them. In such cases, it is possible that the upper aquifers will drain to the lower aquifers by down-hole flow. Some of the perched aquifers north of the C.O.I. canal, especially on the basin floor, are almost certainly receiving recharge from canal leakage and infiltration of irrigation water.

Aquifers producing from above the regional groundwater system cannot be expected to support large-scale development. They do not have sufficient storage or recharge to produce a large amount of water. There is no simple method to determine how much development, or what density of domestic well spacing, can be safely implemented in such aquifers.

It is possible that wells drilled deeply enough in the Powell Buttes area can penetrate the regional groundwater system (below approximately 2700 feet elevation). Wells producing from the regional groundwater system would be drawing from a much larger reservoir with a tremendous recharge area. Such wells could produce relatively large volumes of water on a continuous basis if enough permeability were encountered. In practice, however, this may not be as easy as it sounds. The limiting factor would be finding strata permeable enough to yield water at the required rate. At best, the stratigraphy would be similar to the alluvium at shallow depths, dominated by fine-grained sediments of low permeability. Deeper wells close to the Buttes would likely penetrate John Day or Clarno Formation materials. These units are not generally considered good aquifers due to low permeability. Permeable units probably do occur at depth, but the geology of the area is not known well enough to predict where they occur.

In wells which produce from the regional groundwater system, the entire portion above 2700 feet elevation should be cased and grouted to seal off perched aquifers. If upper zones are not sealed off, they could lose water to the lower zone through down-hole flow. It is suggested that before additional large residential subdivisions in the Powell Buttes area are approved, developers be required to construct a group domestic or community well which produces the required amount of water from below 2700 feet elevation. The entire portion of the well above 2700 feet should be cased and sealed. Such wells should be pump tested for several weeks at the expected average rate and the response (if any) measured in nearby wells of all depths.

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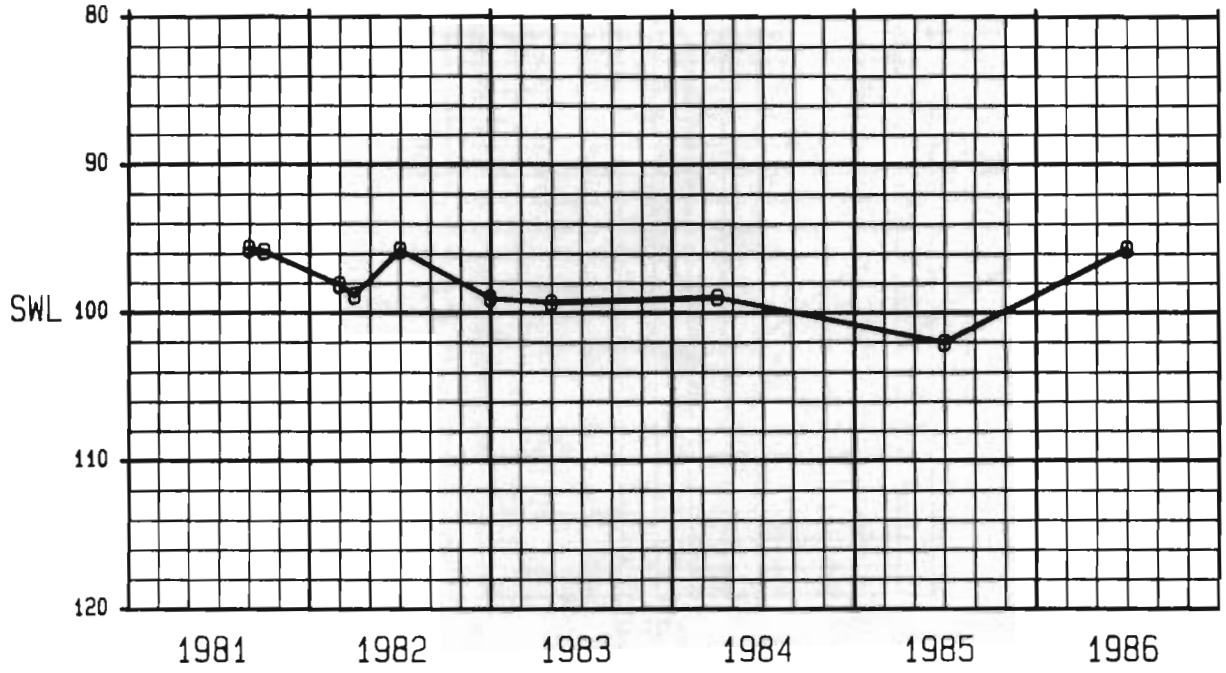
APPENDIX I, HYDROGRAPHS

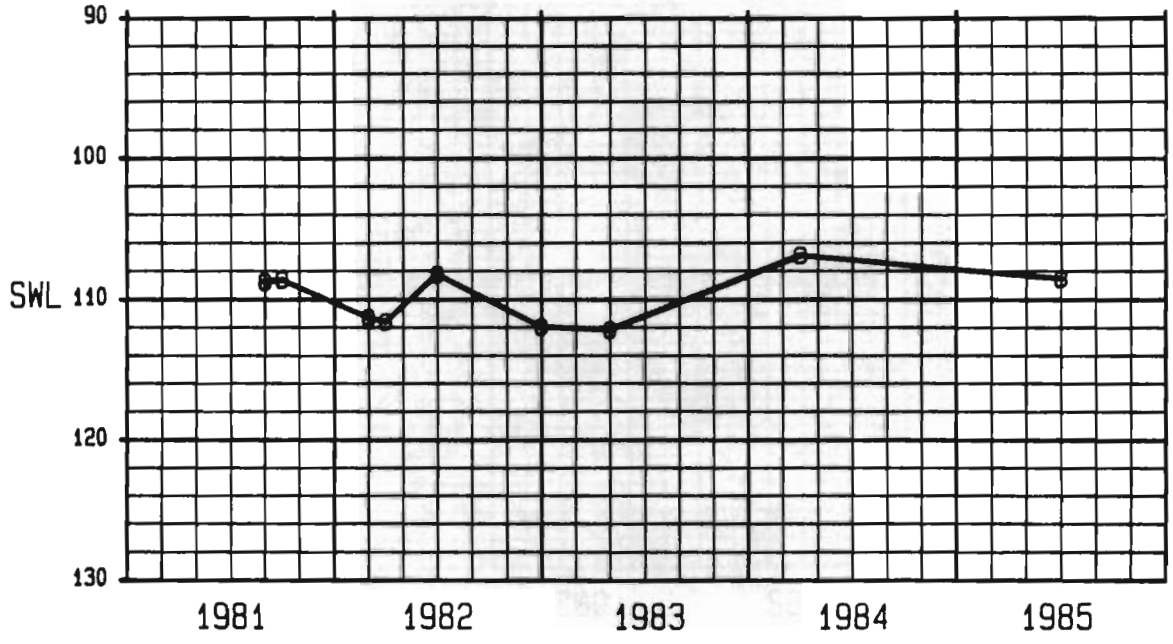
Hydrographs are presented for the following wells for 1981 through 1985. Wells marked with an asterisk were monitored through 1986 and will be considered for future monitoring. Some hydrographs are incomplete due to access problems with the well.

Well Owner/Well Number	Location	Depth in Feet
Ross Curry	15S/14E/11bda	111
Norman Curry	15S/14E/11bda	98
Wampler and Werth #4	15S/14E/11dca	97
Wampler and Werth #2	15S/14E/11dca	90
* Ray Priday	15S/14E/15dad	149
Harold Mansfield	15S/14E/22abb	121
Joe Kueser	15S/14E/22abb	327
Robert Caraway	15S/14E/22abb	125
* Alan Rothenbucher	15S/14E/24ccc	275
Dale Landrus	15S/14E/25db	377
Donald Copley	15S/14E/26ddd	318
Jim McFarlane	15S/14E/34baa	444
Orlo Flock	15S/14E/35bca	597
Rodney Johnson #1	15S/14E/35ddd	679
Rodney Johnson #3	15S/14E/35ddc	650
Gruniger	15S/15E/11cac	475
* Robert Caudle	15S/15E/17bb	420
* Ben Koops #2	15S/15E/28ada	450
Paul Sampaulesi	15S/15E/29baa	482
* Melvin Menge	15S/15E/29bc	300
* Glen Ferguson	15S/15E/29bdb	300
* Wilson	15S/15E/29bdd	180
* McCourtney (No log)	15S/15E/29cbc	NA
Red Cloud C	15S/15E/29dcc	767
Dale Hoskins #1	15S/15E/30aad	655
* Dale Hoskins #2	15S/15E/30aad	450
Stanley Hushour	15S/15E/30adb	402
* Lar Crawford	15S/15E/30dbb	417
* Robert McCall	15S/15E/30ddd	250
* Carl McDonald	15S/15E/31ada	340
Avion Water District #1	15S/15E/31cbb	590
Red Cloud A (No log)	15S/15E/32caa	230 (?)
Red Cloud B (No log)	15S/15E/32bdd	273
Don Howlett	16S/14E/2ccc	320
* Robert McCasland	16S/14E/9add	590
Jensen (No log)	16S/14E/10bab	NA
Lloyd Mathers	16S/14E/11cca	725
Alan Bovee	16S/14E/16cbb	575
Ray Shumway #1	16S/14E/28add	657
Harry Martin	16S/15E/26cdd	560
Shumway Windmill (No log)	16S/15E/29cdd	340
Tony Palmer	17S/14E/13ad	24
Richard Seaverson	17S/14E/24bba	79
Charles Church #1	17S/15E/16cdb	NA

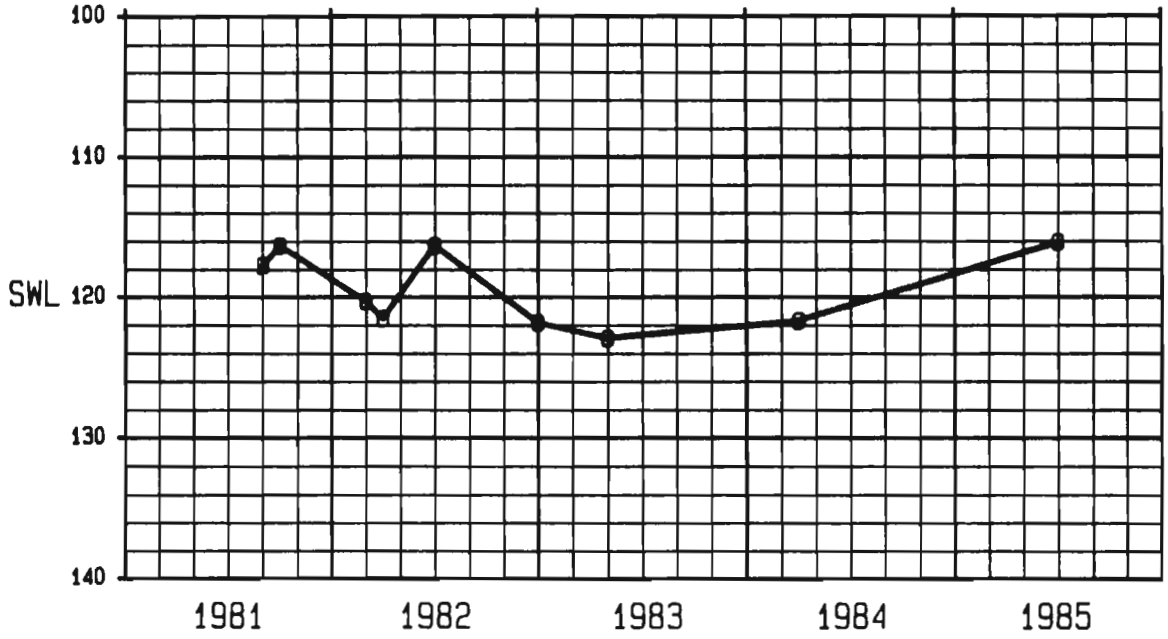
Ray Priday Well



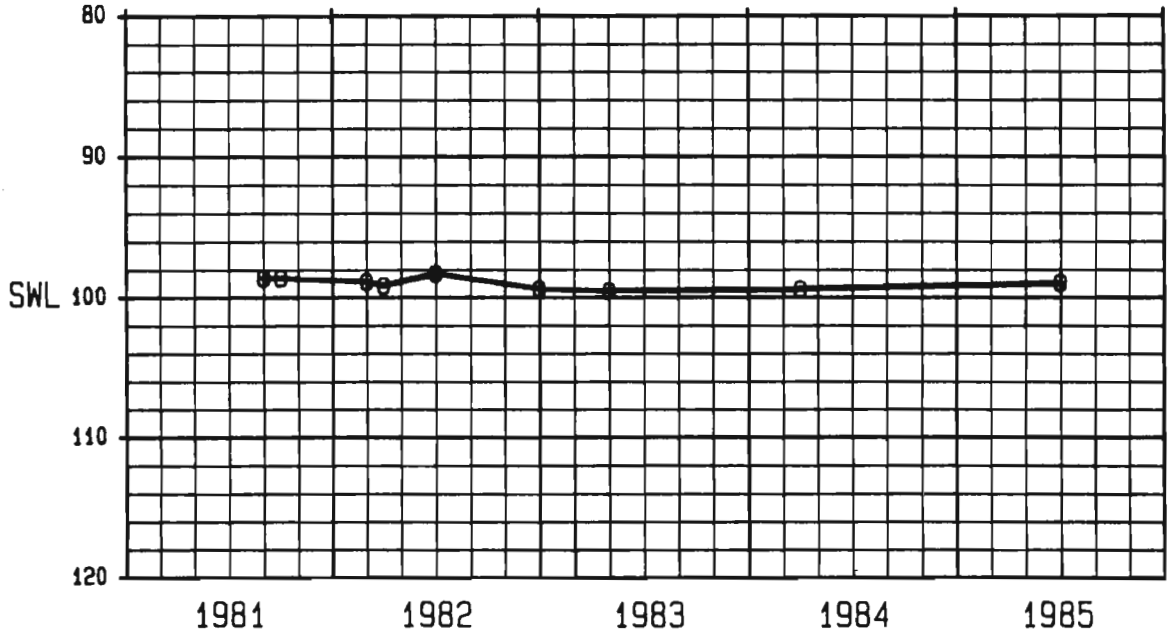
Mansfield Well



Joe Kueser Well



Robert Caraway Well



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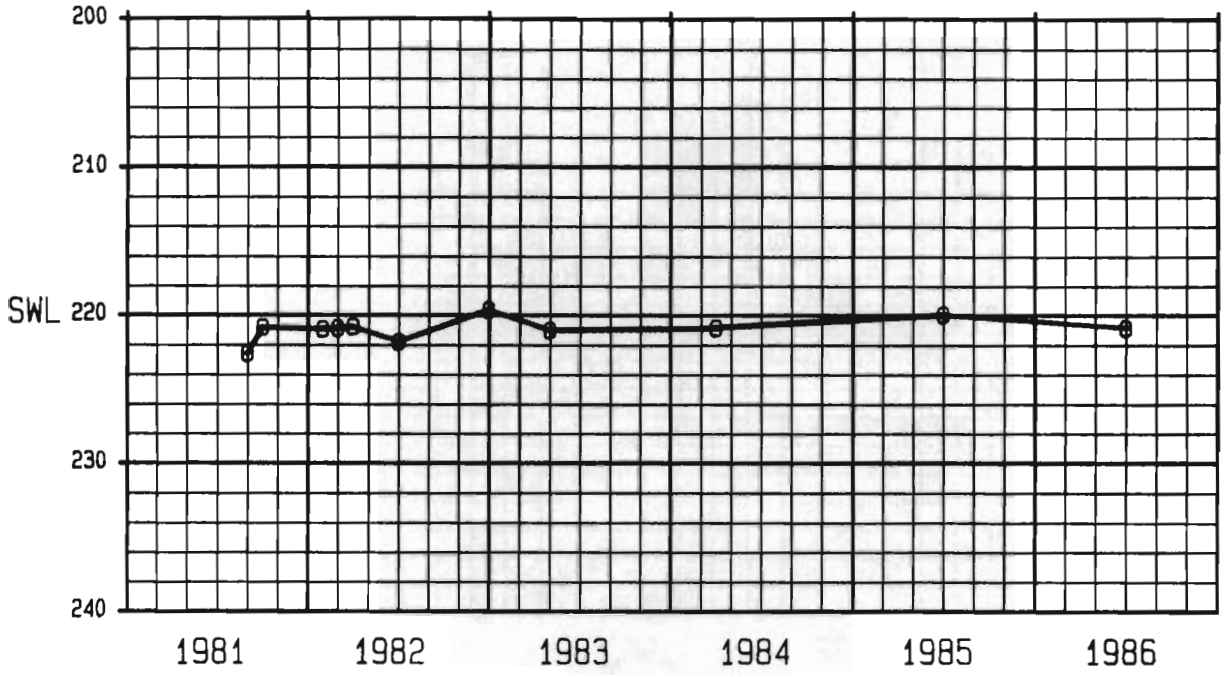

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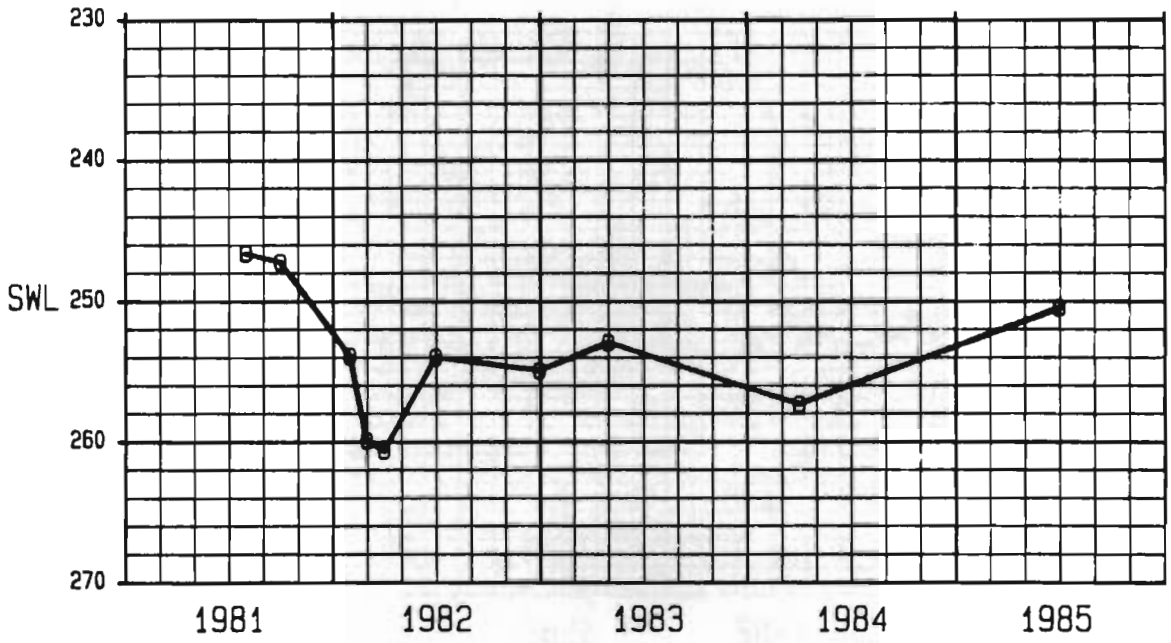
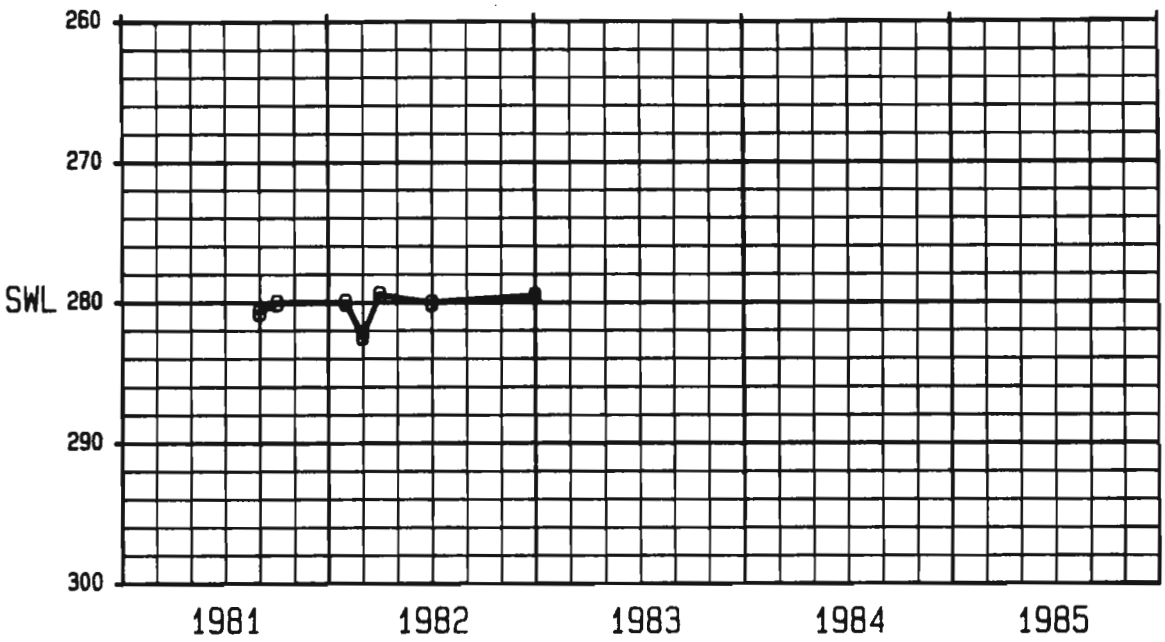


Donald Copley Well



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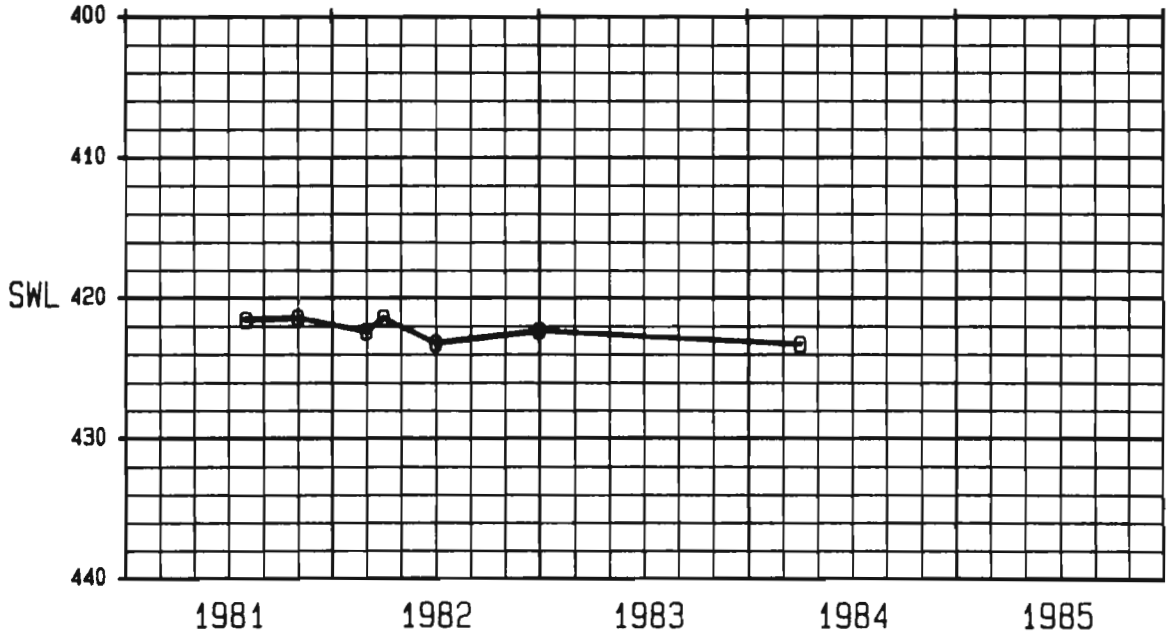

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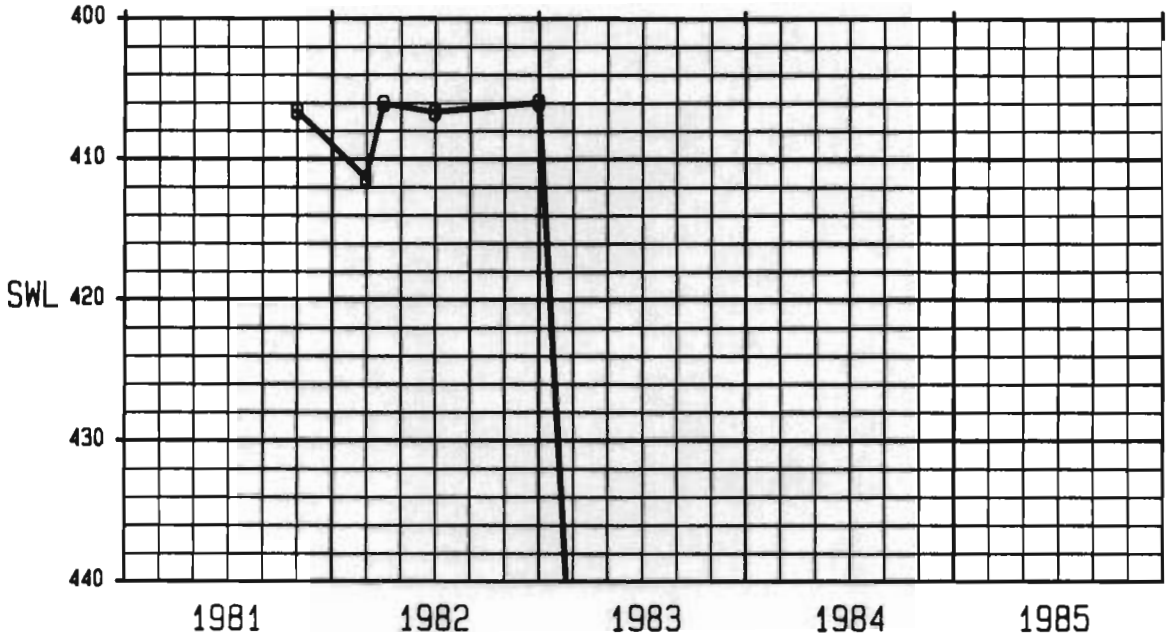

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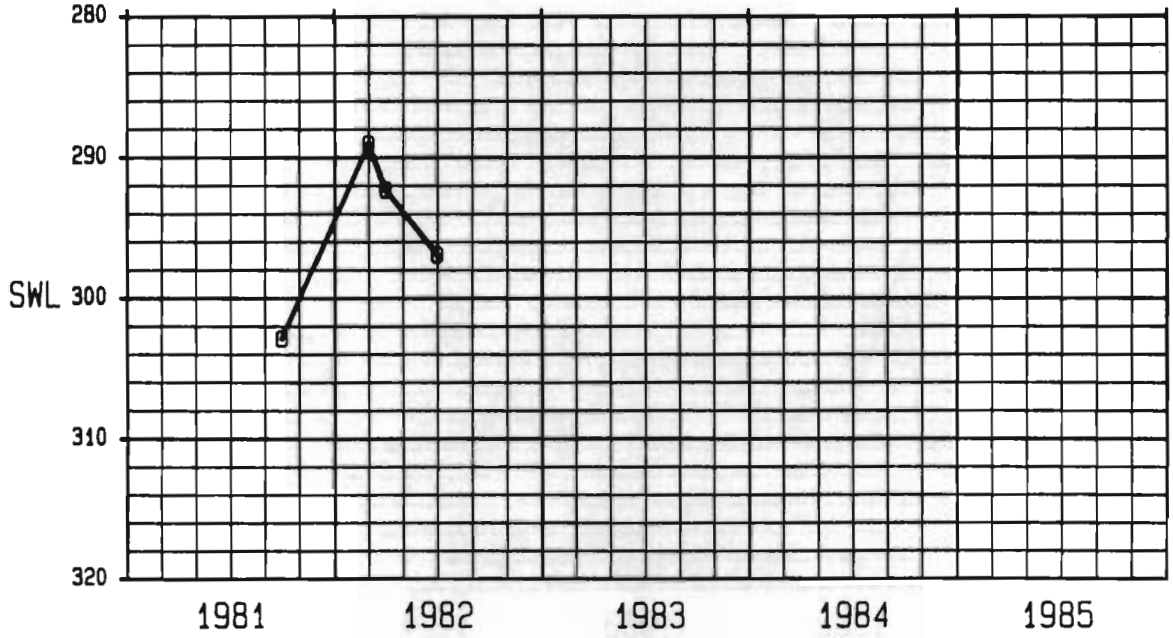

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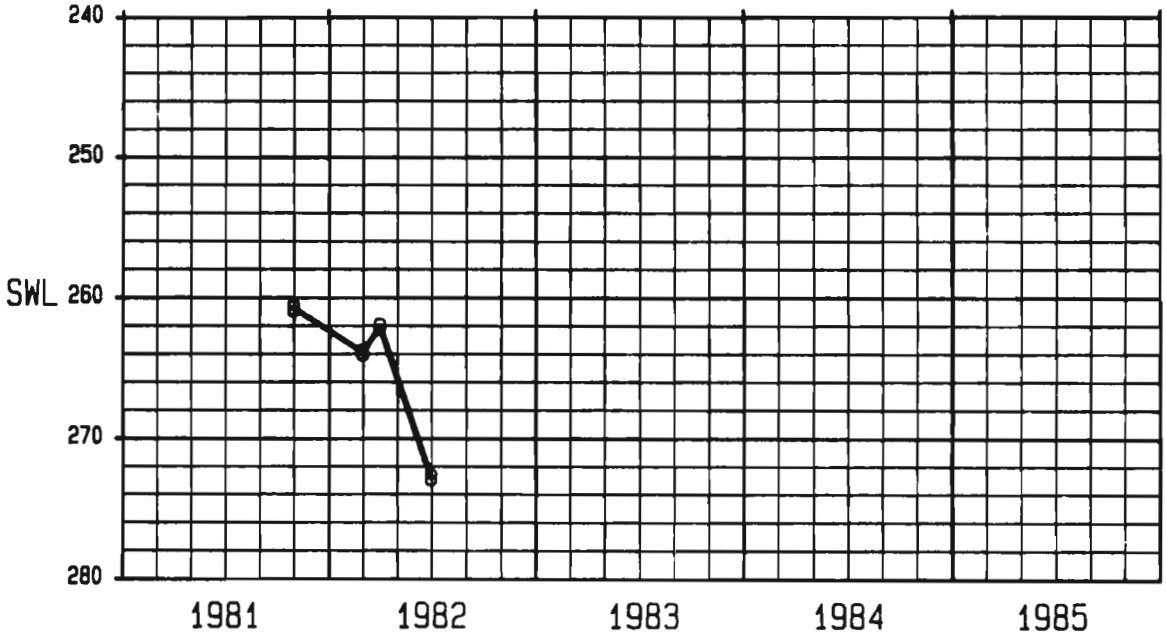

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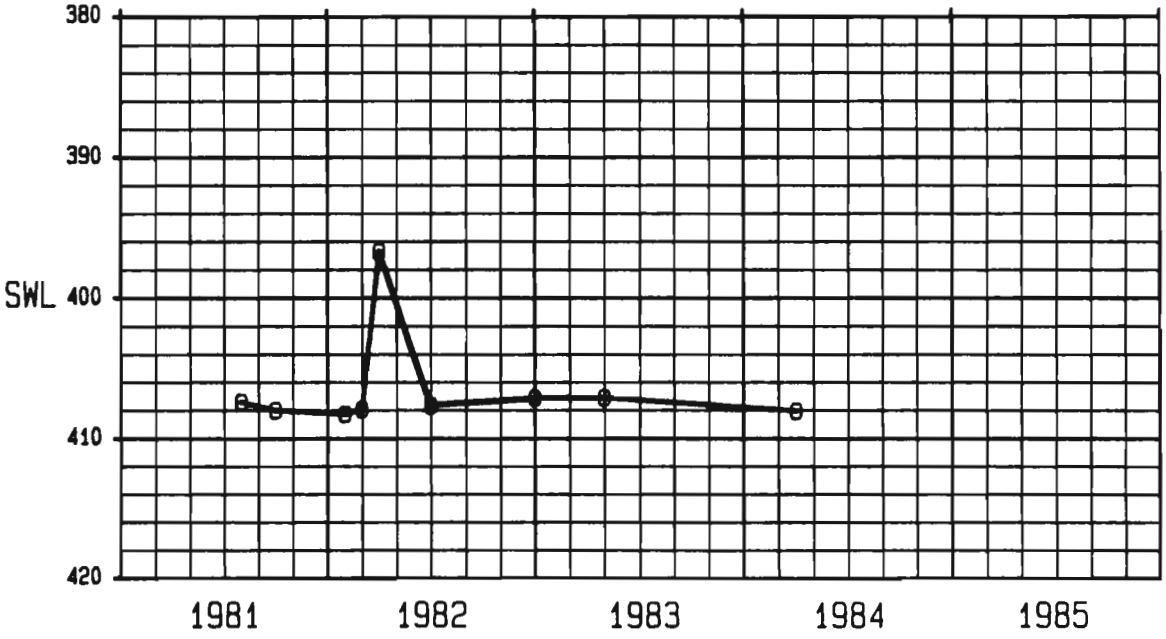
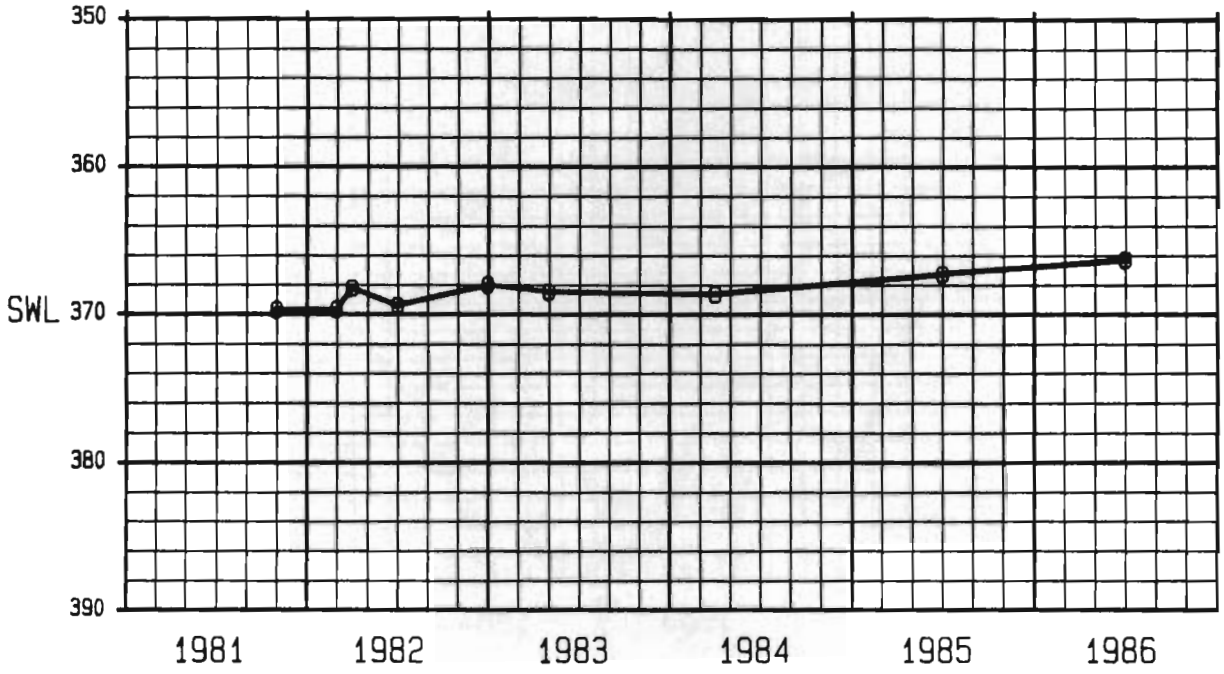


Robert Caudle Well



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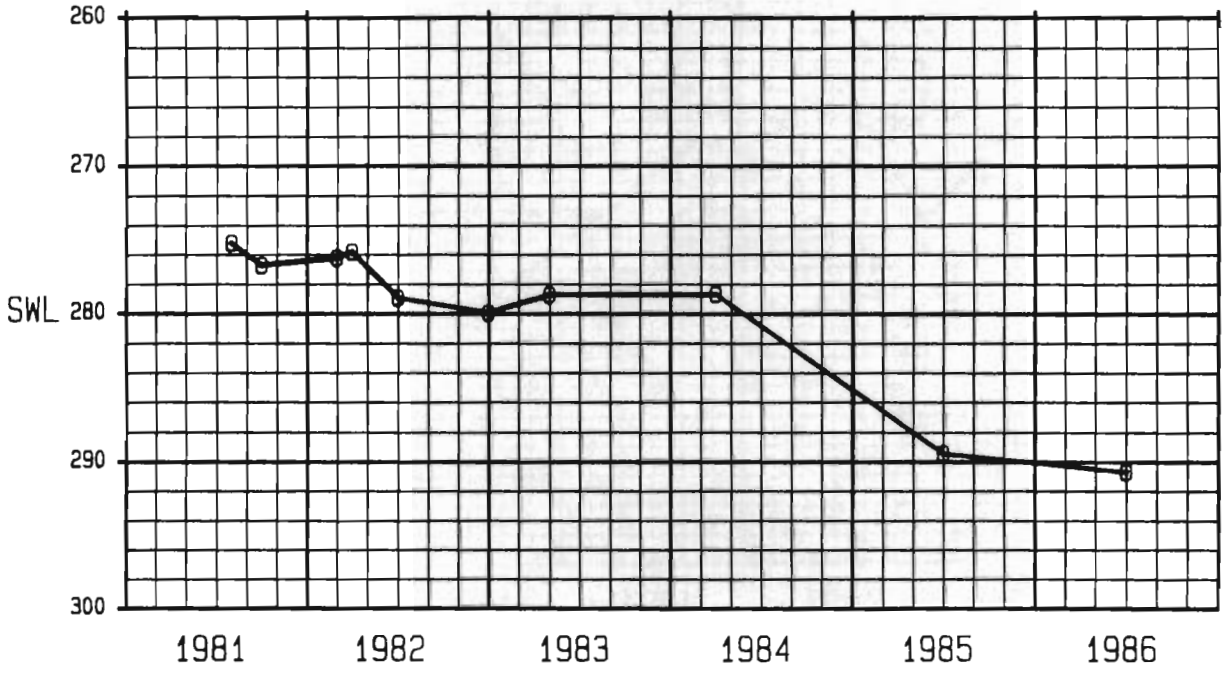
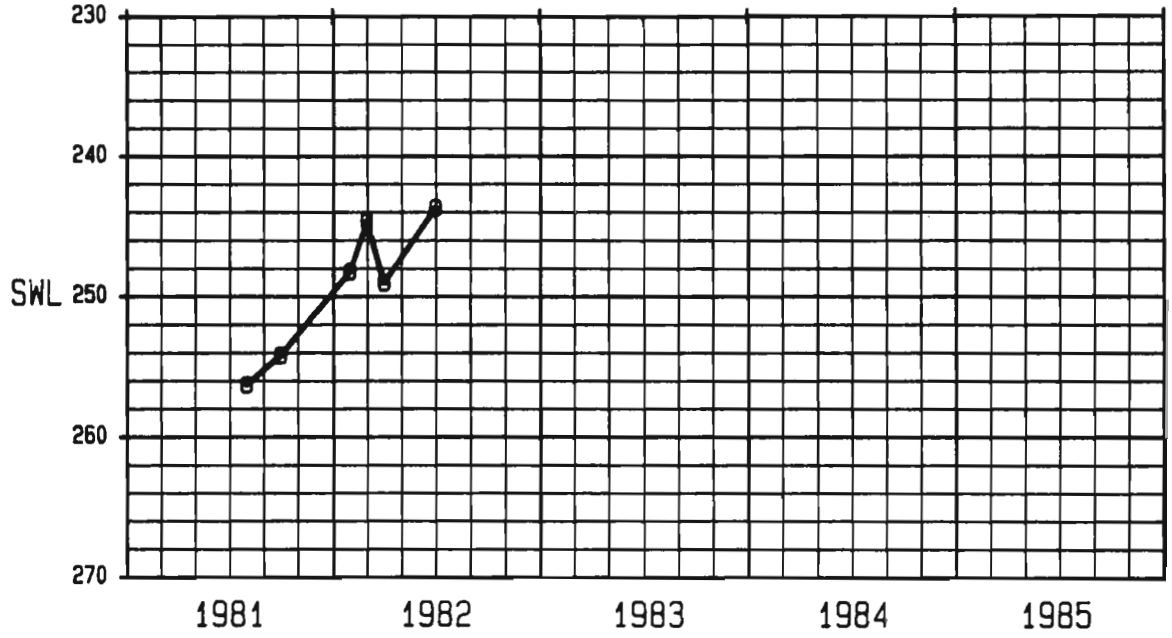
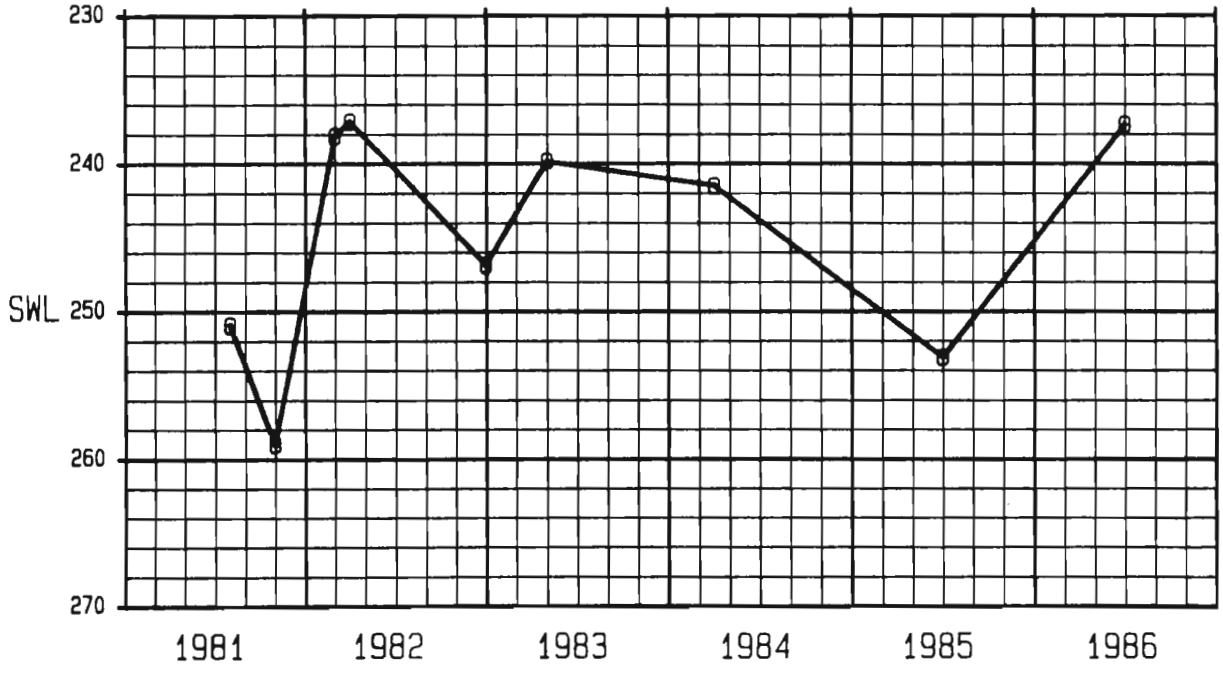


Paul Sampaulesi Well



Melvin Menge Well



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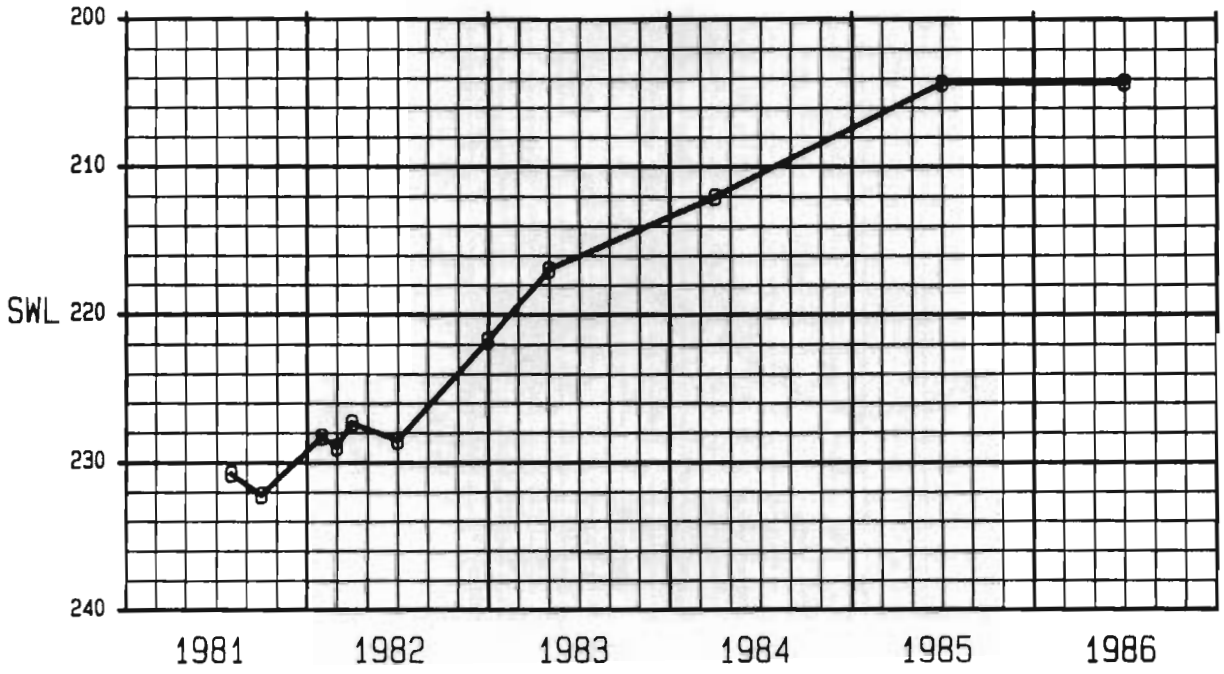
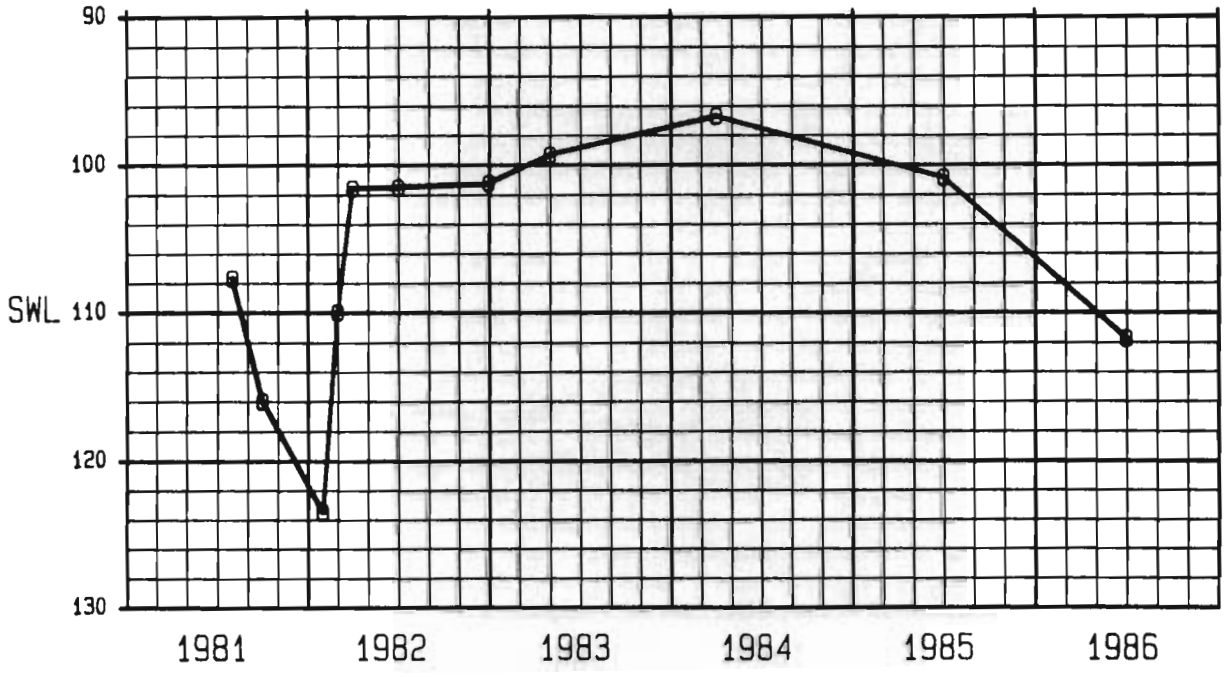
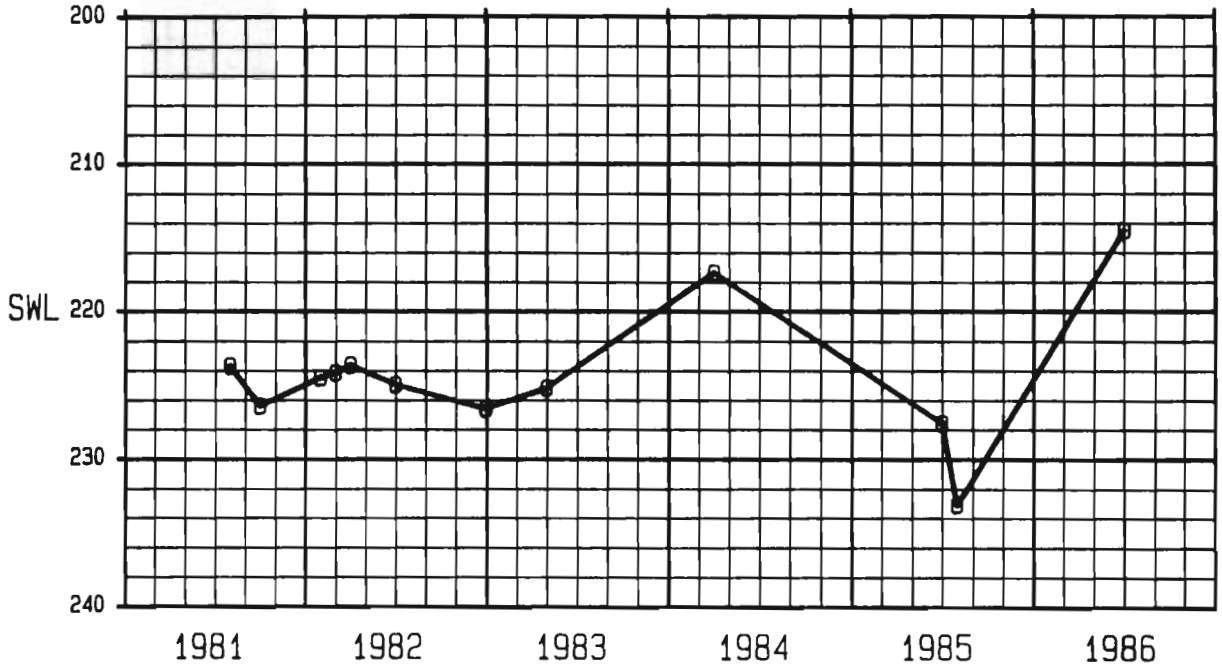


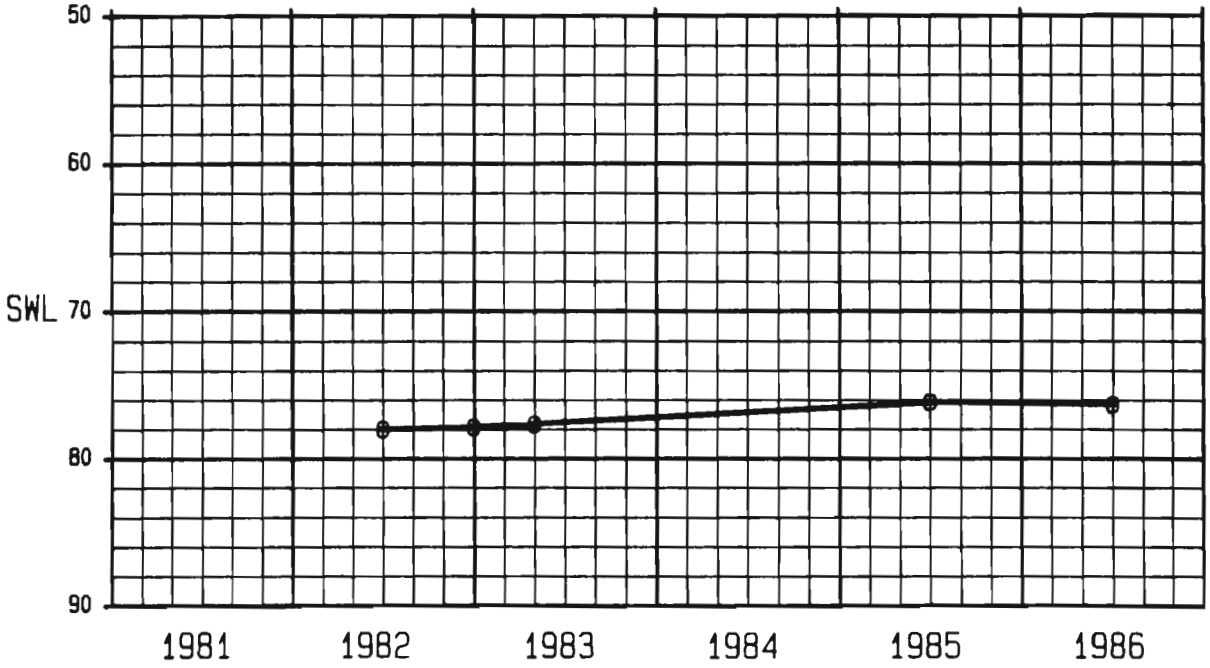
Wilson Well



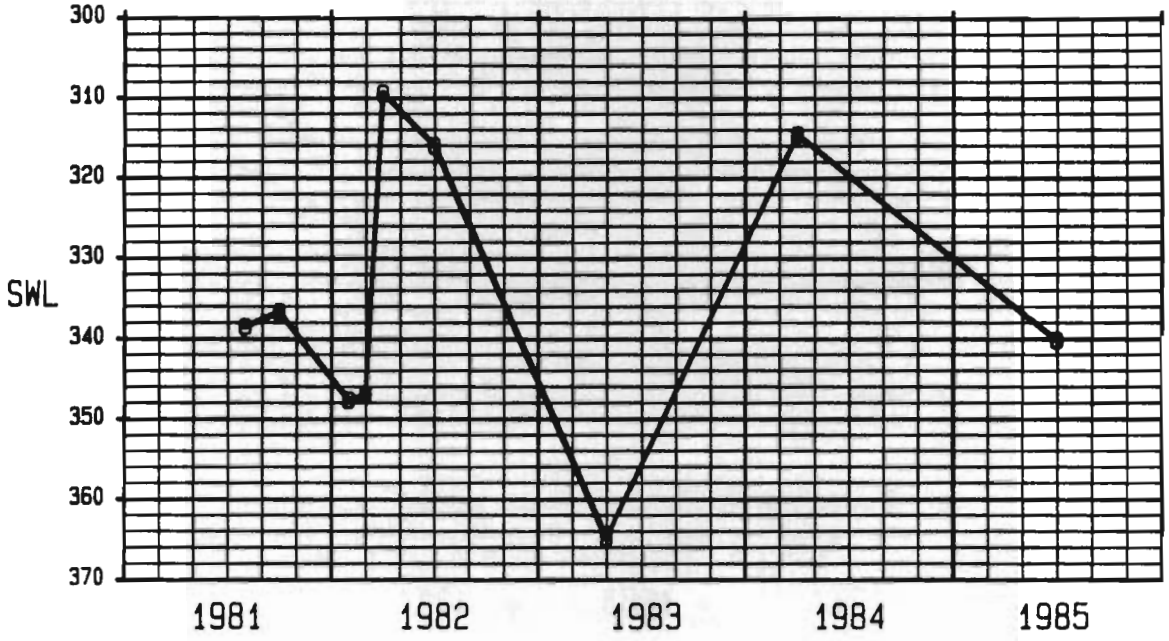
McCourtney Well



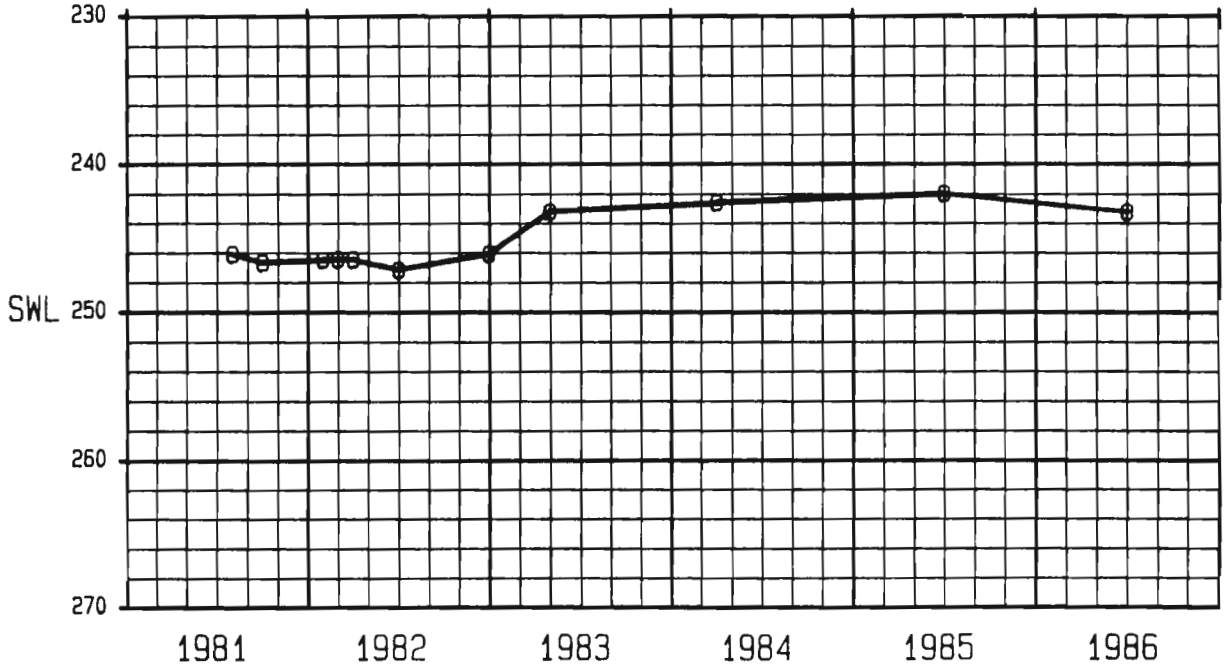
Red Cloud Ranch Well "C"



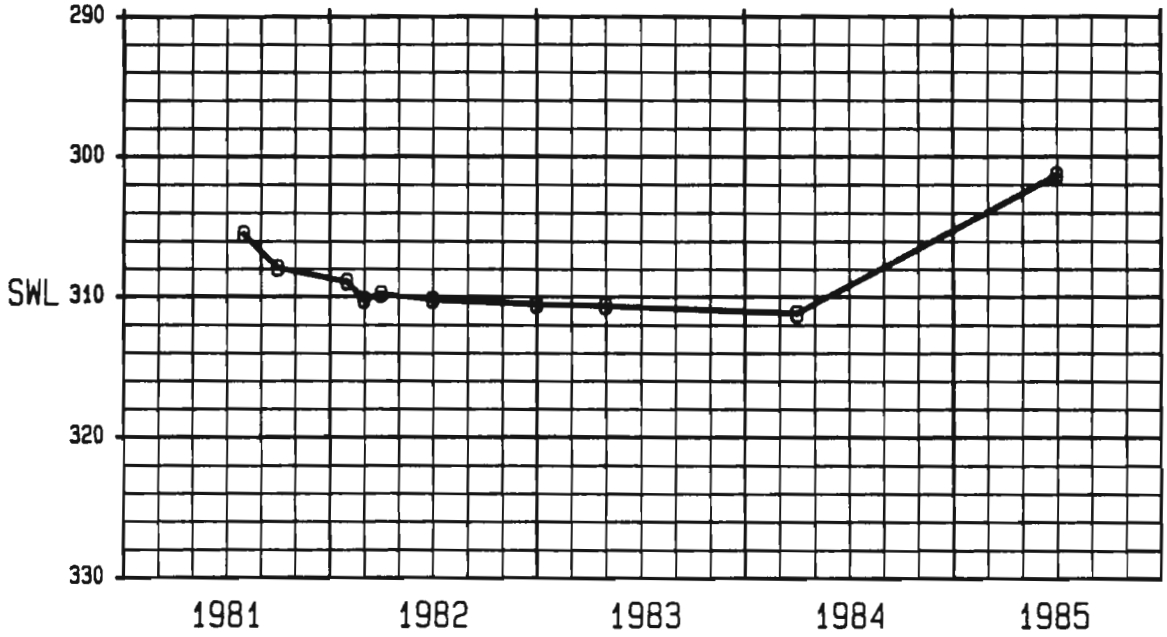
Dale Hoskins Well #1



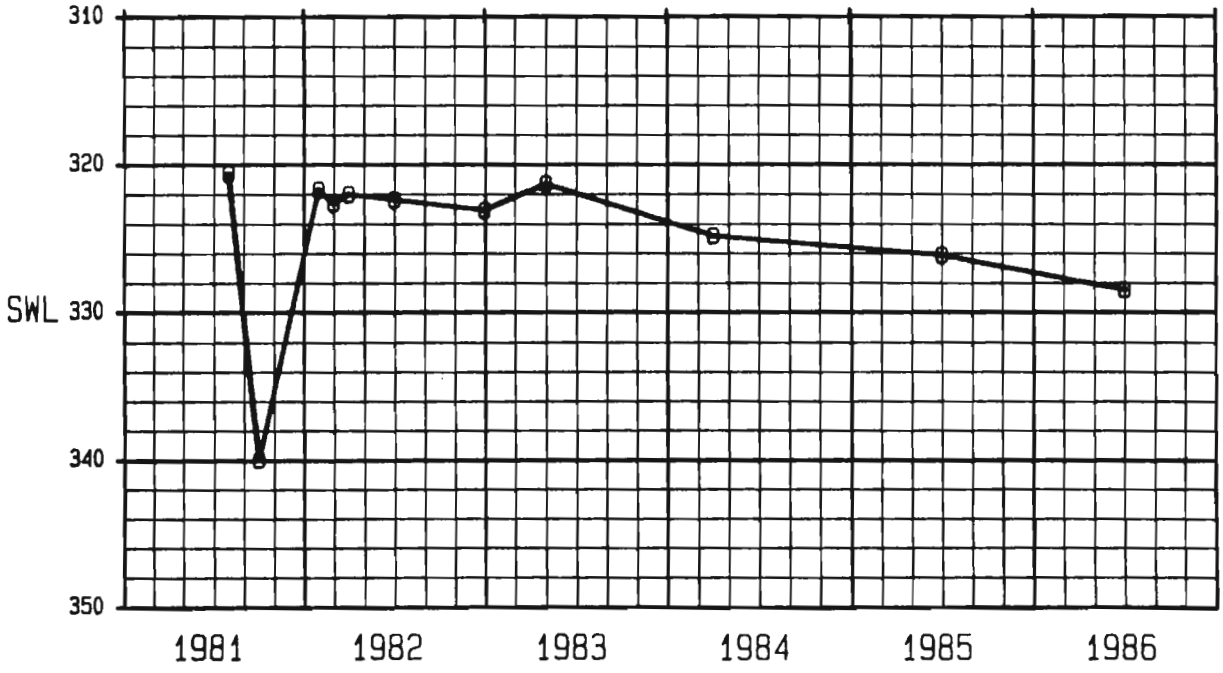
Dale Hoskins Well #2



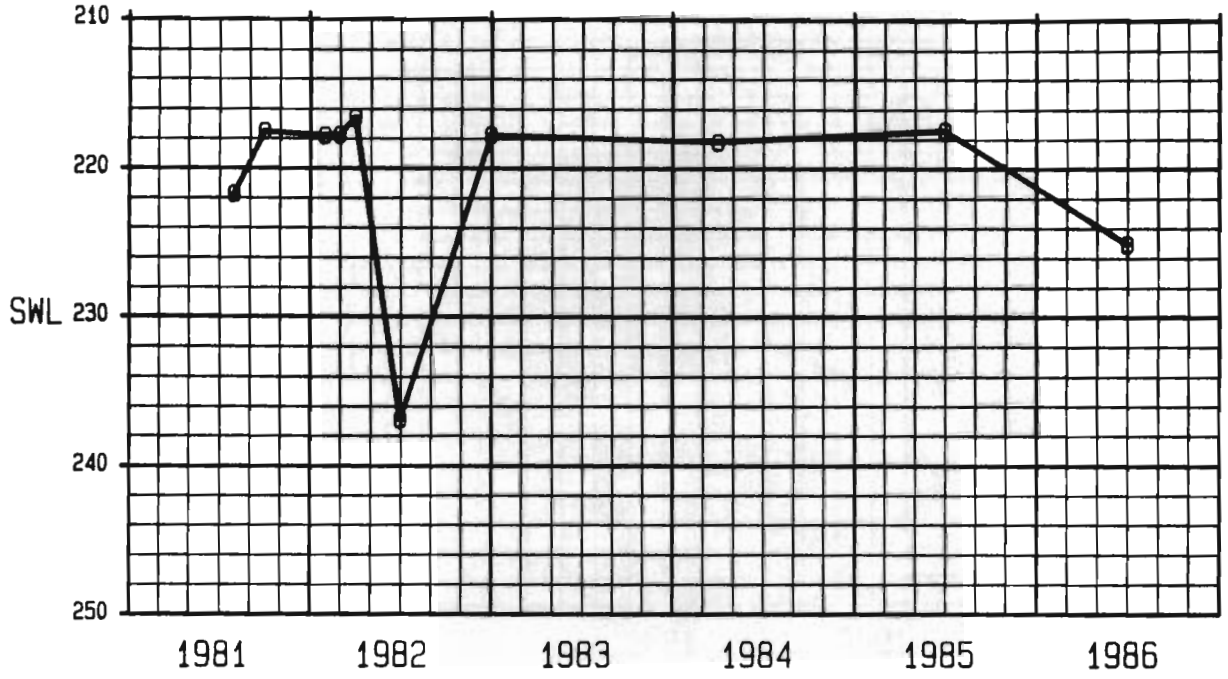
Stanley Hushour Well



Larry Crawford Well



Robert McCall Well



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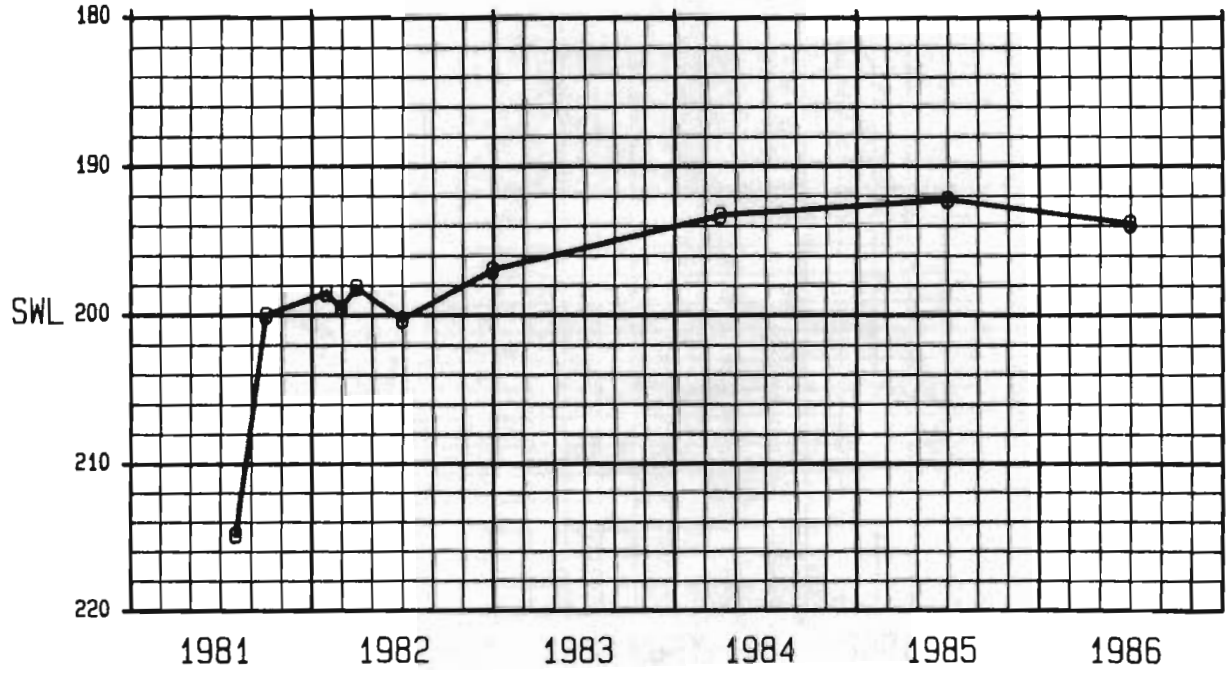

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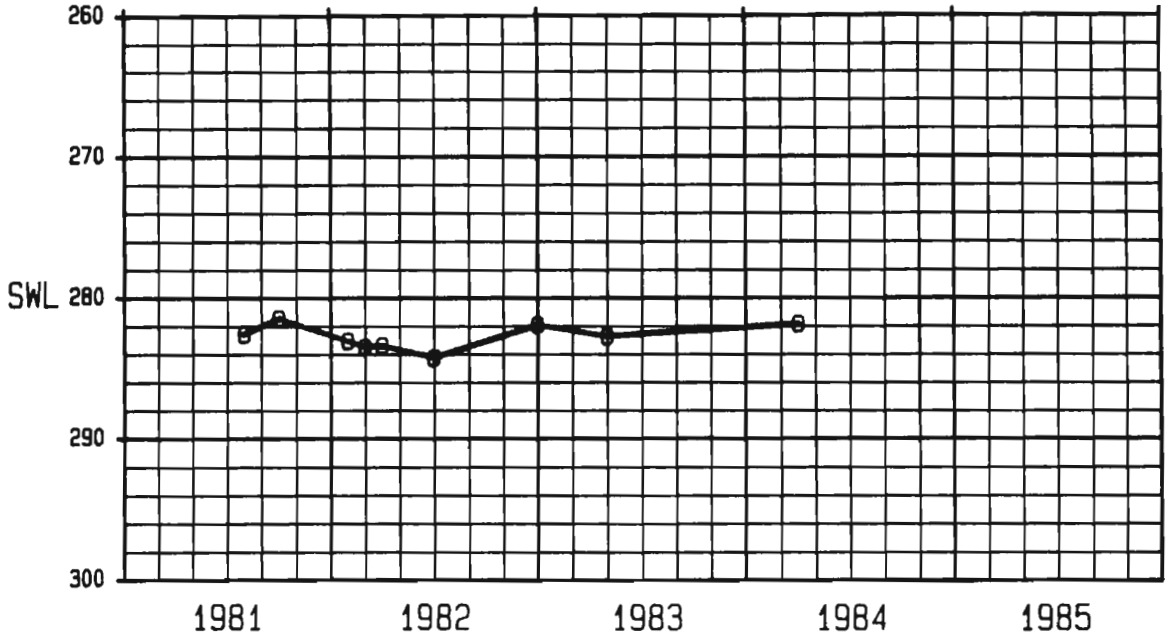

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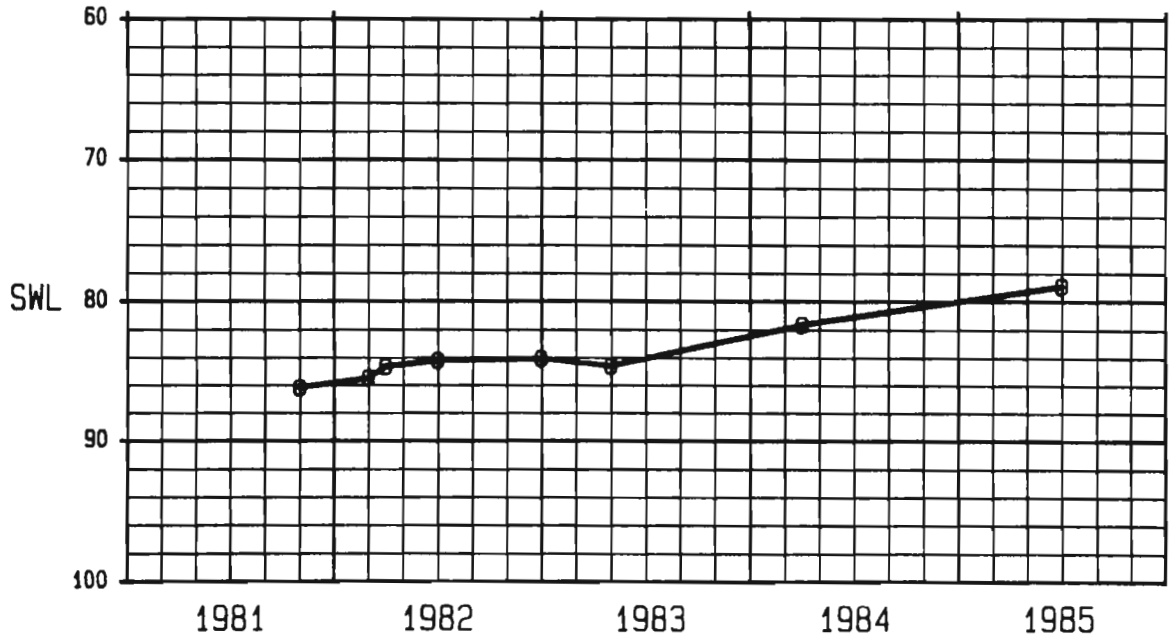
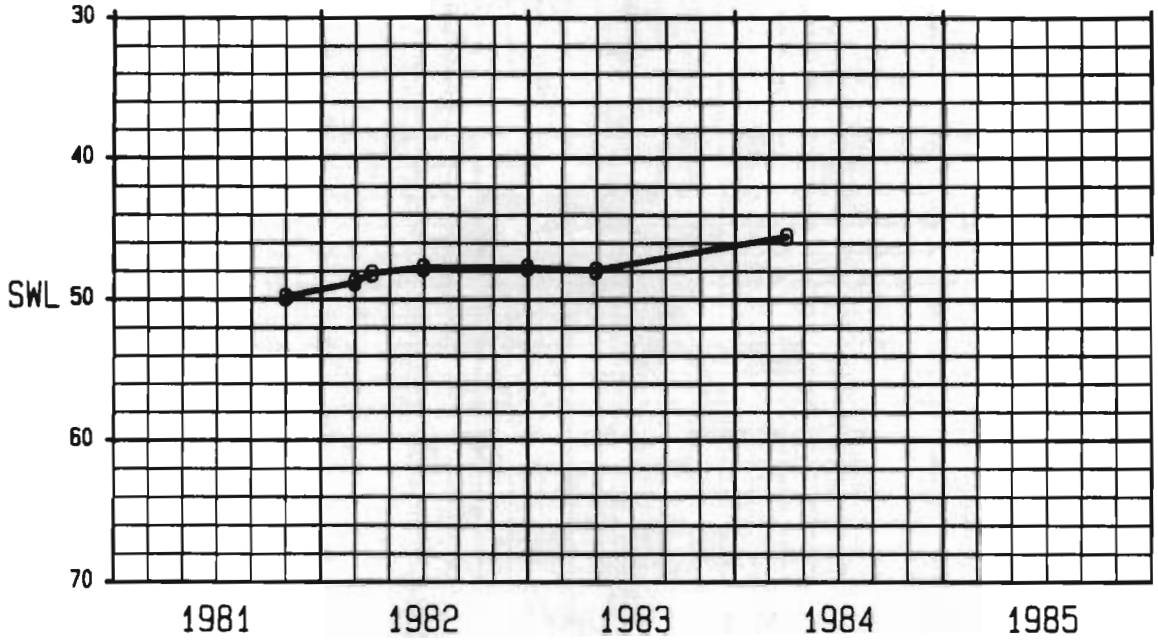
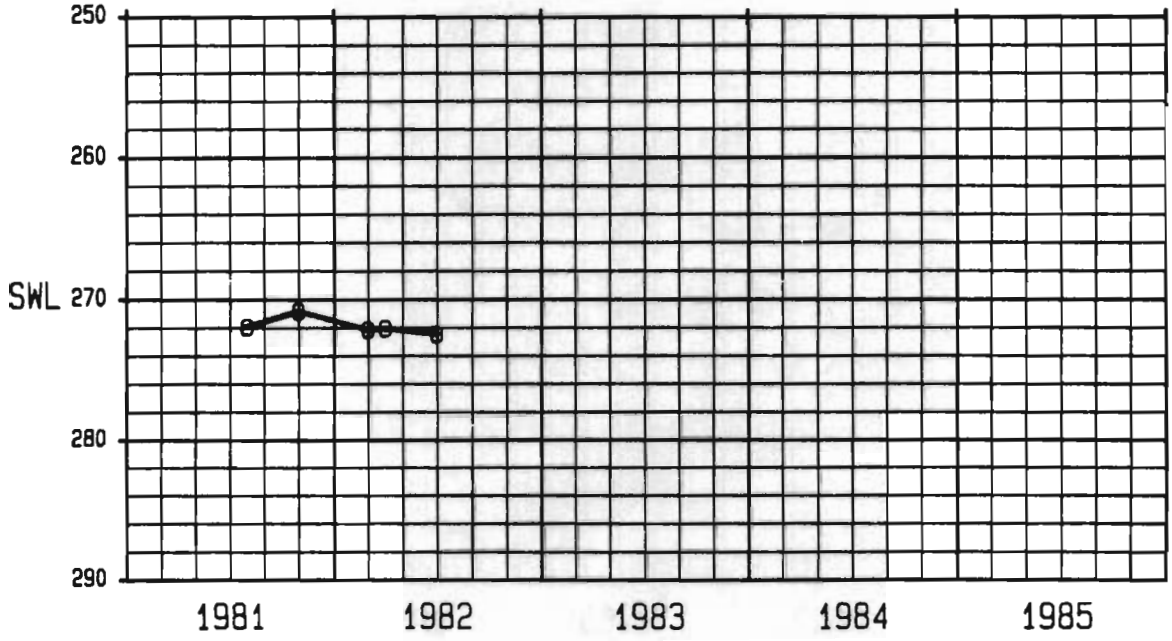


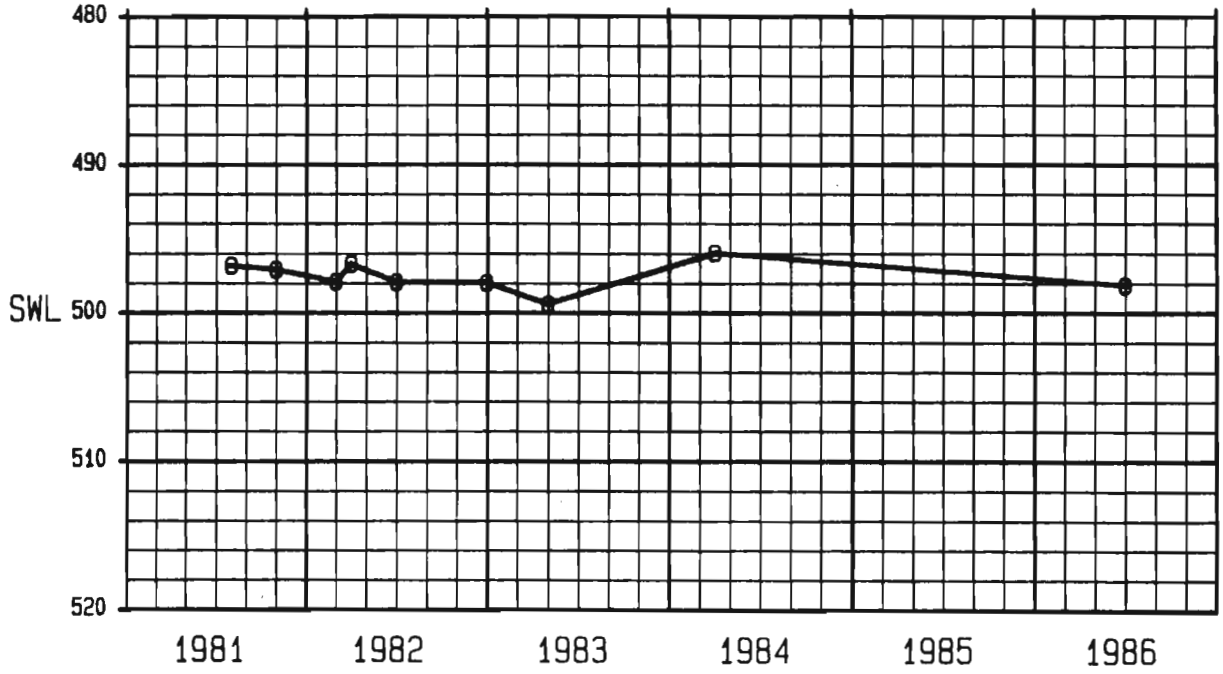
Red Cloud Ranch Well "B"



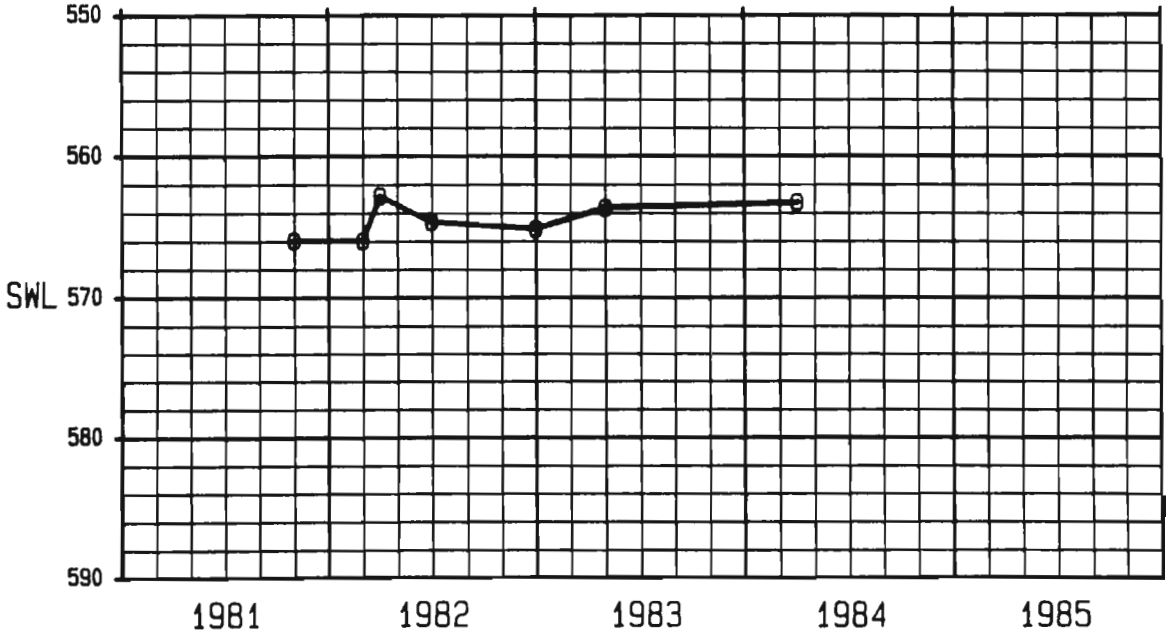
Don Howlett Well



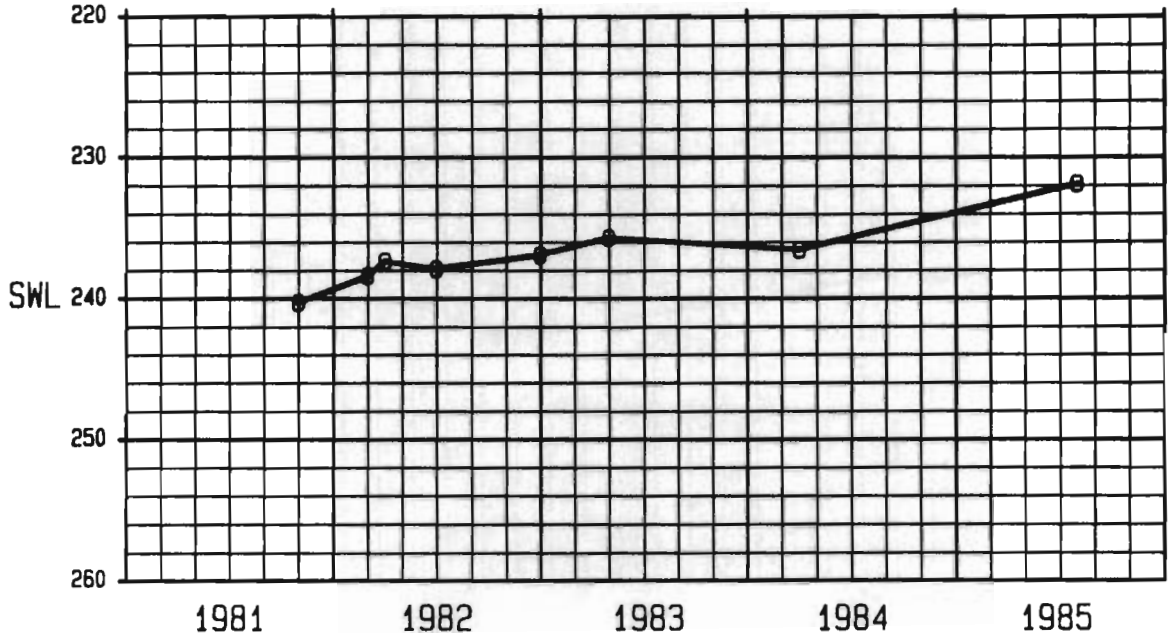
Robert McCasland Well



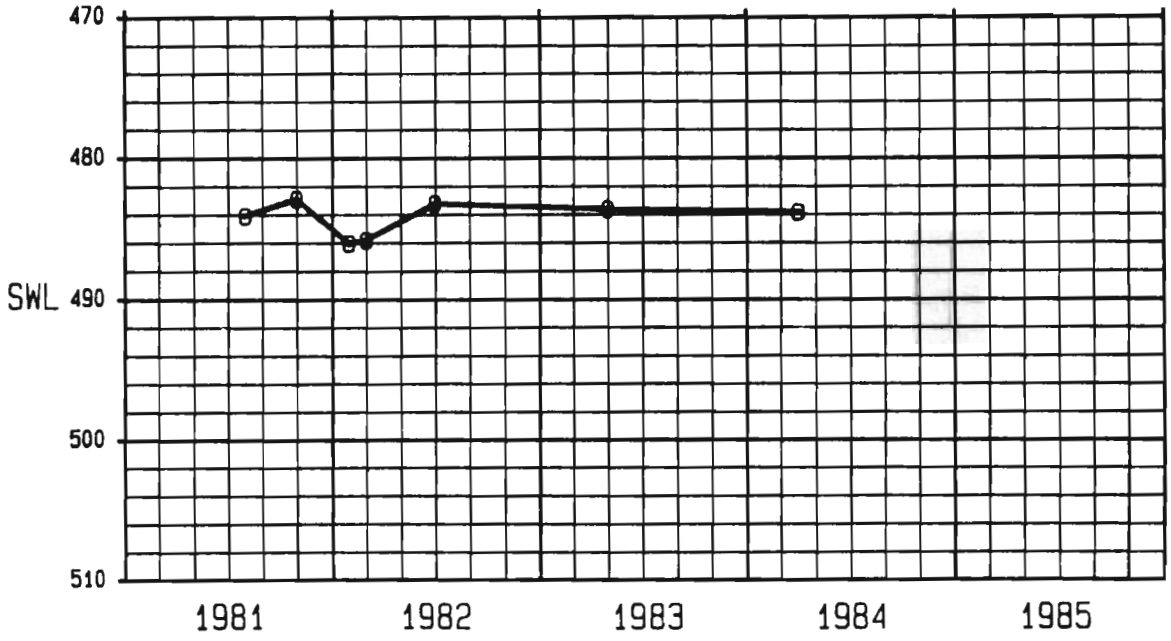
Jensen Well



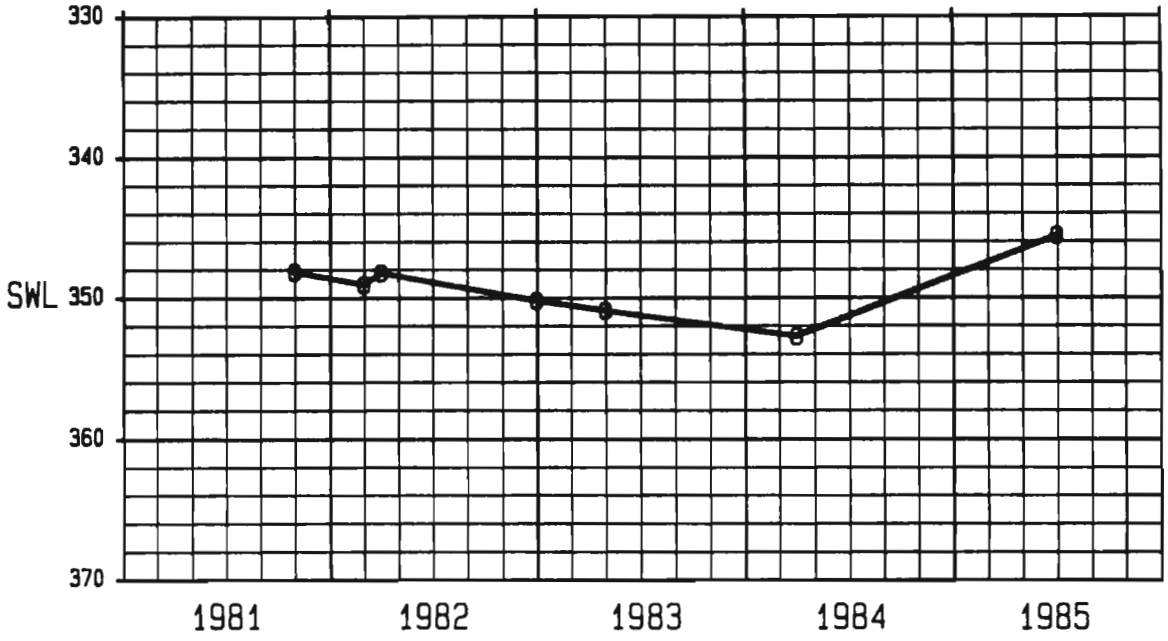
Lloyd Mathers Well



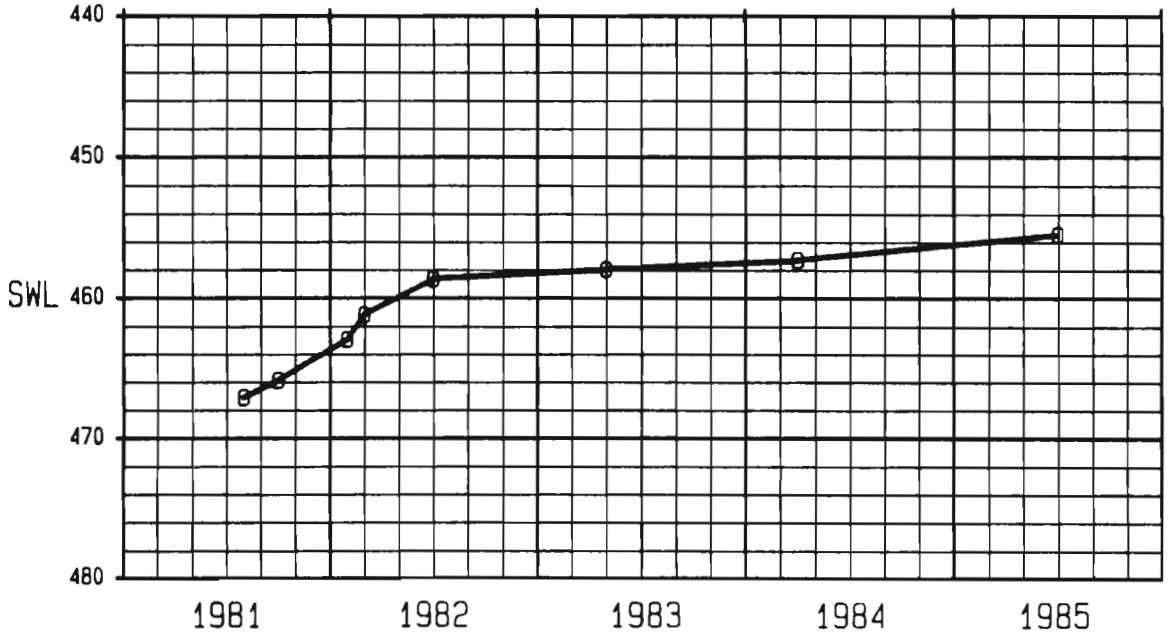
Alan Bovee Well



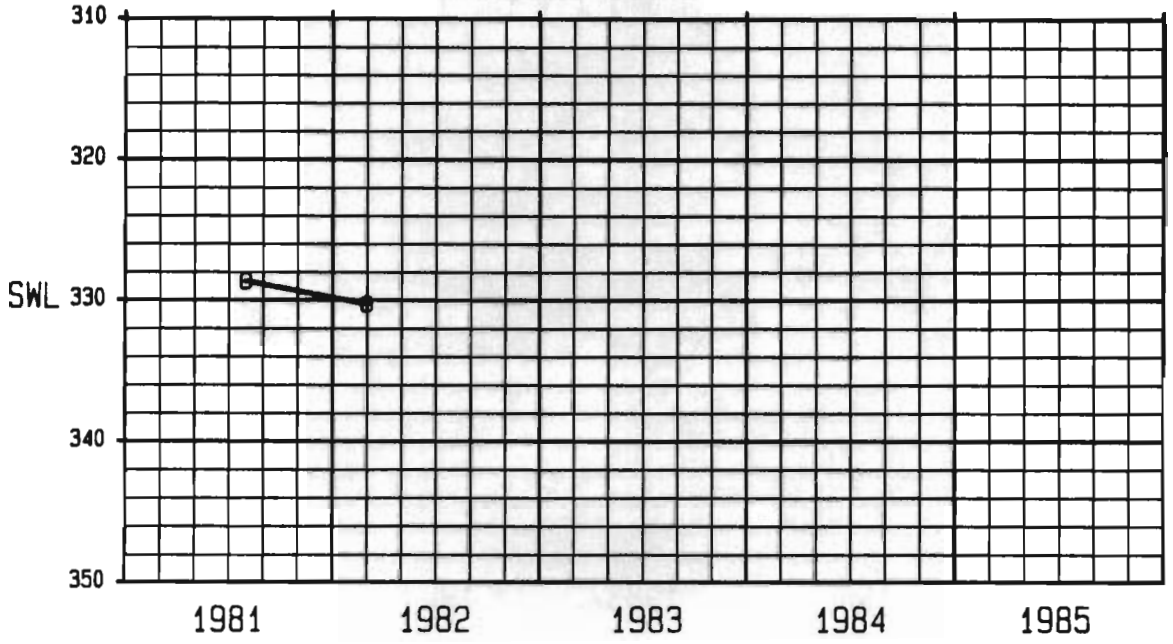
Ray Shumway Well #1



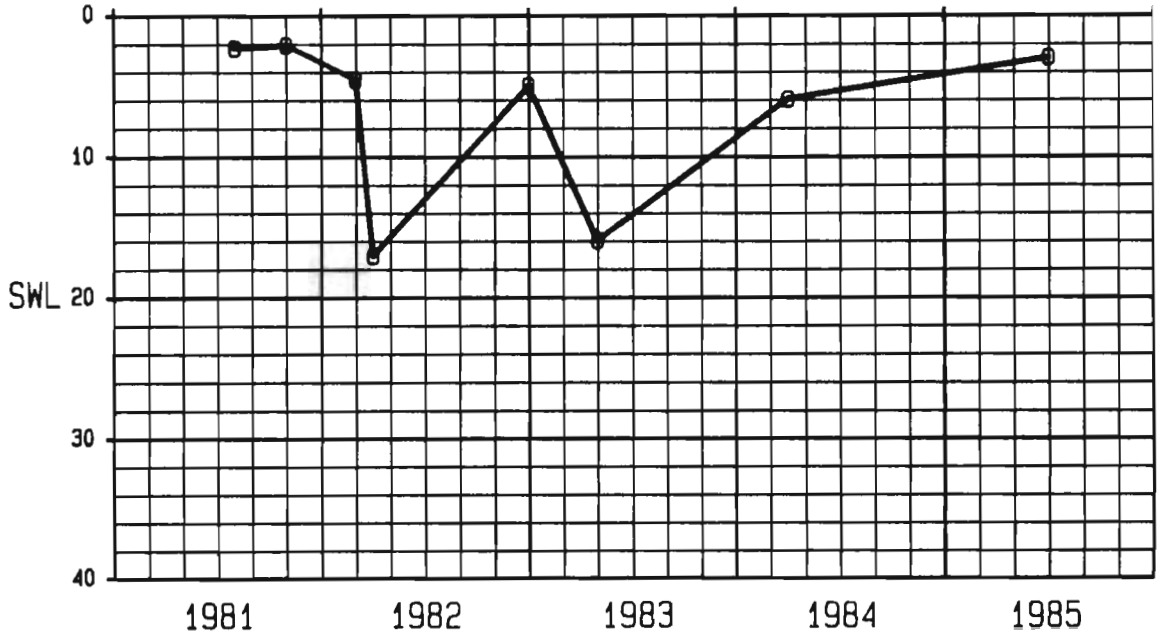
Harry Martin Well



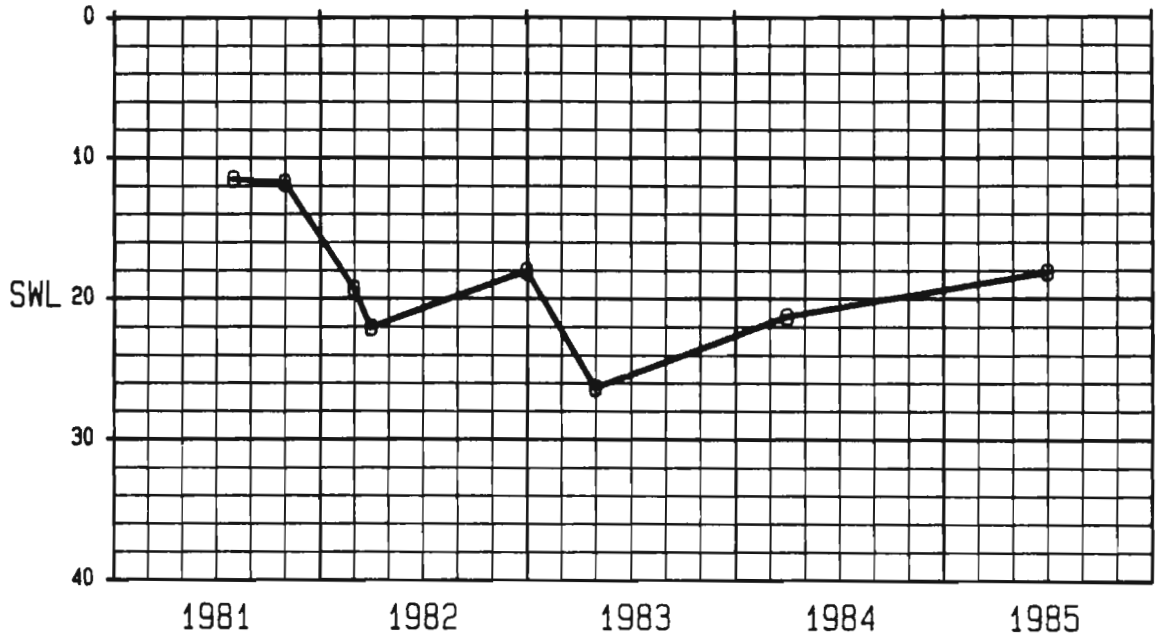
Shumway Windmill Well



Tony Palmer Well



Richard Seaverson Well



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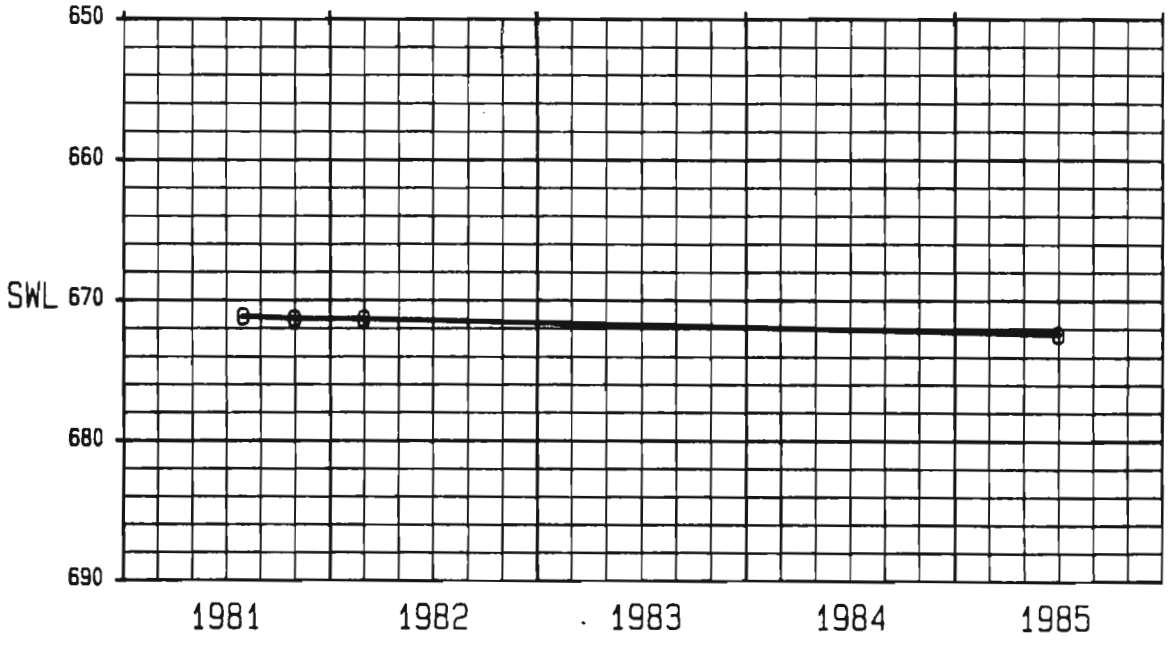
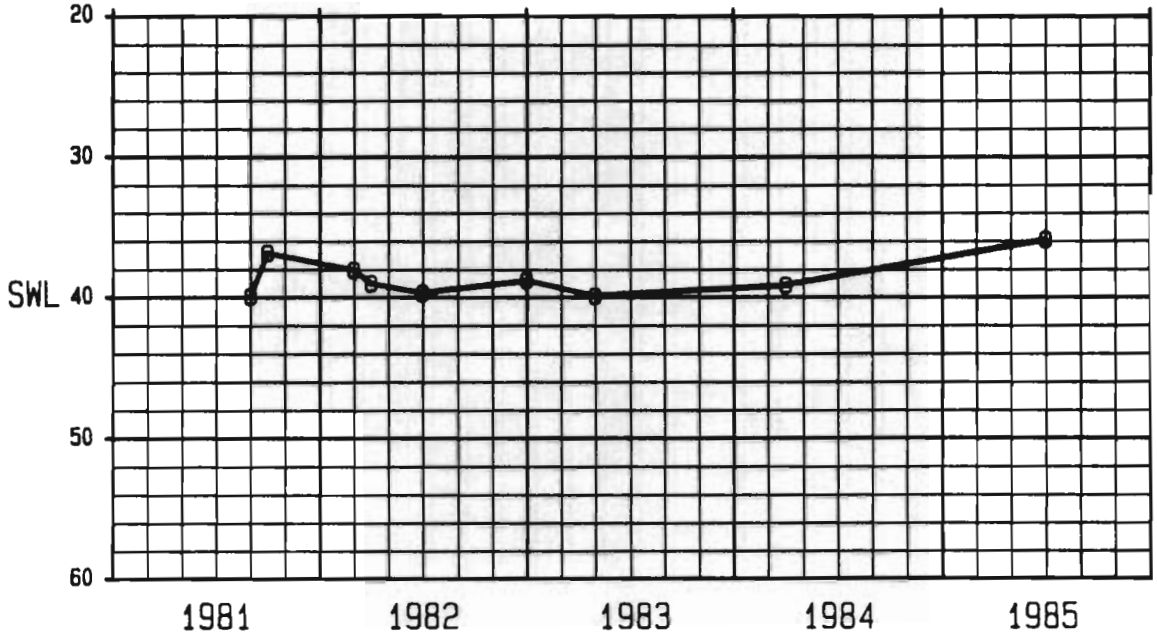
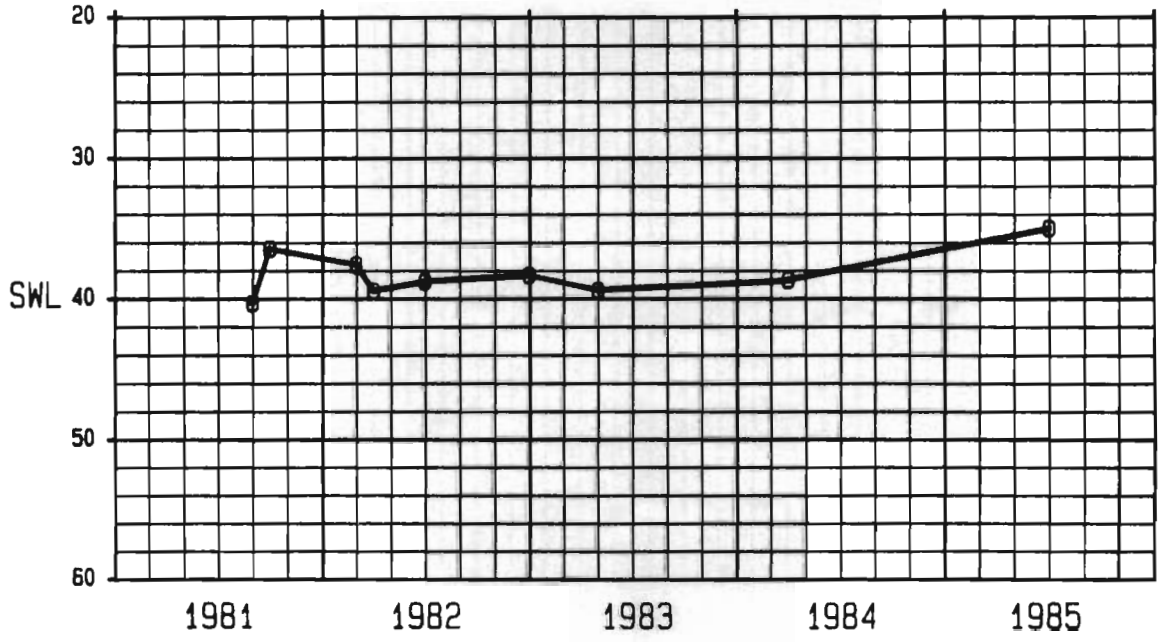


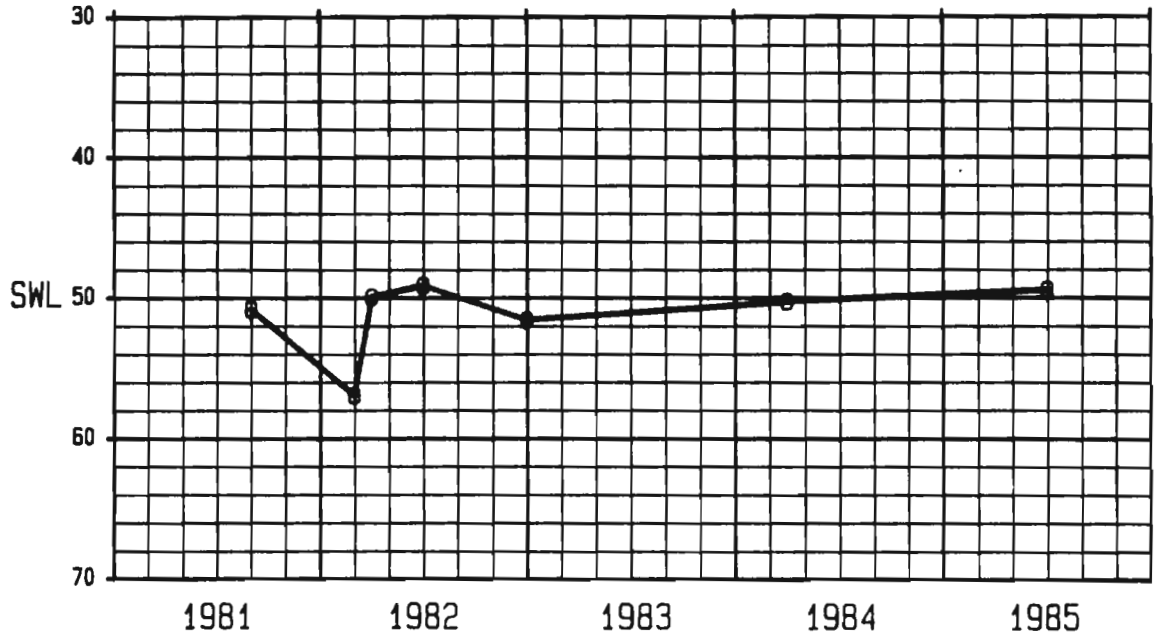
A. Curry Well



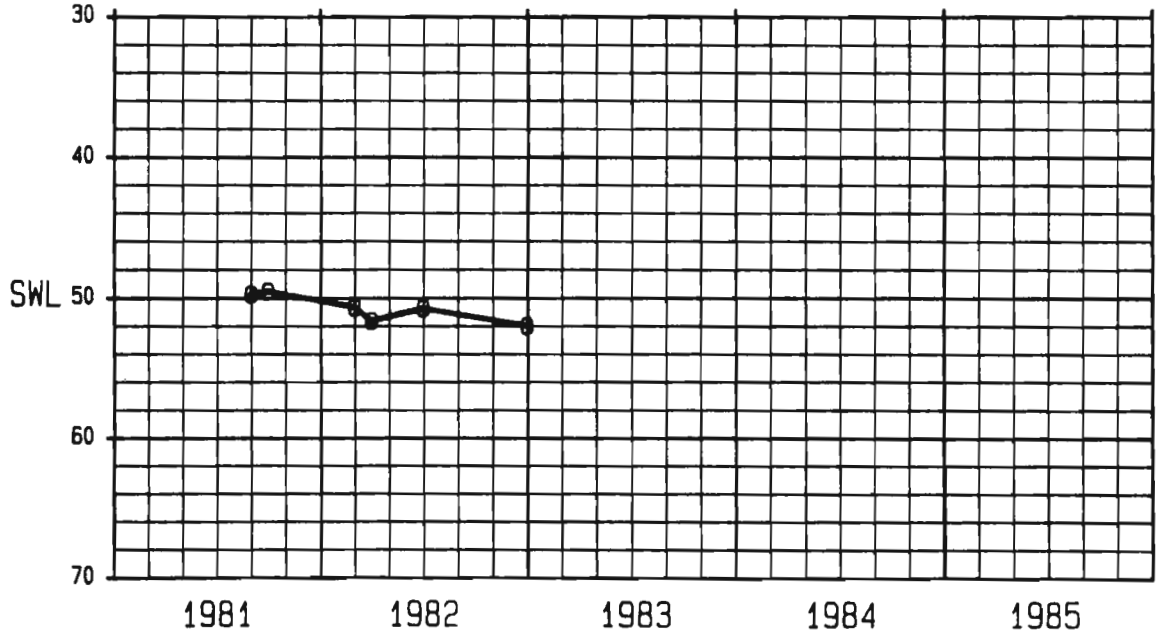
N. Curry Well



Wampler and Werth Well #4



Wampler and Werth Well #2



APPENDIX II, WELL INFORMATION

The following table contains selected information from water well reports for wells in Townships 15S 14E, 15S 15E, 16S 14E and 16S 5E. Wells marked with an asterisk were monitored during this investigation.

SUMARY OF WELL RECORDS IN THE POWELL BUTTE AREA

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
						T15S, R14E								
01	Tschuntre	90	8	20	0	2	P	55	6	20	-	54		
01	Rachor	295	5	12	10	2	P	280	4	290	-	42		
01ac	Van Thompson	285	8 5/8	10	2	5	B	272	10	5	-			
01ca	Miller	62	8	45	0	2	B	19	8	20	-	48		
01cc	Bowen	399	8	20	0	2	B	297	8	20	-	53		
01cc	Smith	107	8	30	6	1	B	70	8	26	-	49		
03	Allen	290	8	18	0	1	P	246	5	290	270-290	57		
03	Miller	290	8	16	0	-	A	253	5	290	250-290	55		
03	Madar	290	8	18	0	-	A	242	6	290	259-290	54		
03b	Johnston	287	8	12	5	-	A	243	6	287	247-287	53		
03ab	James	300	6	25	0	2	B	260	6	175	-	54		
03ab	Anson	297	8	10	2	1	B	260	6	297	277-297			
03ca	Schwarten	280	8	8	0	1	B	242	6	280	240-280	67		
03cc	Davis	276	8	20	0	2	B	234	8	89	-	54		
03da	Kiggins	270	8	20	0	1	B	235	6	19	-	51		
03db	Young	285	8	25	25	1	A	250	5	285	245-285			
03dc	Hunt	287	8	17	0	1	B	240	6	287	247-287	57		
07	Rockwood	105	8	10	20	1	B	76	6	105	92-104	57		
09ac	Waldron	294	8	8	4	1	B	262	6	294	274-294			
10	Leisure Resources, Inc.	355	6	15	Complete	1	B	330	6	140	-	57		
10	Cameron	305	6	30	15	1	A	245	6	220	-			
10a	Nolan	281	8	15	20	2	B	269	6 5	21	-	54		Deepening
10ac	Davis	305	5 1/2	5	0	1	B	260	4	335	310-330			Reconstr.
10ac	Halcorn	337	8	30	9	1	A	266	8	19	317-337	53		
10ad	Waite	261	-	20	0	-	A	213	6	261	231-261	53		Deepening
10ad	Davis	-	-	-	-	-	-	-	5	225	-			Reconstr.
10ad	Waite	61	8	25	0	-	A	36	6	61	31- 61	57		
10ba	Anderson	291	8	15	0	1	B	241	6	290	251-291	57		
10cb	Thompson	310	8	20	0	1	A	270	6	260	270-310	52		
10dc	Waite	293	8	7	0	1	B	249	6	293	253-293	57		
10dd	Schnabele	291	6	12	0	-	A	243	6	225	-	57		
11	Fischer	105	6	5	to bottom	-	B	-	6	47	-	54		
11ac	Wampler and Werth Farms	97	15	1200	5	1	P	44	16	19	-			
11ba	Curry	111	10	15	1	1	B	46	10	18	-			

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
11ba	Curry	102	8	14	4	1	B	-	6	102	82-102			
11ba	Bagley	103	8	35	3	1	B	66	8	21	-	55		
11bc	Gilbert	53	8	30	1	1	B	33	8	21	-	53		
* 11bd	Curry	98	8	100	2	1	A	46	8	25	-	56		
						T15S, R14E								
* 11ca	Wampler and Werth Farms	90	12	45	0	1	B	48	16	19	-			
* 11dc	Wampler and Werth Farms	97	12	480	7	1	P	40	16	19	-			
12	Spillman	135	8	20	0	1	B	55	8	19 1/2	-	55		
12	Chambers	41	6	5	Complete	1	B	20	6	20	20- 28	58		
12	Rockweed	30	8	-	-	-	-	-	-	-	-			Contract Dispute
12	Gibson	420	6	5	375	4	A	320	5	300	215-300			Deepening
12	Berman	35	8	10	4	1	B	23	5	35	30- 34	57		
12	Marshall	88	6 1/2	15	2	1	B	73	5 1/2	88	67- 87	54		
12ac	Gage	90	8	40	-	1	A	57	8	29	-	53		
12db	Curry	117	8	15	2	1	B	94	8	19	-			
13	Boston Ranches	335	8	20	0	2	B	275	8	20	-	60		
13ab	Dunn	395	8	20	-	1	A	315	8	20	375-395	56		
13ac	Hanna	358	8	10	0	1	B	308	6	20	-	50		
13ad	Taira	316	8	6	0	1	B	305	6 1/8	316	296-316	54		
13cc	Dickson	355	6	15	0	1	B	336	6	82	-	70		Deepening
13dd	Wampden	63	8	40	0	1	B	43	8	20 1/2	-	58		
14	Tassen	100	6	20	0	2	B	77	6	19	-	58		
14b	Pridemore	380	8	11	0	1 1/2	B	300	6	19	-	50		
14bb	Wampler Worth Farms	100	12	-	-	-	-	-	16	18	-			
14bb	Wampler Worth Farms	-	-	-	-	-	-	-	-	-	-			Reconstr.
14bb	Wampler Worth Farms	237	2	-	-	-	-	-	-	-	-			Deepening
14bb	Wampler Worth Farms	73	8	32	0	1	B	48	8	19	-			
14bb	Wampler Worth Farms	68	15	28	0	1	B	41	16	18	-			
14cb	MacFarlane	160	6	10	0	1	B	135	6	20	-	55		
14cb	Hauncn	110	8	20	0	1	B	93	8	19	-	47		

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
14cc	Simmons	225	6	6	100	1	A	115	4	220	120-220			
14cc	Simmons	132	8	20	0	1	B	111	8	19	-	47		
14d	Fischer	100	11	25	0	2	B	80	6	18	-			
14dc	Hannen	400	8	-	-	-	-	354	8	19 1/2	-			
15ac	Hacker	352	6	12	0	1 1/2	B	298	6	7	-	60		
15da	Fischer	123	8	12	-	-	A	97	6	123	103-123	57		
* 15da	Priday	149	8	15	-	-	A	119	6	149	109-149	60		
15dc	Fadden	120	8	20	0	2	B	95	6	20	-	51		
19a	Spillman	420	8	10	0	1	B	390	6	19	-			
21ad	Doonbusch	360	8	15	Complete	1	A	315	8	20	-	53		
21ad	Burke	357	8	25	-	1	A	302	8	19	337-357	53		
						T15S, R14E								
21ad	Rickard	390	6	15	Complete	1	A	310	8	60	-	53		
21da	Robins	348	6 1/2	15	0	2	B	326	6	18	-	68		
22	Kewser	347	6	6	0	1	B	331	6	67	-	54		
* 22	Mansfield	121	8	12	0	2	B	112	6	121	107-121	53		
22aa	Crabtree	380	8	53	0	2	P	340	-	-	-	52		Deepening
22ab	Amis	350	8	10	5	1	B	310	6	350	319-350	64		
* 22ab	Caraway	125	8	15	0	1 1/4	B	72	8	20	-	55		
* 22ab	Keuser	327	8	8	4	1	B	251	6	327	-			
22ba	McDonald	345	6	20	-	-	A	271	6	246	-	56		
22bd	Follose	375	8	10	0	1	B	323	6	375	329-375	56		
22cc	Johnson	385	6	14	1	1	B	350	6	375	355-375	60		Deepening
22cc	Johnson	175	11	20	0	1	B	150	8	175	150-175	52		
22cc	Peterson	127	8	25	1	2	B	108	6	42	-	52		
22cc	Bazartl	350	8	10	0	1	B	332	6	350	330-350			
22da	Welch	380	5	10	3	2	B	365	5	357	350-357	70		
23	Sioquist	402	8	25	0	1	B	380	8	19	-	65		
23	Hagbery	480	-	5	60	1	B	350	5	480	440-480	55		Reconstr.
23	Hagbery	480	6	6	Complete	2	A	350	6	114	-	72		
23	Dickson	475	6	23	0	3	A	468	6	315	-	69		
23	McCright	365	8	20	40	2	B	329	6	20	-	46		
23b	McCurdy	435	6	20	-	1	A	390	6	138	-	57		
23aa	McCurdy	175	6	16	Complete	1	A	131	6	120	-	55		
23aa	Welch	145	6	25	0	2	P	126	6	119	-	56		
23bd	Williams	361	8	13	0	-	A	320	6	361	321-361	57		
24	Higgins	260	8	30	-	-	B	232	6	42	-	61		
24ad	Cluff	364	8	40	0	4	P	304	6	364	344-364	55		

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
24bb	Minson	420	8	10	25	2	B	363	8	38 1/2	-	63		
* 24cc	Ruthenbucker	275	8	12	3	1	B	236	8	19	-			
24cc	Musick	260	6	15	3 1/2	2	B	-	6	15 1/2	-			
25a	Dunkin	268	8	10	0	1	B	223	8	18 1/2	-	66		
25ac	Hepperly	305	6	8	20	1	A	265	6	19	-			
25cb	Goodman	275	8	20	0	1	B	220	8	20	-	72		
* 25db	Landrus	377	8	14	-	1	A	325	8	19	357-377	70		
25dc	Hepperle	500	8	10	0	4	A	320	8	20	-			
26	Crook County School Dist.	485	-	20	0	1	B	370	6	485	424-484	76		Reconstr.
26	Frame	500	8	10	0	1	B	393	8	25	-	51		
26	Herbst	497	6	45	0	2	B	261	5	427	-	78		
* 26	Copley	318	8	12	0	1	B	290	8	24	-	75		
26	Sioquist	417	6	20	-	-	B	394	6	187	-	74		
26a	ORE	360	8	10	0	3	B	260	8	21	-	70		
26aa	Higgins	250	6	10	15	1	P	220	6	33	-			
26ab	Crook County School Dist.	470	8	20	93	2	P	361	-	-	-	64		
						T15S R15E								
26ba	Powell Butte Comm. Church	420	8	25	0	2	B	392	8	22	-			
27	Herbst	172	6	15	0	-	B	-	6	15	-			
27ab	Hannen	390	8	15	0	1	B	371	8	19	-	70		
27ab	Dyer	390	8	20	0	2	B	355	6	20	-	52		
27bc	Cunningham	418	8	10	0	1	B	373	6	418	378-418	66		
27cb	Christofferson	162	8	30	0	1	B	142	6	19	-	56		
28dc	Nelson	425	8	20	-	1	A	360	8	20	379.8-423.5			
30cd	Gibson	365	8	15	0	2	B	310	6	20	-	56		
31	High View Estates	640	8	10	0	1	B	410	8	396	-			
31cd	U.S. Army Test Site	492	12	97	0	4	P	370	7	422	-	52		
33da	Weigand	483	8	15	0	1	P	444	8	28	-	68		
				15	0	3	B							
34aa	Johnson	522	8	8	0	1	B	440	6	522	502-522			
* 34ba	McFarlane	444	8	15	0	2	B	418	6	19	-	63		
34bb	Horsell	435	6	6	3	1	B	405	-	-	-	56		Deepening
34bb	Horsell	212	8	3	To Bottom	3	B	180	8	26 1/2	-	56		

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
35ad	Hannemann	462	8	6	12	1	B	359	8	19	402-462			
35ba	Flock	400	8	6	8	1	B	305	8	19	380-400			
35bb	Surplus	390	8	10	0	1	B	370	8	18 1/2	-	72		
• 35bc	Flock	597	8	-	-	-	-	-	-	-	-			Deepening
35bd	Flock	403	8	7	34	1	B	246	8	19	383-403			
• 35d	Johnson	650	8	10	-	1	A	270	8	18 1/2	-	78		
• 35d	Johnson	679	8	-	-	-	-	-	-	-	-			D and Aband
35d	Johnson	318	6	20	0	12	P	271	6	65	-			
35dd	Johnson	470	10	13	0	1	B	320	10	41 1/2	-			
36aa	Conter	450	8	15	0	3	B	310	8	20	-	56		
36aa	Lasher	380	8	15	0	1 1/2	B	320	8	22	-	77		
36ba	Wolf	303	8	15	0	2	B	215	8	20	-	63		
1aa	Broadwater	45	6	105	0	1	B	22	6 5/8	41	21- 41	51		
5ab	Marjama	480	8	55	-	1	A	351	8	55	450-480	70		
5ab	Dunkin	235	8	20	6	1	B	184	6	235	195-235	61		
5bd	Dunkin	285	8	150	6	1	A	210	8	19	245-285	62		
5d	Moore	260	8	30	1	2	P	208	8/	27	-	54		
5da	Zug	245	8	9	0	1	P	205	-	19	-	52		
				6	0	1	B							
6	Griffin	308	6	15	0	1 1/2	B	276	6	6	-	70		
6	Camden	60	6	20	20	1	B	30	6	60	54-59	56		
6	Wilkins	65	6	10	15	2	B	30	6	65	45-65	56		
6	McDaniel	250	8	20	1	0	B	193	6	22	-	62		
6	Muncie	116	8	20	0	1	B	97	6 5/8	20	-	54		
6	Curry	154	8	20	Complete	2	B	134	6	154	133-153	56		
6	Gross	118	8	10	-	-	P	73	-	118	?	55		
				10	-	-	B							
6ad	Cook	155	8	16	0	1	B	119	6	155	109-155	57		
6ca	Beal	252	8	10	10	1	B	180	6	252	232-252			
6cd	Carter	80	6	10	30	1	B	30	6	70	-	53		
6da	Shivers	288	6	12	1	1	A	223	6	25	-			
6dd	Lovrien	162	8	18	-	1	A	132	8	20	142-162	52		
7	Wood	90	6	351	-	-	B	72	6	83	70- 82	49		
8cd	Crawford	417	8	8	3	1	B	375	8	19	397-417			
11c	Prineville Airport	420	8	30	0	2	B	400	5	420	-	64		
• 11db	Gruniger	475	8	135	-	2	A	414	8	25	-			
12	Winslow	420	8	9	0	1	B	340	6	19	-	50		

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
14	Essig	210	6	-	-	-	-	Flows	6	199 1/2	-	53		
14	Essig	218	6	40	20	1	B	+1	6	200	-	54		
14	Poarch	205	6	50	40	1	P	15	6	205	-			
16ac	Ochoco Const.	552	8	-	-	-	-	-	8	27	-	52		
16ac	Ochoco Const.	473	8	10	0	1	B	423	8	29	426-468	56		
17bb	Curry	415	8	9	20	1 1/2	B	355	6	415	365-415	67		
17bc	Rhodes	400	8	10	0	1	B	370	5	400	340-400			
17bc	Genor	420	6	6	0	1	A	395	6	48	-			
* 17bc	Caudle	420	8	10	0	1	P	380	8	20	-			
17dc	Sinclair	420	8	15	12	4	B	381	8	20	-	82		
18aa	Dunn	398	8	20	-	1	A	345	8	19	378-398	61		
18bc	Wing	370	8	12	0	1	B	340	8	18 1/2	-	65		
18bdd	Michel	208	8	20	0	1	B	113	6	207	141-208	57		
18cd	Hanna	395	10	10	8	1	B	367	6	394	382-394	68		
18dd	Robinson	402	8	7	8	1	B	359	8	19	380-402			
19cb	Dunn	300	8	5	0	1	P	225	6	300	200-300			
20ab	Wiley	408	8	12	0	1	A	345	8	20	384-404	66		
* 28	Engelhart													
	(Koops)	450	6	3	160	2	B	280	-	-	-			Deepening
28cc	Harris	400	4 1/2	10	50	1	B	250	4 1/2	400	240-400	56		
29	Combs	237	8	8	0	1	B	220	6	237	190-237	52		
29	Cripe	655	6	4	-	1	A	300	6	139	-	59		
29	Deitz	243	6	20	0	1	P	208	6	105	-	62		
29	Harris	280	6	16	Complete	2	B	220	6	198	-	59		
29	High View													
	Estates	590	8	10	0	1	B	390	6	515	455-515	58		
29	Pilant	190	6	20	50	2	B	120	6	95	-	62		
29	Pilant	360	6	30	30	2	B	170	-	-	-	70		Deepening
29	Sleethammer	405	6	20	10	1 1/2	B	330	6	25	-	64		
* 29bdd	Steffey													
	(Wilson)	180	6	75	63	1	A	102	6	73	-			
29	Stillman	350	6	20	100	2	P	240	6	176	158-176	75		
				10	40	1	B							
29ba	Anderson	372	8	3	19	1	B	309	6	372	312-372			
29ba	Viera	280	6	15	12	1 1/2	B	199	6	159	-	71		
* 29ba	Sampaulesi	482	6	8	Complete	1/2	P	312	-	-	-			Deepening
29ba	Sampaulesi	340	6	4	Complete	1	B	255	-	-	-	71		Deepening
* 29bc	Menge	300	8	16	0	1	B	237	8	20	-	59		

	Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
*	29bd	Conter													
		(Red Cld C)	767	10	150	625	1/2	P	135	10	19	-	74		
	29bd	Penwell	240	8	10	0	2	B	150	8	25	-	53		
	29ca	Varcoe	295	8	10	150	1	B	170	6	60	-	66		
	29ca	Varcoe	345	-	12	Complete	1	B	170	-	-	-	66		Deepening
	29cb	Roberts	300	6	200	0	1	A	225	6	180	-	52		
	29cc	Ferguson	402	8	3	45	1	B	260	8	18	-			Deepening
	29da	Koops	330	6	15	20	1	B	260	5	320	300-320	56		
*	29da	Ferguson	300	6	5	150	1	A	135	6	70	-			
	29dd	Cleveland	325	6	10	100	1	A	200	4	325	265-325			
	30	Falling Rock													
		Invest. Co.	385	8	20	0	2	B	362	6	20	-	54		
	30	Falling Rock													
		Invest. Co.	368	8	-	-	-	-	-	6	20	-			
	30	Dale ?	235	-	-	-	-	-	-	-	-	-			Dry
	30	Kimerling	765	8	1.25	0	6	P	280	8	23	-	56		Deepening
*	30	McCall	250	8	7	20	2	B	215	8	18 1/2	-			
	30	Myers	275	8	10	3	1	B	255	8	19 1/2	-			
*	30aa	Hoskins	450	8	-	-	-	-	-	8	18 1/2	-			Temp. Aband
*	30aa	Hoskins	655	8	5	30	1	P	615	8	19	-	58		
	30ac	Johnson	457	6	5	-	-	A	368	6	22	-	59		
*	30adb	Hushour	402	8	8	5	1	B	342	8	19	-			
	30ba	Davis	402	8	8	2	1	B	340	6	388	368-388			
	30bb	Blecha	310	8	25	0	1 1/2	B	262	6	18	-	56		
	30bd	Dunn	400	8	6	200	1	A	150	8	20	-			
	30bd	Dunn	-	-	-	-	-	-	-	-	-	340-380			Liner Inst.
	30c	Clark	500	8	10	0	1	B	479	-	-	-			
	30d	Williams	300	8	10	0	1	B	235	8	19	-			
	30d	Clark	390	8	10	0	1	B	350	6	19	-	54		
	30da	Kimberling	490	8	1	20	1	B	290	8	19	-	57		
	30da	Cleveland	325	6	10	100	1	A	200	4	325	265-325			
*	30db	Crawford	417	8	10	4	1	B	370	8	19	-			
	30dc	Clarke	500	8	8	0	1	B	300	-	-	-			Deepening
	30dd	Slavers	375	6	17	15	1	A	210	6	100	-			
	31	Deason	818	6	-	-	-	-	-	6 5/8	250	-			
	31	Deason	300	8	2 1/2	0	1	B	236	8	19	-	56		
	31	Gross	133	8	31	5	1	B	80	6	133	83-133	52		
*	31	High View	590	8	10	0	1	B	390	6	515	455-515	58		

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
	Estates (Avion)													
31	High View													
	Estates (Avion)	640	8	10	0	1	B	410	8	396	-			
31	Lewis	380	6	-	-	-	-	202	-	97	-			
31	Poling	260	6	17	0	2	B	210	6	139	-	54		
31	Sanders	40	8	-	-	-	-	-	6	20	-			
31	Weitgenant	242	6	10	4	1	B	221	6	92	-	59		
* 31a	McDonald	340	6	5	Complete	1	A	200	6	100	-	55		
31a	Hutching	500	6	-	-	-	-	-	6	119	-			Dry
31a	Bullington	323	6	7	Complete	1	A	184	6	119	-	56		
31b	Boyle	241	8	20	10	1	B	196	6	40	-			
31baaa	Prost	385	6	1/2	101	1	B	284	6	19 1/2	-	57		
31baaa	Prost	385	6	1	180	1	B	205	5	300	240-300	57		
31baaa	Prost	803	8	1/2	-	-	B	284	8	19	-	57		
31bb	Watts	275	8	3	100	1	P	200	5	275	175-275			
31bb	Watts	225	6	2	30	1	B	170	6	22	-			
31bb	Dalbero	419	8	7	6	1	B	360	6	419	399-419			
31bc	Williams	604	8	8	1	0	A	300	5	600	66-400			
31bc	Meyers	280	6	4	140	1	A	240	6	28	-			
31dc	Krauth	770	8	-	-	-	-	-	8	43	-			Dry
32	Davis	295	6	60	20	8	P	24	6	210	70-210	51		
32	Davis	294	6	50	25	1	P	42	6	187	100-185	58		
32ba	Krauth	465	6	2	80	1	B	175	6	175	-	58		
36aa	Conter	450	8	15	10	3	B	310	8	20	-	56		
36bd	Moore	23	6	10	0	1	P	8	6	23	-			
36ca	Miller	400	6	11	30	1	B	320	5	400	380-400	58		
						T16S, R14E								
1bb	Richter	414	8	10	0	1	B	354	6	414	374-414	68		
* 2ccc	Howlett	320	6	10	Complete	1	A	270	6	314	294-314	68		
3aa	Craddock	-	-	-	-	-	-	430	4	550	480-550			Liner inst.
3aa	Craddock	550	6	8	-	-	A	437	5	396	147-167			
3bb	Hindman	535	8	20	10	2	B	486	6	18	-	61		
3bc	Spillman	545	5	6	20	1	B	500	5	545	525-545	70		
3cc	Miller	598	8	12	0	-	A	527	6	598	558-598	70		
4ca	Ward	523	8	12	33	1	B	243	6	523	265-523	54		
4cc	Wright	462	8	8	4	1	B	400	6	462	442-462			
4cc	Hansen	401	-	-	-	-	-	-	-	-	-			Dry hole
8	Albertsen	466	6	301	-	-	P	448	6	436	-			

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
				15	-	-	B							
8	Albertsen	24	8	2	15	2	B	6	8	23	18- 23	56		
* 9	McCasland	590	8	12	0	2	P	520	6 5/8	20	-	90		
				10	0	1	B							
10	Russell	500	8	15	Complete	1	A	425	8	23	-	54		
10	Meeker	518	6	1/2	32	1/2	B	478	4 3/4	518	478-518	52		
						T16S, R14E								
10da	Turner	84	8	-	-	-	-	-	8	18 1/2	-			No water
11cc	Mathers	520	6	-	-	-	-	-	6	360	-			Deepening
11cc	Mathers	360	8	-	-	-	-	-	8	20	-			
* 11cc	Mathers	725	6	14	360	7	B	263	-	-	-	80		Deepening
14	Brown	260	6	5	40	1	P	180	6	35	-	56		
				10	47	1	B							
14bc	Moultrie	205	10	4	85	2	B	90	10	175	-	52		
14cc	Teuscher	260	6	20	1	0	B	147	6	258 1/2	130-258 1/2	60		D & Recon.
14cc	Teuscher	290	6	30	0	1	B	147	6	203 1/2	140-203	60		
14cc	Teuscher	340	-	5	0	1	B	260	5	340	200-340	60		Reconstr.
15dbd	Moultrie	175	8	-	-	-	-	-	10	20	-			Dry well
15dd	Teuscher	815	-	2	730	4	B	80	-	-	-	59		Deepening
15dd	Teuscher	1025	8	5	215	1	B	432	8	852	-	59		Deepening
* 16cb	Bovee	575	8	10	40	1 1/2	B	484	6	568	560-568	71		
16d	Jackson	500	8	-	-	-	-	-	8	138	-			
16d	Jackson	480	6	25	0	1	A	-	6	310	-			
16da	McDaniel & Crabtree	600	-	-	-	-	-	-	-	-	-			No water
16da	McDaniel & Crabtree	767	-	-	-	-	-	-	-	-	-			No water
16da	McDaniel	735	8	-	-	-	-	-	8	107	-			No water
17ab	Skidgel	487	8	8	0	1	B	469	6	486	446-486	62		
20bd	Miller	480	6	10	0	1	B	443	6	376	344-376	62		
21ba	Marshall	595	8	8	0	1	B	550	8	19	-	88		
21bb	Marshall	485	8	4	0	2	B	471	8	20	-	65		
22a	Teuscher	210	6	-	-	-	-	-	6 5/8	23	-			No water
23	Alexander	370	6	15	2	1	P	352	6	362	352-362	70		
23ab	Moultrie	400	12	4	20	4	B	320	12	20	-	60		
23bb	Teuscher	402	5 1/2	15	282	1	P	120	5	382	117-382	62		Deepening
24bc	Teuscher	717	10	-	-	-	-	115	10	18	-			H20 found
24bc	Teuscher	840	15	-	-	-	-	-	10	700	52-?			Temp. aban.

Section	Owner	Depth (feet)	Diameter (inches)	Yield (gpm)	Drawdown (feet)	Time (hrs.)	Test Type	Static Water Level (ft)	Casing size	Cased Depth (inches)	Perforated Interval (feet)	Temp. (feet)	F	Comments
28	Meisner	540	8	15	-	-	A	490	8	22	-	53		
28	Meisner	561	-	-	-	-	-	-	5	561	456-561			Deepening
28	Hughes	78	8	10	25	1/4	P	35	8	20	-	51		
				10	25	1	B							
* 28ac	Shumway	657	6	20	150	1	P	343	6	632	335-632	73		
28ad	Shumway	705	6	10	Total	1/2	P	335	6	532	492-532	64		
						T16S, R15E								
29aa	Simpson	474	8	15	0	2	B	434	6	474	454-474	61		
4	Bowdie	85	6	60	2	1	B	53	6	85	65- 85	54		
13aa	Halcomb	420	6	10	50	1	B	185	6	175	-	60		
* 26ca	Martin	560	8	0	-	-	A	-	8	79	-			
26ca	Martin	800	6	1/2	Complete	1	A	675	6	79	-			
26cc	Martin	125	8	0	0	-	B	-	6	19	-			
31cb	Meyers	280	6	-	-	-	-	240	5	280	220-280			Reconstr.
32	Jackson - War, Inc.	290	12	20	0	6	B	130	12	18	-	56		

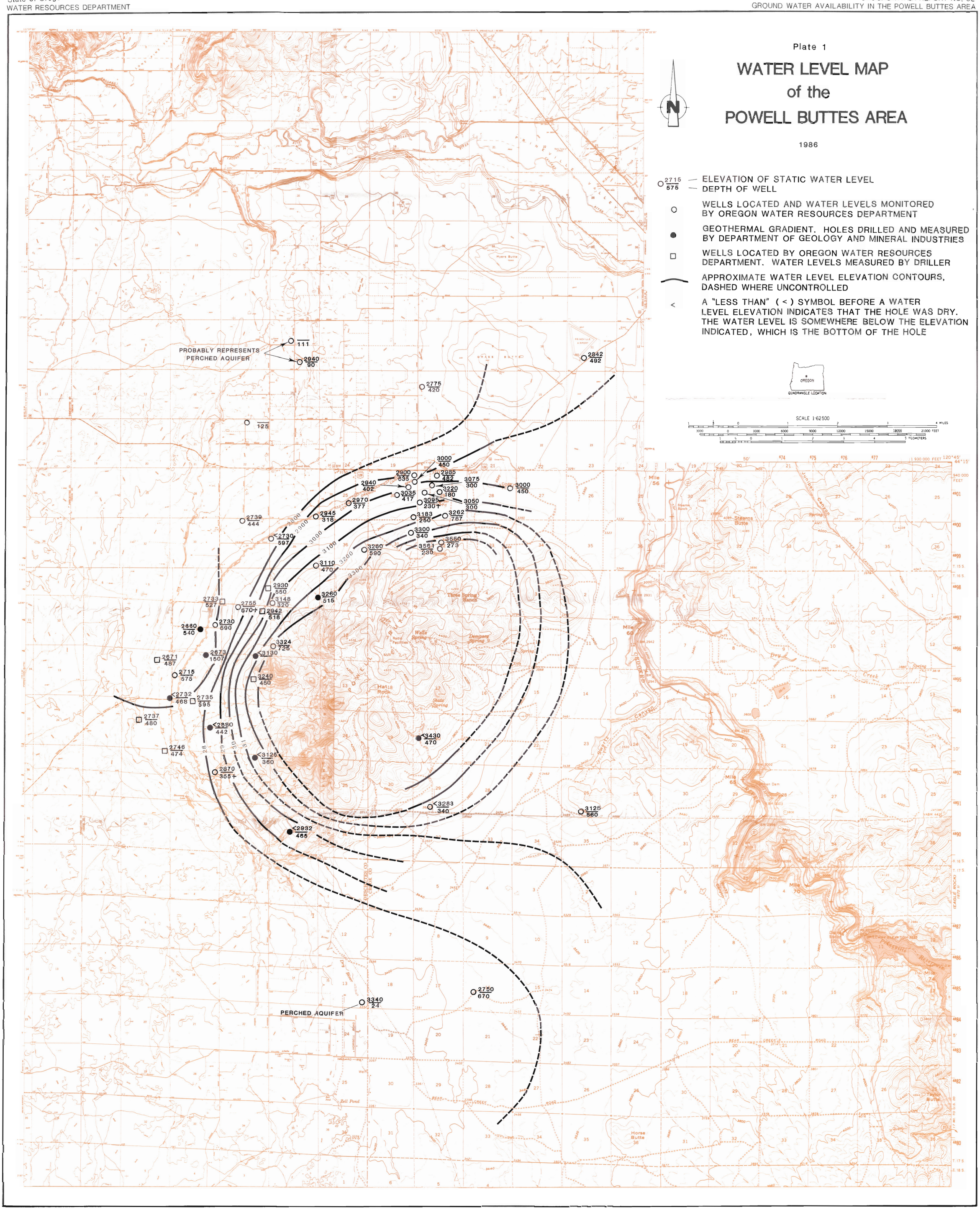


Plate 1
WATER LEVEL MAP
of the
POWELL BUTTES AREA
1986
2715 / 575 — ELEVATION OF STATIC WATER LEVEL / DEPTH OF WELL
WELLS LOCATED AND WATER LEVELS MONITORED BY OREGON WATER RESOURCES DEPARTMENT
GEOTHERMAL GRADIENT. HOLES DRILLED AND MEASURED BY DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
WELLS LOCATED BY OREGON WATER RESOURCES DEPARTMENT. WATER LEVELS MEASURED BY DRILLER
APPROXIMATE WATER LEVEL ELEVATION CONTOURS, DASHED WHERE UNCONTROLLED
A "LESS THAN" (<) SYMBOL BEFORE A WATER LEVEL ELEVATION INDICATES THAT THE HOLE WAS DRY. THE WATER LEVEL IS SOMEWHERE BELOW THE ELEVATION INDICATED, WHICH IS THE BOTTOM OF THE HOLE
OREGON
QUADRANGLE LOCATION
SCALE 1:62500
4 MILES
21000 FEET
5 KILOMETERS
PROBABLY REPRESENTS PERCHED AQUIFER
PERCHED AQUIFER
111
2940 / 90
2775 / 420
125
2842 / 492
3000 / 450
2900 / 635
2935 / 482
2940 / 402
3075 / 300
3000 / 450
3220 / 180
3035 / 417
3095 / 230+
3050 / 300
2970 / 377
2945 / 318
2739 / 444
3183 / 250
3262 / 767
<2730 / 597
3300 / 340
3550 / 273
3561 / 230
3260 / 590
3110 / 470
2930 / 550
3148 / 320
2733 / 527
2755 / 570+
2942 / 518
3260 / 515
2660 / 540
2730 / 590
3324 / 725
2671 / 487
2673 / 1507
<3130
2715 / 575
3240 / 450
<2732 / 468
2735 / 595
2737 / 480
<2880 / 442
<3430 / 470
2746 / 474
<3126 / 360
2870 / 355+
<3283 / 340
3125 / 560
<2932 / 465
2750 / 670
3340 / 24
2800
2900
3000
3100
3200
3300
28
29
30
31
Mile 56
Mile 60
Mile 65
Mile 70
Mile 74
Stearns Butte
Three Spring Ranch
Wells Spring
Dempsey Spring
Hat Rock
Skatz Spring
Dry Creek
Juniper Canyon
Horse Butte
Zell Pond
Taylor Butte
DESCHUTES CO
CROOK CO
BEAR CREEK ROAD
HORSELL ROAD
HIGHWAY 126
PRINEVILLE - REDMOND
EAGLE ROCK (STATE 11)
T. 15 S.
T. 16 S.
T. 17 S.
T. 18 S.
120°45'
44°15'
1 930 000 FEET
940 000 FEET