Ground Water Report No. 31

STATE OF OREGON

WATER RESOURCES DEPARTMENT

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Director

GROUND WATER CONDITIONS IN THE FORT ROCK BASIN, NORTHERN LAKE COUNTY, OREGON

By

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PREFACE

The readability of this report is important to its understanding. To that end the author has defined or limited jargon. Many readers may elect to limit their reading to only the abstract and the conclusions. These readers should learn much. For those with more time or interest, the entire text gives much more detail and analysis. The concepts and equations in the report are basic and should not be an impediment for the diligent reader.

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DEFINITIONS OF SELECTED TERMS

Acre-Foot (AF) -- The volume required to cover 1 acre to a depth of 1 foot. This is equal to 43,560 cubic feet or 325,851 gallons.

Alluvium -- Detrital deposits of clay, silt, sand and gravel resulting from the erosion and/or deposition by modern rivers, thus including the sediments laid down in river beds, flood plains, lakes, at the foot of mountain slopes, and estuaries.

Anticline -- A fold that is convex upward, in which strata dip away in opposite directions from a common ridge or axis and whose core contains stratigraphically older rocks.

Aquifer -- A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells or springs.

Artesian Aquifer -- Artesian is synonymous with confined. An aquifer that contains water under sufficient hydrostatic pressure to cause the water level in a well to stand above the bottom of the overlying confining layer. When the water pressure is sufficient to raise the water level above land surface, a well penetrating the aquifer will flow.

Confined Ground Water -- Ground water that is under pressure greater than atmospheric. In a well that taps a confined ground water body, the static water level is above the top of the aquifer.

Critical Ground Water Area -- An area in which an underlying ground water reservoir is specially controlled by order of the Oregon Water Resources Commission due to certain current or pending water supply or quality conditions.

Drawdown -- The lowering of the ground water level caused by well discharge. It is the difference between the non-pumping water level and the pumping water level in a well.

Evapotranspiration -- Water transferred to the atmosphere by evaporation from water surfaces or moist soil and by plant transpiration.

Fault -- A fracture or series of fractures in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Full Appropriation -- The level of ground water withdrawal through rights and entitlements which equals the present or future capturable portion of average recharge without injuring senior rights or entitlements.

Ground Water -- Any water, except capillary moisture, beneath the land surface or beneath the bed of any stream, lake, reservoir or other body of surface water within the boundaries of this state, whatever may be the geological formation or structure in which such water stands, flows, percolates or otherwise moves [ORS 537.795(3)].

Ground Water Reservoir -- A designated body of standing or moving ground water having exterior boundaries which may be ascertained or reasonably inferred [ORS 537.515(4)].

Hydraulic Gradient -- The change in static head per unit of distance in a given direction. The direction generally is understood to be that of the maximum rate of decrease in head.

Interference -- The drawdown at wells or springs which is the result of the withdrawal of water from another well(s).

Overdraft -- The artificial removal of ground water at a rate which exceeds its average annual recharge.

Permeability -- The ability of a rock or soil to transmit fluid such as water under a hydraulic gradient.

Perched Ground Water -- Ground water separated from an underlying body of ground water by an unsaturated zone of material.

Permit -- A document issued by the Oregon Water Resources Department which authorizes the diversion and beneficial use of public waters of the State.

Porosity -- The ratio of the total volume of voids in a rock or soil to its total volume, usually expressed as a decimal, fraction or percentage.

Potentiometric Head -- The level to which water in an aquifer will rise by hydrostatic pressure usually expressed as an elevation above sea level.

Residual Drawdown -- The distance during a recovery period that the water level in a well is found to be below the pre-pumping water level.

Specific Capacity -- The rate of discharge of water from a well divided by the drawdown.

Storage Coefficient -- The storage coefficient is the volume of water an aquifer releases from or takes into storage per unit area of aquifer per unit change in head.

Transmissivity -- The rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It is equal to the average hydraulic conductivity times the saturated thickness of the aquifer. In common terms, the ability of an aquifer to transmit water.

Unconfined Ground Water -- Ground water in an aquifer that has a water table.

Unconformable -- Having the relation of unconformity to the underlying rocks; not succeeding the underlying strata in immediate order of age and in parallel position.

Unconformity -- A surface of erosion or nondeposition that separates younger strata from older rocks.

Water Level -- The distance from land surface to the top of the water column in a well that penetrates either an artesian, perched or water table aquifer. When the well is pumping, the water level is referred to as a pumping level. The water level is referred to as a static water level in a well that has recovered from pumping.

Water Table -- The water surface in an unconfined ground water body, at which the pressure is atmospheric.

Water Year -- The year which begins October 1 and ends the following September 30. It carries the year number during which it ends. For example, Water Year 1985 (WY 1985) ended September 30, 1985.

The well and spring numbering system used in Oregon is based on the rectangular system used for subdivision of public land. Each well number indicates the geograhic location of the well and describes the township, range, and section. For example, the well number 26S/17E-20ca or T26S/R17E-20ca indicates a well located within Township 26 South, Range 17 East, and Section 20. The letters following the section number indicate the well location within the section as shown in Figure 1. The first letter (c) represents the quarter section (160 acres), the second letter (a) the quarter-quarter section (40 acres). If more than one well is located within a 40-acre tract, a series number is added following the second letter to distinguish each well.

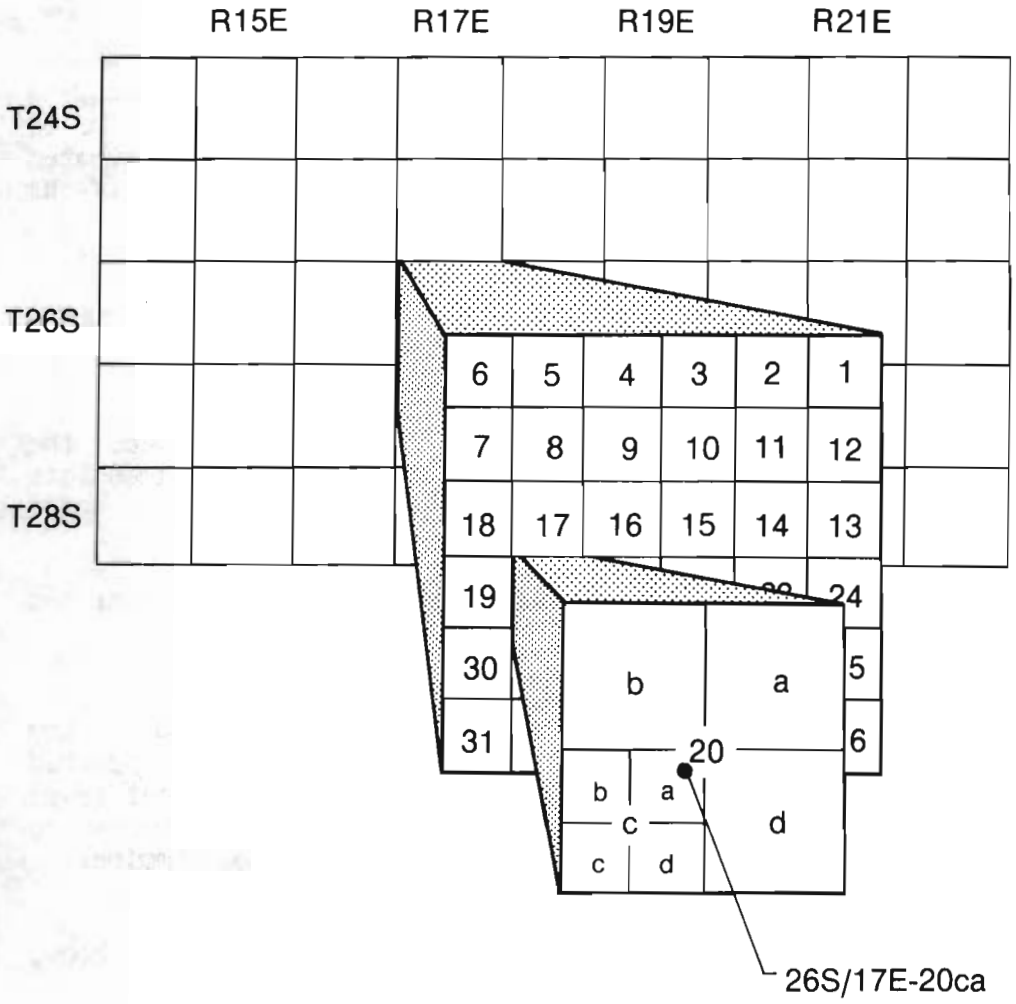

Figure 1. Well Numbering System

GROUND WATER CONDITIONS IN THE FORT ROCK BASIN, NORTHERN LAKE COUNTY, OREGON

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by Donn W. Miller

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ABSTRACT

The Fort Rock Basin is a region of interior drainage located in south-central Oregon. It comprises a total of about 2500 square miles in three component valleys: Fort Rock Valley in the northwest, Christmas Valley in the east, and Silver Lake Valley in the southwest. The basin lowlands account for 1/3 of the basin area and are nearly continuous, ranging in elevation from approximately 4300 to 4500 feet. Rugged mountains and ridges form the perimeter of the basin with divide elevations ranging from about 4700 feet on the east to 8200 feet at Yamsey Mountain on the southwest.

The basin lowlands are semiarid, commonly receiving less than 12 inches of precipitation per year. In contrast, the higher uplands can receive up to 40 inches per year. The growing season in the lowlands is less than 100 days and records show that killing frosts can occur every month of the year.

Surface water supplies in the basin are essentially limited to Silver Creek and two other perennial streams which flow from the southwest uplands into Silver Lake Valley. In northern Christmas Valley, Peter Creek occasionally flows and sinks into the valley floor during rapid snow melt or intense precipitation conditions. Elsewhere in the basin, except for small springs and ponds, surface water and natural drainage development is largely absent.

Cenozoic volcanic rocks underlie the entire area. These rocks include basalt, andesite, tuff, basaltic agglomerate, pumice and cinders. The total thickness of these volcanic rocks is unknown but certainly more than 1000 feet. In the lowlands, these rocks are largely overlain by sedimentary deposits which contain up to several hundred feet of diatomite, clay, silt, sand and gravel. Except for tuff, properly constructed wells penetrating the volcanic rocks are consistently capable of yields of 1000 gpm (gallons per minute) or more. Wells in sand and gravel can obtain these yields also. The production capacity of andesite is untested in the basin. The depths of wells range from less than 50 to nearly 1500 feet, but most are between 100 and 500 feet.

Winter precipitation within the basin is the principal source of recharge to ground water in the basin. This recharge occurs in parts of both the upland and lowland areas. The natural flow of ground water leaves the basin by subsurface outflow to the Deschutes

Basin on the northwest, by evapotranspiration within Christmas Valley in the east, and by subsurface outflow to the Summer Lake Basin on the south.

The main ground water reservoir is the dominant source of ground water in the Fort Rock Basin. Water levels in the reservoir generally rest between altitudes of 4285 and 4300 feet. Most surface waters are perched above these levels. The main ground water reservoir is widespread and consists of aquifers of volcanic and sedimentary materials. The reservoir displays both confined and unconfined conditions. Only one flowing well is known, but others could also be drilled in eastern Christmas Valley where land surface altitudes are below 4290 feet. The reservoir is very favorable for the transmission and storage of water. Aquifer test calculations at irrigation wells in each valley render high transmissvities of 70,000 to 2,750,000 gpd/ft. (gallons per day per foot). One test lead to a high storage coefficient of 0.10 to 0.12.

Water level monitoring in wells is concentrated in the lowland areas. In the absence of pumping, typical water levels in the main ground water reservoir seem to fluctuate less than 1.1 feet per year. Under very strong annual recharge conditions, water levels may rise 1 foot. Conversely, under very weak annual recharge conditions, levels may drop 0.4 foot. Long-term water level fluctuations lag about 1 year behind the recorded long-term precipitation and streamflow fluctuations. With widespread pumping, water levels may fluctuate annually less than 1.1 feet in isolated areas to more than 100 feet at pumping wells.

Ground water in the basin is usually of good quality for drinking, irrigation, and other uses. In general, it has a dissolved solids content of less than 250 mg/l(milligrams per liter), hardness of less than 150 mg/l, and boron less than 1 mg/l. Ground water in the area is usually of the sodium bicarbonate type and has an average specific conductance of about 300 micromhos per centimeter. Water temperatures range from 50° to 97°F with most between 50° and 60°F. A Carbon-14 water sample from a 700 feet well rendered an apparent ground water age of 2500 years before present.

Prior to 1972, ground water pumpage was less than 20,000 AF (acre-feet) per year and showed no discernible long-term affect on water levels in wells. The period 1972 to 1981 displayed steady increases in estimated pumpage from 22,000 to 91,000 AF. Pumpage between 1981 and 1985 has fluctuated between 68,000 and 92,000 AF annually, averaging about 80,000 AF. Consistent pumpage in excess of 40,000 AF/year has resulted in a discernible effect on water levels.

A regression of typical water level change per calendar year and local streamflow per water year prior to 1972 shows good correlation of natural water level fluctuations to varying recharge conditions. Under the weakest annual recharge conditions a drop of 0.39 foot in

water level is calculated, representing average discharge from this reservoir. Under long-term natural equilibrium conditions, the average recharge will approximate the average discharge from the reservoir. The effects of pumping since 1976 have served to discharge artifically as much water as is normally recharged. From 1976 to 1986, water levels dropped about 2.5 feet while the non-pumping regression predicts a rise of 2.0 feet. At current pumping intensities and closer to average recharge conditions, water levels in the reservoir will drop about 0.4 foot/year and pumping discharge will slowly supplant natural discharges. Water level stability at lower water levels can be restored as discharge changes occur. Since ground water in storage is many hundreds of times the average recharge, running out of water is not imminent.

Irrigated agriculture provides a living for many of the 1100 inhabitants of the Fort Rock Basin and represents most of the water pumped there. Irrigation of about 40,000 acres occurred from wells in 1986. The Oregon Water Resources Department reports valid ground water permits on 65,000 acres from 400 wells. Potentially, at least 100,000 acres are suitable for irrigation in the basin. In March, 1984, the Water Resources Director halted permit issuance in the area. By October, 1986 the Department had accepted applications for the irrigation of 6,000 additional acres. The decision to act on these and subsequent applications rests with the Oregon Water Resources Commission.

INTRODUCTION

PURPOSE

In 1980, the Oregon Water Resources Department began this study to address the ground water supply concerns of water users and managers reacting to rapid increases in irrigated agriculture in the Fort Rock Basin. The availability of irrigable raw land was sufficient to sustain a doubling of lands irrigated with ground water. The economic setting was also very favorable for this expansion to occur. In addition to actual pumpage, the issuance of new, unexercised ground water permits represented a future indicator of water use on thousands of new acres. The purpose of this study was to determine ground water conditions in the Fort Rock Basin for reasons of water supply management. In order to accomplish this, the objectives of the present study were to describe (1) the hydrogeology of the basin, (2) the ground water flow system, (3) the quantity of ground water withdrawals and appropriations, (4) the effect of withdrawals on the perennial supply of ground water, (5) the quality of ground water, and (6) possible actions for future ground water monitoring and management.

To achieve these objectives, various reports, records, and hydrologic data were reviewed and analyzed. A field inventory of more than 300 wells provided a basis for estimating pumpage from power records. Other field studies included the leveling of wellhead altitudes at about 35 wells, sampling and analyzing water at selected wells, conducting three aquifer tests and ongoing measuring of water levels in observation wells.

ACKNOWLEDGEMENTS

The cooperation of local well owners greatly facilitated this study by providing access to wells and ground water data. Certain financial and materials support from Lake County, North Lake County Water Users, Midstate Electric Co-op, and the U.S. Bureau of Land Management were appreciated. Clint Carrico and Gordon Emery kindly allowed their wells to be used for aquifer tests. Special thanks go to Bud and Helen Parks for the use of their wells for an aquifer test, for their dedication to the collection of precipitation and water level data, and for many hours of invaluable discussion on irrigation practices and basin history.

PREVIOUS STUDIES

Ground water resources of the area were described in geologic reports by Russell (1884), Waring (1908), and Hampton (1964). Basic ground water data was tabulated by Trauger (1950) and ground water recharge for the basin was estimated by Newcomb (1953). Hydrologic reports by Phillips and Van Denburgh (1971) and Brown (1957)

explored certain ground water/surface water relationships. Miller (1984) examined limits to ground water development in the basin. Geologic mapping of the area was completed by Walker (1977); Peterson and McIntyre (1970); Walker and others (1967); and Wells and Peck (1961).

LOCATION

The Fort Rock Basin (figure 2) occupies a total of about 2500 square miles (mi2) in south-central Oregon. It rests entirely in northern Lake County except for about 70 mi2 in Deschutes County and 140 mi2 in Klamath County. The basin consists of three valleys of near equal size: Silver Lake Valley in the southwest, Fort Rock Valley in the northwest, and Christmas Valley in the east. The latter valley is also known by the more traditional name Christmas Lake Valley. Each valley has its own interior drainage with fairly low central divides separating component valleys.

In the course of study, it was apparent that certain data were needed in adjacent areas in order to better understand ground water conditions within the Fort Rock Basin. Therefore, ground water data were taken from wells and springs in the Klamath Basin to the southwest, the Deschutes Basin to the northwest, the Crooked River Basin to the northeast, the Harney, Alkali, and Abert Basins to the east, and the Summer Lake Basin to the south. Fully viewed, the Fort Rock Basin region noted by plates in this report is about 10,000 mi2.

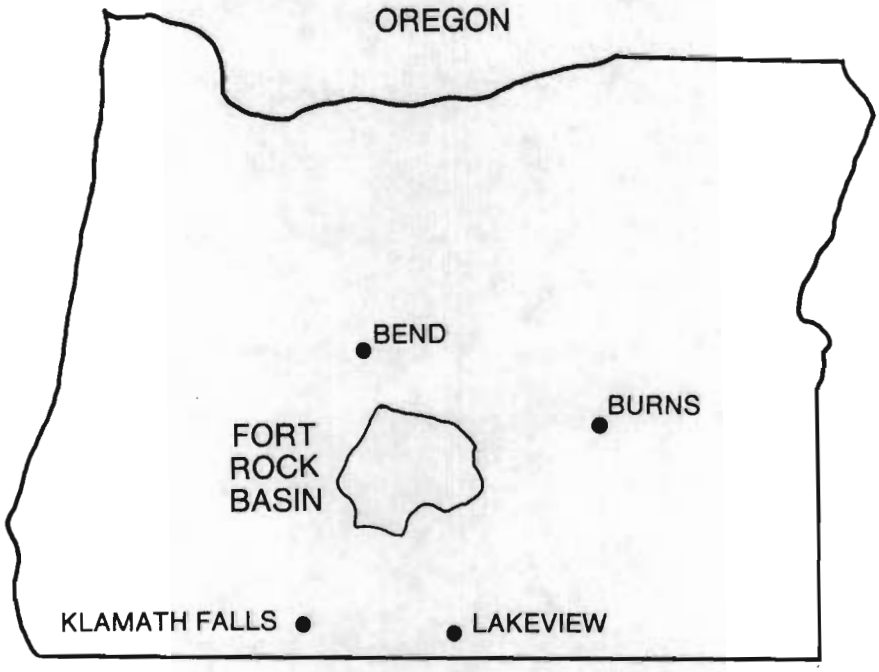


Figure 2: Location Map of the Fort Rock Basin.

ADMINISTRATIVE ACTION

On March 26, 1984, William H. Young, Oregon Water Resources Director, initiated a proceeding for the determination of a critical ground water area in the Fort Rock Basin (Appendix IX, Plate 1). This was based on preliminary findings which gave him reason to believe that ground water levels in the area were declining and the available ground water supply in the area was about to be overdrawn. This action served to halt the issuance of new permits for the appropriation of ground water permits until the resolution of a critical area determination. This administrative process survived a test of its legality through a decision of the Oregon Supreme Court in December 1985.

At the time of the initiation, a hearing on the matter was anticipated within two to four years. This would allow for the collection and analysis of additional data. In 1985, the Oregon Legislature created the Water Resources Commission with direct authority over ground water. In August 1986, the Commission directed Water Resources Department staff to proceed with authorization through the withdrawal or classification process for unappropriated ground water in the Fort Rock Basin instead of seeking a critical area. These processes could close the area to new appropriations for certain uses but not restrict existing appropriations as could a critical area. While the future of current administrative action is uncertain, it appears that the withdrawal/classification, critical area determination, and pending permit application matters will be concluded in 1987.

GEOGRAPHIC SETTING

CLIMATE

The lowlands below an elevation of 4500 feet are semi-arid, receiving an average annual precipitation of less than 12 inches (figure 3). Precipitation increases with increasing elevation of the land surface such that average values of about 18 inches occur at 5000 feet and 40 inches at 7300 feet. Most of the precipitation falls during the winter months of October through March under the influence of storms moving inland from the Pacific Ocean. Convective thunderstorm conditions can result in very intense but localized precipitation during the summer.

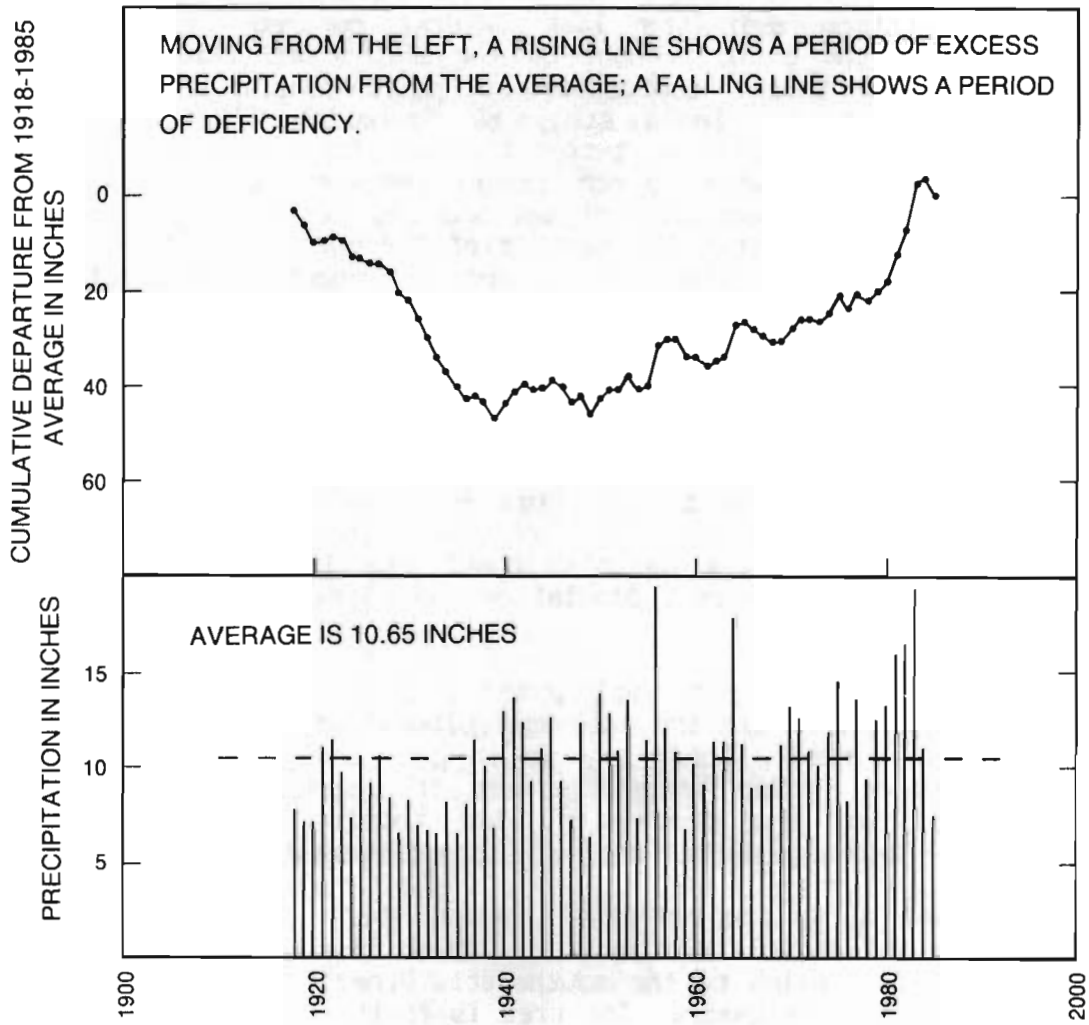


Figure 3: Calendar Year Precipitation and Cumulative Departure from Average Precipitation in inches: 1918-1985 (Fremont, Oregon).

Summers are usually warm and dry and winters are typically cool and moist. Mid-summer high temperatures are about 80°F while mid-winter highs are about 40°F. Diurnal temperature changes of more than 40°F are not uncommon in the basin during the summer. Because of the high elevation (4300+ feet) and latitude (43°N), morning frosts can occur any month of the year. This condition generally limits the growing season to less than 100 days per year.

Winds are of additional note in the Fort Rock Basin. Damaging winds can occur in any month. The winter winds are often persistent while summer winds are usually less intense and drying.

The climate of a region is composed of its weather factors. In general, only a few decades of record are available with which to characterize these factors. Precipitation is of particular interest in the Fort Rock Basin since the average is so low. Studies by Keen (1937) and Antevs (1938) examined tree ring growth of ponderosa pine in the Great Basin of Oregon in order to establish a proxy record for precipitation over the last several hundred years. They observed that the acute drought of the 1920's and 1930's was the most severe in recent centuries, but that similar periods had previously occurred. In a study by Graumlich (1985), it was concluded that precipitation reconstructions from tree ring widths in the Pacific Northwest do not reveal long-term changes in mean conditions, but show episodes of wet and dry conditions. Although there is no question that the climate of the Fort Rock Basin region has evolved with time, there is no concensus about current climatic changes in Oregon, according to Kelly Redmond, Oregon's State Climatologist (personal communication, 1985).

CULTURE AND INDUSTRY

About 1100 people live in the Fort Rock Basin. The population centers are the small towns of Christmas Valley, Silver Lake, and Fort Rock. Most of the basin's inhabitants live outside of the towns. Much of the current population has migrated to the area in the last ten years.

Agriculture forms the principal industry of the basin. Livestock, hay and small grains are the main agricultural products. Due to its high protein content, local hay is in good demand by dairymen in western Oregon. Other industries are the harvesting of timber, diatomite mining and processing, and tourism. The latter is supported by local geologic, archeologic and recreational features.

State Highway 31 is the principal roadway which crosses the basin. It provides access to the larger population centers of Bend to the northwest and Lakeview to the southeast. Other paved roads connect the towns within the basin. The area is further served by numerous gravel and dirt roads.

PHYSIOGRAPHY

Topographically, the basin can be divided into two categories: a lowland area below 4500 feet elevation and an upland area above 4500 feet. The lowland is generally flat, semi-arid, often suitable for farming, and contains about one-third of total basin area. The upland is generally rugged, semi-arid to humid, and unsuitable for farming. Much of the lowland is covered by sagebrush, greasewood and rabbitbrush while much of the upland is covered by stands of pine and juniper. Land surface elevations in the Fort Rock Basin range from 4285 feet in eastern Christmas Valley to about 8200 feet at Yamsey Mountain on the southwest boundary.

The Basin and Range and the High Lava Plains physiographic provinces merge at the Fort Rock Basin . The Basin and Range area covers approximately the southern third of the basin and is characterized by north-trending faults, prominent fault scarps (rim rocks), and basins of interior drainage between fault-block mountains. The High Lava Plains region is a relatively undeformed and undissected expanse of young lava flows dotted in places by cinder cones, tuff rings, and shield volcanoes. The basin interior is rather flat, exhibiting certain shoreline features from Ice-Age lake wave action.

Surface drainage in the Fort Rock Basin is internal (Plate 1). Perennial streams consist of Silver Creek, Buck Creek and Bridge Creek. They rise in the southwest mountains, merge in the lowlands of Silver Lake Valley at Paulina Marsh and flow to Silver Lake. Additional intermittent streams occur in this area. In northern Christmas Valley, Peter Creek occasionally flows and sinks into the valley floor during rapid snow melt or intense precipitation conditions. Ephemeral streams are common on the south, east and northeast upland areas of the basin. Such drainage is poorly developed on the west and northwest. Numerous small springs occur in the southwest mountains but are rare elsewhere in the basin. Many small, shallow ponds form in lowland depressions following wet periods. The shallow lakes of Silver Lake (T28S/R15E) and Christmas Lake/Alkali Flat (T26S/R18E) can be several square miles.

GEOLOGIC SETTING

GENERAL DESCRIPTION

The rocks of the Fort Rock Basin range in age from Pliocene (1 to 12 million years ago) to Recent. Volcanic rocks underlie the entire basin and almost all of the surrounding area shown on Plate 2. These rocks consist largely of basalt, andesite, tuff, basaltic agglomerate, pumice and cinders. Overlying these rocks in lowlying areas are sedimentary deposits of diatomite, clay, silt, sand and gravel.

Hampton (1964) first detailed the various rock units in the Fort Rock Basin (figure 4). In addition to naming formations, he outlined the structural geology of the area and assessed the ground water conditions and potential of the rock unit. Subsequent investigations have modified some of his work. This report refers to many of Hampton's descriptions in the text, but combines certain rock units of similar age and general composition for simplicity in Plate 2 after the work of Weissenborn (1967).

STRATIGRAPHY

PICTURE ROCK BASALT

The Picture Rock Basalt is the oldest outcropping rock unit in the basin and is of Pliocene Age. It consists of a thick sequence of basaltic lava flows and interbedded pyroclastic and sedimentary materials. The maximum exposure of basalt is 700 feet while the maximum observed thickness of interbed material is 250 feet. Total thickness of the unit may exceed 1000 feet.

Individual basalt flows are 10 to 50 feet thick with scoriaceous tops and bottoms. According to Hampton (1964), these scoriaceous zones are permeable and constitute a large portion of total flow thickness. Interbedded materials add further to the porosity of these zones. Conversely, the middle parts of flows are dense with few cracks and joints to provide permeability.

The Picture Rock Basalt crops out on the southern rim of the basin on the mountain arc from south of the spectacular exposure at Silver Lake graben (29S/16E) to southeastern Christmas Valley. The unit probably exists below much of the central area of the basin as well as the northern portion of the Summer Lake Basin. Exposures are heavily faulted. This feature makes the depth to the unit highly variable under the alluvium covered areas of the basin floor.

In general, the water-bearing and transmitting characteristics of the Picture Rock Basalt are good. The permeability and porosity of the scoriaceous tops of flows as well as the interbedded materials

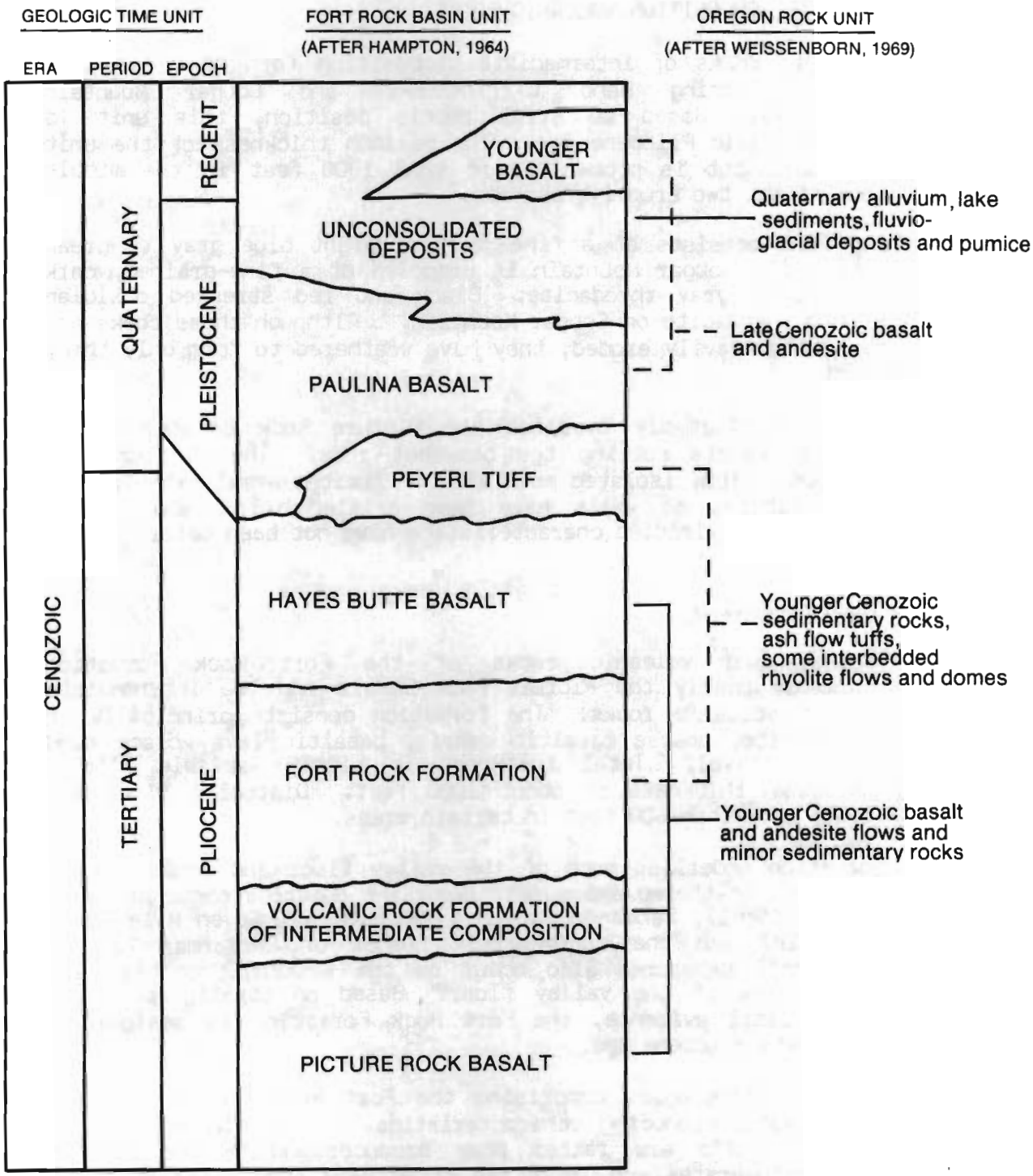


Figure 4: Stratigraphy of Rock Units in the Fort Rock Basin.

make the Picture Rock Basalt an important aquifer. Numerous wells in the south and central portions of the basin penetrate the formation and produce large quantities of water.

INTERMEDIATE COMPOSITION VOLCANIC ROCKS

The volcanic rocks of intermediate composition form the lava cone masses of Horning Bend (T27S/R14E-1) and Cougar Mountain (T25S/R15E-14). Based on stratigraphic position, this unit is assigned a middle Pliocene Age. The maximum thickness of the unit is uncertain, but is probably more than 1000 feet in the middle portions of the two eruptive centers.

Horning Bend consists of a fine-grained, light blue gray to cream andesite while Cougar Mountain is composed of a fine-grained, dark pink to bluish-gray rhyodacite. Black and red streaked obsidian grade into rhyodacite on Cougar Mountain. Although these rocks are fractured and heavily eroded, they have weathered to form only thin, rocky soils.

The unit unconformably overlies the Picture Rock Basalt, having issued from faults cutting the basement rock. The viscous lava formed rather high, isolated mountains of limited areal extent. Due to these factors no wells have been drilled into these rocks. Therefore, water yielding characteristics have not been determined.

FORT ROCK FORMATION

Sedimentary and volcanic rocks of the Fort Rock Formation unconformably overly the Picture Rock Basalt and the intermediate composition volcanic rocks. The formation consists principally of tuff, diatomite, coarse basaltic debris, basaltic lava, black sand and pumice gravel. Total thickness is highly variable with a maximum known thickness of about 1000 feet. Diatomite alone may constitute more than 600 feet in certain areas.

The formation underlies much of the valley floor and crops out in irregular and scattered exposures. Important outcrops occur at Table Rock (T28S/R15E-1), Fandango Canyon (T28S/R18E-4), Seven Mile Ridge (T27S/R17E-28) and the southeastern border of Christmas Valley. Numerous small exposures also occur on the western, northern and eastern margins of the valley floor. Based on stratigraphic and diatomite fossil evidence, the Fort Rock Formation is assigned a middle to late Pliocene Age.

The various lithologies comprising the Fort Rock Formation offer differing water-producing characteristics. The diatomites and fine-grained tuffs are rather poor producers while the coarser basaltic agglomerates and lavas are often very good aquifers. The diatomite and fine-grained tuffs at shallow depths, particularly in the Thorn Lake/Christmas Valley areas, generally make shallow wells modest producers.

HAYES BUTTE BASALT

The Hayes Butte Basalt unconformably overlies the Fort Rock Formation and older volcanic rocks. Due to its stratigraphic position, it is assigned a late Pliocene Age although early Pleistocene (about 2.5 million years ago) is possible. The unit consists of numerous flows, ranging in thickness from 10 to 30 feet. The maximum measured thickness exceeds 1300 feet at Hayes Butte.

Principal outcrops of the unit occur at Hayes Butte (T27S/R15E-8), Table Mountain (T25S/R16E-19), the eastern upland border of Christmas Valley and the area surrounding much of Paulina Marsh. Primary eruptive centers are the cones at Hager Mountain (T29S/R14E-35) and Hayes Butte. Exposures reveal that individual flows consist of a thin scoriaceous base, a dense yet jointed center and a rubbly top. The basalt has undergone faulting. Displacements are generally less than 50 feet but exceed 100 feet in certain places.

The water-bearing properties of the Hayes Butte Basalt appear to be very good. Several deep irrigation wells penetrate the unit in the Paulina Marsh area where they produce large quantities of water with little drawdown. In general, the formation occurs in areas where surface sources of water are available or soil conditions are not favorable for irrigation.

PEYERL TUFF

The Peyerl Tuff unconformably overlies a portion of the Hayes Butte Basalt. This late Pliocene or early Pleistocene unit consists of a sequence of essentially undeformed tuffs, tuffaceous sandstones and pumice conglomerates. The maximum thickness of the formation may be 400 feet with individual layers being generally only a few feet.

The outcrop area is confined to a 10 square mile area on the western edge of the basin in what was once a small basin. These waterlain materials originated from eruptive centers located to the west of the outcrop area. In addition, a welded rhyolitic tuff at the top of the formation suggests deposition by a glowing cloud for that part of the formation.

The Peryerl Tuff appears to occur above the water table. Therefore, it is not an aquifer. Exposures suggest that, if the unit were saturated in places, it may be good water-producing material.

PAULINA BASALT

The Paulina Basalt unconformably overlies the Peyerl Tuff and the Hayes Butte Basalt. However, Peterson and McIntyre (1970) were unable to distinguish the Hayes Butte Basalt from the Paulina Basalt. In any event, a series of late Pliocene and Pleistocene flows

forms the dominant lithologic unit along the northern border of the basin. Extrusion of this unit came from the numerous low shield volcanoes of the Paulina Mountains, which are northwest of, and adjacent to, the Fort Rock Basin.

Individual flows of the Paulina Basalt are fairly thin, ranging in thickness from 5 to 20 feet. The total thickness of the formation is probably in excess of 1000 feet at eruptive centers. Typically, flows are slightly brecciated on the bottom, dense but jointed in the middle, and broken and scoriaceous on the top. Flows have undergone minor faulting with displacements usually less than 10 feet.

Exposures suggest that the water yielding character of the Paulina Basalt is very good. Scoriaceous material at flow contacts provides excellent horizontal permeability while jointing and faulting give good vertical permeability. The formation is an important aquifer in the northern part of the basin and The Sinks area (T25S/R18E) in particular.

UNCONSOLIDATED DEPOSITS

A thin mantle of surficial material overlies the older sedimentary and volcanic rocks in the Fort Rock Basin. This cover is essentially limited to the valley floor and consists of lacustrine and deltaic deposits of Pleistocene age and streambed, playa and windblown deposits of Recent Age. The source of material for these deposits was the underlying sedimentary and volcanic rocks of the basin.

Pleistocene Fort Rock Lake occupied the present basin during that wetter period to a maximum elevation of 4500 feet. Varying lake stages deposited and reworked lacustrine deposits between that level and the present valley floor level at about 4300 feet. Lake bed deposits of fine-grained clay, silt, sand, volcanic detritus and diatomaceous earth cover much of the interval between 4300 and 4500 feet. Coarser-grained sand and gravel are the remnants of shoreline terraces, bars and spits. The finer-grained lacustrine deposits constitute the soil of much of the farmed area.

Concurrent with lacustrine deposition at Fort Rock Lake, deltaic deposition occurred on the southwest shore where streams were present. The lower reaches of Silver, Bridge, Buck and Murdock Creeks display remnants of a delta in the form of bedded terraces. These deposits show a depositional range from gravel to clay layers.

Recent airborn transport of Pleistocene lakebed deposits has formed stabilized and moving sand dunes in the eastern portion of Christmas Valley. These dunes may serve as a good ground water infiltration medium since they are more permeable than nearby lakebed deposits. In a special case, perched ground water in dune material is the source of water for the trees of the Lost Forest.

Stream valley alluvium of Recent Age has accumulated along the lower reaches of the perennial and intermittent streams. This material consists of thin layers of gravel, sand, silt or clay. Water in these materials seem to provide baseflow to streams and a modest source of water to shallow wells.

YOUNGER BASALT

Unconformably overlying the Paulina Basalt in several areas on the northern slopes of the basin are younger basalts of Recent Age. This unit consists of virtually unweathered lava flows as well as cinder cones with prominant exposures at T24S/R16E and T25S/R17E. Individual flows range in thickness from 5 to 50 feet. Total thickness at eruptive centers is as much as 200 feet.

The inflated granules of the cinder cones and the broken lava of the flows suggest that these basalts are an important ground water recharge inlet. The basalts lie above the saturated zone, so the unit is not an aquifer. Precipitation striking the basalt can be rapidly conveyed downward to the Paulina Basalt, thus escaping high losses due to evaporation and transpiration.

GEOLOGIC STRUCTURE

The most important geologic structures in the Fort Rock Basin with regard to ground water are faults and folds. These structures influence the current topography and drainage in the basin. A knowledge of the structures will help explain the occurrences and thicknesses of the various rock units.

North-trending faults are the dominant faulting pattern in the Fort Rock Basin. Movement along these normal faults occurred sporadically from the early Pliocene to Recent time. Displacements are greatest within the Picture Rock Basalt. Displacements in that unit may exceed 800 feet while those of younger units are generally less than 100 feet.

Deep faulting of the Picture Rock Basalt has resulted in the generation of horsts and grabens. These features control the thickness of overlying beds (generally Fort Rock Formation). In the Thorn Lake area (T28S/R16E), graben filling has resulted in more than 1000 feet of sediment accumulation above the basalts. Quite visibly, the Silver Lake graben (T28S/R15 and 16E, T29S/R15 and 16E) shows the severe downdropping of a block within the Picture Rock Basalt.

Faulting trends are also indicated by alignment of eruptive centers. These fault zones have locally controlled the distribution of volcanic units younger than the Picture Rock Basalt. Alignment of eruptive centers is particularly conspicuous in the areas of Paulina and younger basalt extrusion.

Though the principal normal faults are north-trending, a number of other normal faults intersect them at approximately right angles. These faults occur in the Picture Rock Pass area as well as adjacent areas of the Summer Lake Basin to the south (Donath, 1962). The displacement along these east-west trending faults is usually less than 50 feet but exceeds 100 feet in places.

Hampton (1964) stated that of several major folds in the Fort Rock Basin, only one could be accurately mapped. The axis of the St. Patrick Anticline forms the crest of the southern basin boundary from Picture Rock Pass to Sheep Rock. The axis trend is arcuate, being east-northeast on the west, east at St. Patrick Mountain and southeast on the east. This anticline is asymmetrical with rock layers of the Picture Rock Basalt dipping 2° to 5° north on the north limb and 7° to 10° south on the south limb. This folding occurred basically during Pliocene time prior to Fort Rock Formation deposition.

The St. Patrick Anticline serves to depress the older Picture Rock Basalt below the valley floor due to its northerly dip. The presence of the Fort Rock Formation allows fine-grained material to act as confining layers above the more permeable Picture Rock Basalt. Wells in Christmas Valley often encounter very little water until the Fort Rock Formation is fully penetrated. Upon encountering underlying basalts, water levels rise to near land surface and yields increase greatly.

Colbath (1982) in his work on the diatomites of the upper Fort Rock Formation found that these beds have been systematically deformed and dip 0.5° to 5° to the west or northwest in the area of Thorn Lake. Truncation of the diatomite beds in this otherwise flat area suggests that an open drainage system operated in the basin, allowing for the erosion of tremendous quantities of diatomite. Such an open drainage probably would have occurred through an opening on the northwest border of the current basin. This gap could have been subsequently closed by flows of Paulina Basalt.

GROUND WATER USE

The dominant use of ground water in the Fort Rock Basin is irrigation, accounting for more than 95% of pumpage. Other uses include stock-watering, domestic, fish culture, quasi-municipal, industrial, commercial, and lake maintenance. Water well reports display the presence of about 500 wells for irrigation and 700 wells for other uses (largely domestic and stock) in the basin. It is believed that about 60% of the wells were in use in 1986.

WATER RIGHTS

Oregon has a ground water rights system which follows the appropriative doctrine. It provides for the distribution of water from a source in time of shortage based on the principle "first in time is first in right". It is a formal filing process through a system of permits, certificates and registrations except for certain nominal exempted uses such as domestic and stock-watering. In general, perfecting a ground water right requires developing a ground water project under the time and use constraints of a permit. Subject to a verifying survey and the user's proof of that survey, a certificate of water right is issued. This right goes with the land in the case of irrigation and does not end with ownership changes. For flexibility, a formal filing system of transfers can accommodate changes in well locations and places of use while preserving a priority of use. A water right is maintained by use and is subject to forfeiture following five successive years of non-use.

A water right permit or certificate carries certain maximum limitation. In the Fort Rock Basin the maximum allowable "duty" of water for irrigation is 3 acre-feet (AF) per acre per year and one-eightieth cubic foot per second (cfs) per acre. This means that for the irrigation of a quarter section (160 acres) there is a maximum application of 480 AF/year at a maximum rate of 2 cfs. For irrigation, the water can only be applied when the crops can make direct use of the water. This places the irrigation season in the basin from about April 1 to October 1.

Although several beneficial uses of ground water are under permit in the Fort Rock Basin (Appendix VII), permitted acreage for irrigation serves as a gage to reflect the development of water rights generally (figure 5). Permitted acreage consists of demands for ground water through permits, certificates, and registrations. Permitted acreage increased rapidly during the period 1972-1984 from about 7500 to 65,000 acres. This dramatic increase involved several factors: favorable crop prices and yields; availability of irrigable land and water supply; advances in irrigation technology; and attractive financing. the slowdown in permitting since 1982 reflects poor financing conditions, reductions in farm land values, higher power costs and, finally, cessation of permit issuance in 1984 through administrative action. As of November 1986, there are

applications on file for permits to irrigate 6000 additional acres. Eventually, the Oregon Water Resources Commission will decide if these and future applications are to receive permits.

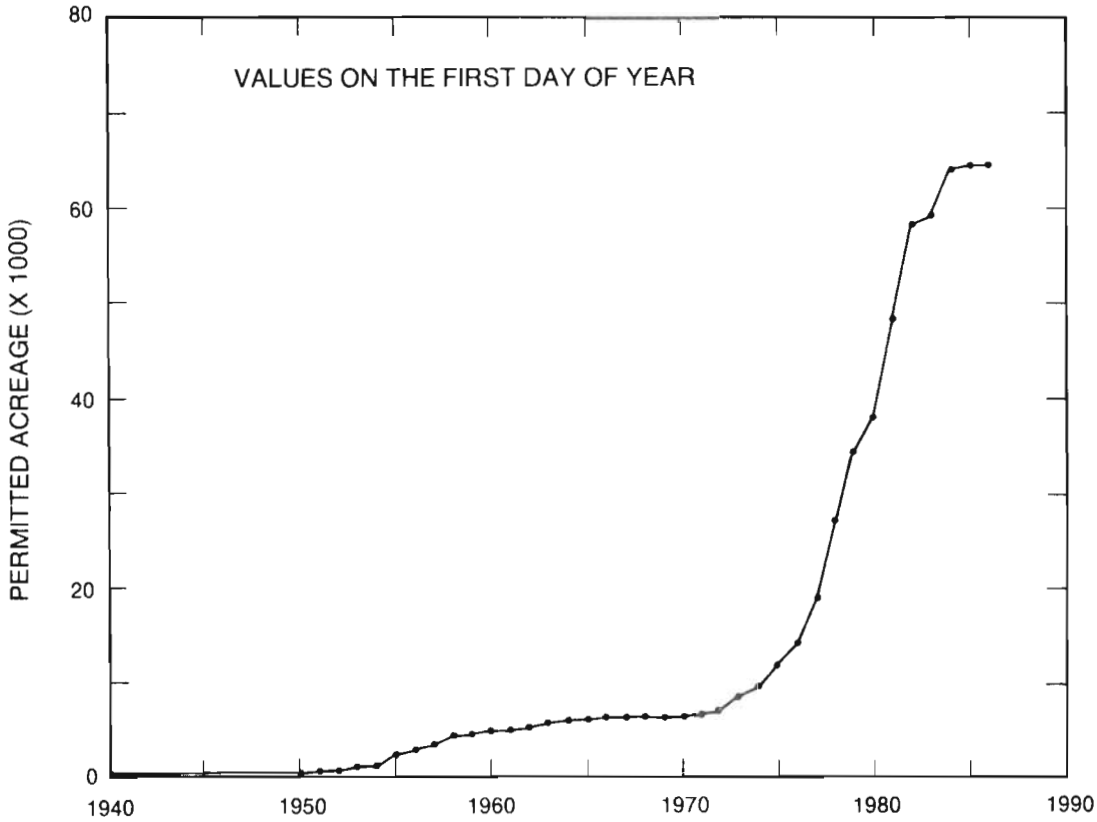


Figure 5: Fort Rock Basin Ground Water Rights.

PUMPAGE

Field studies by the Oregon Water Resources Department (OWRD) in 1981 and 1982 provide the basis for ground water pumpage estimates in the Fort Rock Basin. Weighted efficiencies of pumping systems revealed that approximatedly 360 kilowatt hours (KWH) of electricity were needed to pump one acre foot (AF) of water. Utilization of irrigation power records led to estimates of ground water pumpage since 1956 when electric power first came to the basin (figure 6). Table 1 lists many of the values.

TABLE 1

Estimated Annual Ground Water Pumpage in the Fort Rock Basin
(Year and Pumpage in Acre-feet)

1971	17,000	1976	42,000	1981	88,000
1972	22,000	1977	51,000	1982	68,000
1973	26,000	1978	51,000	1983	80,000
1974	31,000	1979	67,000	1984	92,000
1975	35,000	1980	82,000	1985	71,000

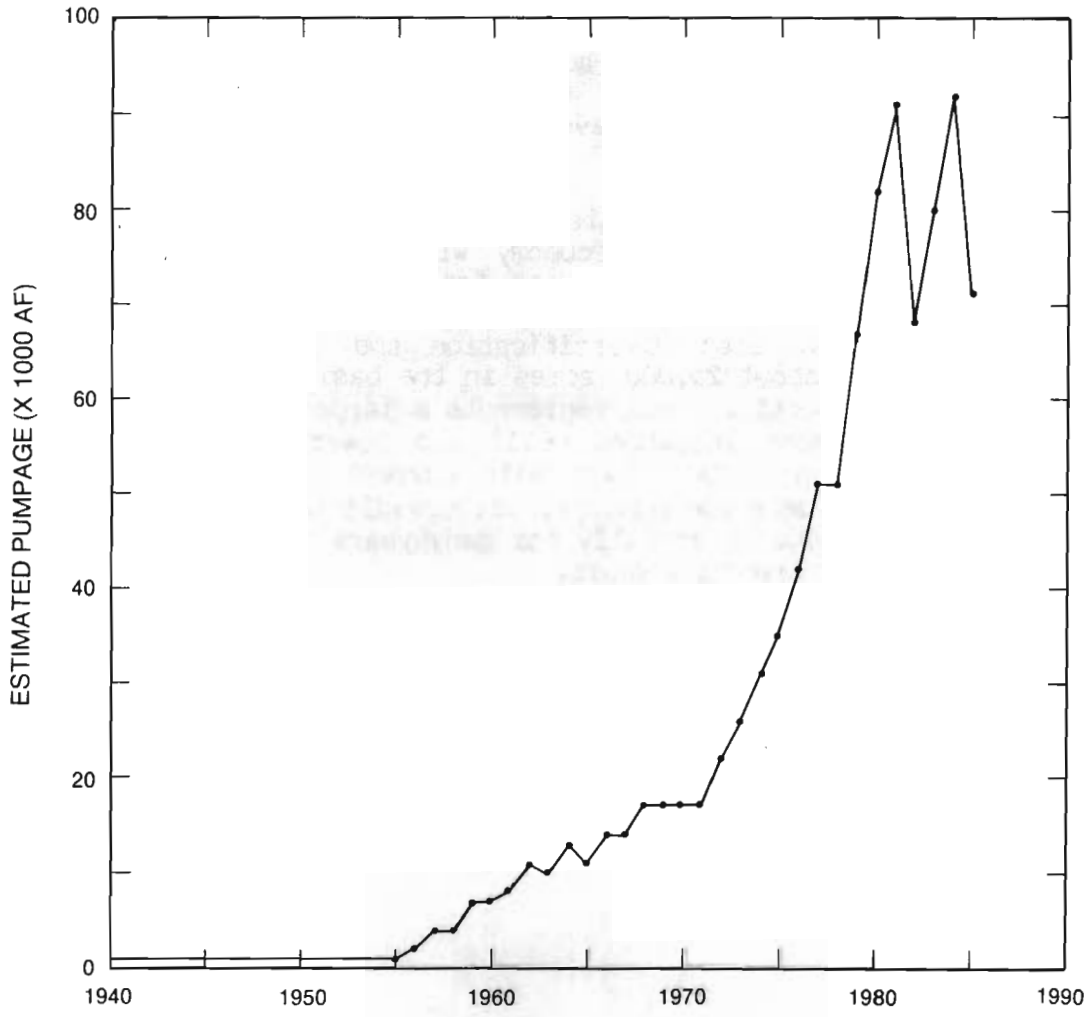


Figure 6: Fort Rock Basin Estimated Ground Water Pumpage

Pumpage estimates contain certain assumptions. Basic among these are that the basin-wide ratio of KWH/AF has been constant through time. In the Fort Rock Basin, sprinkler irrigation and electric power have been strongly linked since 1956. An evolution in sprinkle irrigation technology has probably served to lower the ratio with time. Electric power use by irrigation accounts was also basic to the estimates. Yet, some pumpage through general household electric accounts or diesel power are not represented in the estimates. Considering the various uncertainties involved, it is believed that estimates are accurate to within 15%.

A comparison of water rights and pumpage shows a striking similarity. This is not surprising since most irrigators follow the permitting requirement and permitting reflects intended pumpage. However, pumpage volume consistently falls below the maximum which the duty and permitted acreage allow. This basically reflects both the total irrigated acreage any given year and crop demands. As an example in the dry year of 1981, the average application rate was about 2 AF per acre on 45,000 acres. The maximum could have been 3 AF per acre on 50,000 acres. Given current cropping patterns in the basin, it is unlikely that average applications will exceed 2 AF per acre per year.

Future pumpage of ground water is difficult to predict. Changes in the currently depressed farm economy will be very important and result from several factors. These factors are both complex and numerous. They include crop prices, power costs, financing costs, weather conditions, crop diversification and government actions. Data suggest that about 25,000 acres in the basin are permitted but not irrigated currently. This represents a large potential increase in pumpage. In most instances wells and power lines to service these areas are in place. Even with current uncertainties which could increase or decrease pumpage, withdrawals will probably range from 70,000 to 90,000 AF annually for many years as noted by pumpage estimates over the last five years.

GROUND WATER

Ground water in the Fort Rock Basin occurs in the interconnected pore spaces of rock materials under confined, unconfined, and perched conditions. Pore spaces of material in the basin are largely fractures and joints in volcanic rocks and intergranular openings in sedimentary materials. The pores in both media store a considerable volume of ground water that is readily tapped by wells.

HYDROLOGIC CYCLE

Ground water is part of the larger hydrologic cycle, the earth's water cycle, consisting of the continuous circulation of moisture and water on our planet. The cycle has no beginning or end, but it is commonly presented as originating in the oceans where the greatest expanse of water occurs. Nature circulates water from the oceans to the atmosphere by evaporation, to the land by condensation, to rivers by runoff and subsurface flow, and back to the oceans by surface flow. Principal driving forces are solar radiation and gravity. Alternate paths from the broader scheme are many and include evaporation and transpiration of terrestial waters, evaporation from rivers and lakes, and precipitation on oceans and glaciers. The time required for a water molecule to move through one or more phases of the hydrologic cycle ranges from minutes to millenia. Evaporation from a surface water body could return to it as precipitation within a short time. In contrast, certain ground waters can require many centuries to complete their journeys back to the surface. This slow-motion feature of ground water results in extensive storage of fresh water underground. Except for glacial ice, ground water is the greatest source of fresh water on earth, equaling about 25 times the volume of fresh water lakes, reservoirs, and rivers.

QUANTITY

RECHARGE

Ground water recharge in the Fort Rock Basin originates from precipitation that falls in the basin. Precipitation infiltrates directly into the subsurface whenever unsaturated permeable materials are at the land surface. This water percolates downward under the force of gravity until it reaches the zone of saturation where it becomes ground water. Some precipitation infiltrates indirectly into the subsurface when swollen streams lose water to adjacent unsaturated materials.

Recharge varies from year to year, depending on the amount and seasonal distribution of precipitation, soil/rock permeability, and other factors. Most of the precipitation in an area does not become ground water but is either transpired or evaporated in the area

where it falls. It is conservatively estimated in this report and by Newcomb (1953) that the average annual recharge in the Fort Rock Basin is less than 0.1 foot over the basin area.

Water levels in wells reflect that ground water recharge comes from precipitation. Observations indicate that a one year lag time is needed following precipitation to allow full assimilation of recharge effects in lowland wells (figure 7). This suggests that recharge occurs, at least in part, in upland areas, necessitating time for ground water movement to the lowland. There is no strong evidence to suggest that any recharge occurs through subsurface flow from other areas into the Fort Rock Basin (Plate 3).

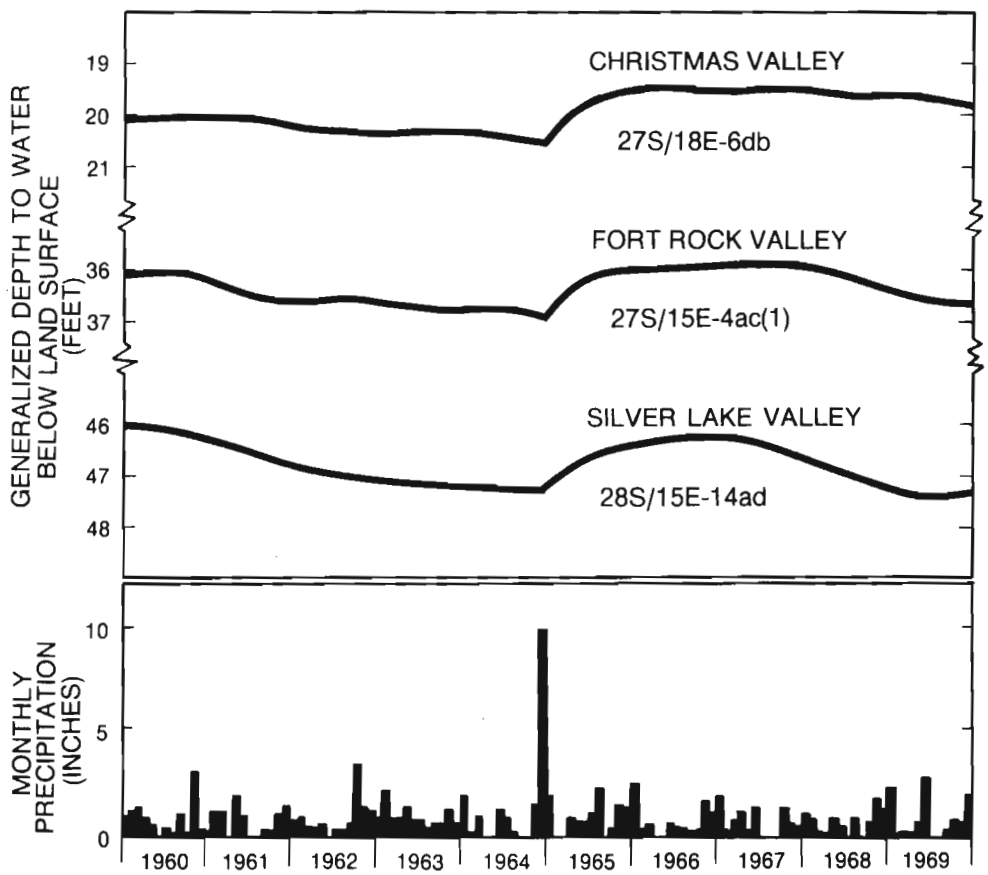


Figure 7: Recharge Lag Time

DISCHARGE

Natural discharge of ground water from the Fort Rock Basin occurs principally as subsurface outflow and evapotranspiration in areas of shallow ground water. To a lesser extent, it occurs as springflow and seepage to surface water bodies, notably the perennial streams. Artificial discharge consists of pumpage from wells (figure 6).

Subsurface outflow is probably the largest natural ground water discharge from the basin. Ground water mapping based on potentiometric heads indicates flow gradients to the Deschutes Basin on the northwest and the Summer Lake Basin on the south (Plate 3). Flow to the Deschutes Basin is difficult to quantify but probably exceeds 10,000 AF/year. Flow to the Summer Lake Basin may consist of all the spring and flowing well discharge in the northern part of that basin. This is estimated at more than 90,000 AF/year. The source area for this water appears to be the southwest uplands in the Silver Lake Valley rather than the entire basin.

Due to the magnitude of subsurface outflow, further explanation is in order (Appendix VIII). Several lines of data support subsurface outflow to the Summer Lake Basin and include:

1. Hydraulic gradient: Potentiometric heads are up to 60 feet lower at wells and springs in the northern Summer Lake Basin than in the Fort Rock Basin.

2. Water Chemistry: Excellent water quality with negligible chloride content from wells and springs in the northern Summer Lake Basin is similar to that found in adjacent wells in the Fort Rock Basin.

3. Faulting: Ground water flow may be influenced by fault patterns that show intense north/northwest trending faults extending from Silver Lake and Christmas Valleys through the intervening mountains to northern Summer Lake Basin.

4. Geography: The northern Summer Lake Basin is adjacent to the Fort Rock Basin and contains ground water discharges which cannot be explained by its small drainage area. The rest of the basin does not display such ground water discharge even though land surface elevations are similar.

5. Spring Flow: Near constant flow and 66°F water temperature at Ana Springs suggest a deep, large and highly modulated flow system. The main ground water reservoir of the Fort Rock Basin contains these elements and a general water temperature of about 52°F. A deep flow path could easily increase temperatures by 14°F.

6. Spring Hydraulics: The most widely known artesian flow in the northern Summer Lake Basin is Ana Springs, which has a specific capacity of about 1.4 cfs per foot (Brown, 1956). The total average spring flow of about 86 cfs represents a steady state drawdown of about 63 feet in the aquifer. This drawdown is the approximate potentiometric difference from the main ground water reservoir in the Fort Rock Basin to Ana Springs.

7. Water Level Changes: The water level in the observation well at 30S/R16-1cb near Ana Reservoir shows a decline of 2 feet from 1976 to 1986 and no decline in the previous record from 1963 to 1976. Such changes are similar to those found in the Fort Rock Basin.

8. Ground Water Ages: Limited Carbon 14 data from deep well waters suggest that ground water near Ana Springs is older than that near Silver Lake.

Evapotranspiration is an important source of ground water discharge in the Fort Rock Basin, but is far less than subsurface outflow and pumpage. In the Paulina Marsh area, shallow ground water is tranpired by plants and evaporated from saturated ground (Reed et al, 1984). In the lowlying greasewood flats of eastern Christmas Valley, phreatophyte transpiration appears to be significant and is evidenced by a potentiometric head depression in the area (Plate 3). A maximum value of evapotranspiration in the basin is 40,000 AF/year based on area of 300 square miles of "shallow" ground water (10 to 35 feet) and an assumed transpiration rate of 0.2 foot per year. Although certain literature studies suggest these values, the margin for error is great. Actual values are probably much less.

WATER LEVELS

Water level depths with time are displayed on charts called well hydrographs. These graphs are among the most diagnostic sources of hydrogeologic information. Over the course of many years, these records assist in providing good information on the yield capacity of a ground water reservoir and aid in the determination of recharge rates. Over a few hours, they can give information on the hydraulic properties of the aquifer(s) through controlled testing.

Causes of water level fluctuations in wells can be classified into four basic types:

1. Changes in ground water storage,

2. Changes in atmospheric pressure,

3. deformation of aquifers,

4. Disturbance within wells.

In the Fort Rock Basin, the dominant source of water level fluctuations is changes in ground water storage. This means that water level fluctuations show the result of change in recharge to, or discharge from, the reservoir at the wells.

The Oregon Water Resources Department (OWRD) currently collects and maintains water level records on more than 30 wells in the Fort Rock Basin. New data are collected several times per year (Appendix II). In all, more than 90 wells in the basin have been monitored at various times. Historically, spot measurements began in 1932 when the U.S. Geological Survey (USGS) began observations on 7 wells. Subsequent expansion of irrigation resulted in the addition of new wells. The current observation well program began in 1962 as a cooperative effort between the USGS and OWRD.

Water level data are subject to certain errors. Human errors can appear in the form of mistakes in measurements, readings, data entry, and calculations. Mechanical errors may occur from calibration errors on measuring tapes, measuring point changes, and oil layer development on the water surface. The last item is of particular note since the presence of oil layers in Fort Rock Basin irrigation wells is common. In general, the accuracy of measurements will decrease with increased depth to water since the possibility of tape stretch and non-plumb conditions increases. Field notes were reviewed to limit errors as possible and are presented in Appendix II. Abrupt water level changes under unexplained conditions differ from the sluggish trend of water levels in the basin and were easily noted as questionable readings.

Hampton (1964) noted that long-term fluctuations of ground water levels in a large part of the Fort Rock Basin are, in general, represented by the levels measured in well 27S/15E-4ac(1). That observation is confirmed by subsequent data presented in Appendix II and Plate 4. This well is located on the Poplars Ranch which is owned by the Parks Family and is sometimes known as the Parks well. The type-response feature of this well in the irrigated lowlands offers much to the understanding of the dominant ground water reservoir in the basin.

A good indication of recharge lag time is made through comparisons of water levels and monthly precipitation values when annual pumpage was low (figure 7). Precipitation in December 1964 was the highest monthly value at the Fremont precipitation station and was almost equal to an entire year's occurrence. This precipitation occurred as rain, resulting in flooding in lowland areas of the Fort Rock Basin. Regionally, precipitation was very high throughout the northwest for the month and produced widespread flooding, property damage, and loss of life.

The unusual precipitation conditions were so unique that they offer a laboratory-like environment for recharge analysis in what was largely a natural system. Water levels in wells rose in response to the precipitation. The rise was asymptotic, being more rapid initially. The total rise was about one foot and required about one year to be accomplished. There is some evidence that full response may actually require two years with the second showing a nominal rise. Since recharge conditions are the greatest in the months of October through March and recharge lags about one year, water level changes over a calendar year will basically reflect recharge conditions of the water year. The time necessary for assimilation suggests that recharge occurs largely on the upland areas of the basin. The small rise indicates that water levels are highly modulated and change little even under unusual natural conditions.

The water level drop during 1968 occured under weak recharge and low pumpage conditions. The drop of about 0.4 foot progressed across the entire year and was the largest annual drop on record prior to pumpage expansion in the 1970's. The steady nature of the drop suggests that subsurface outflow was the dominant discharge mechanism rather than seasonal evapotranspiration in the summer. Although precipitation was about 8 inches for the water year in comparison to an average of 11, streamflow may better reflect relative amounts of water available for recharge. Streamflow was about 8,000 AF rather than the 26,000 AF average. The drop of 0.4 feet offers an approximation of annual discharge under very low recharge conditions.

The well hydrograph of the Parks well (27S/15E-4ac(1)) shows the long-term trend of water levels in most lowland wells (Appendix II). Exclusive of pumping levels, the water levels display a range of 6 feet over the period of record 1922-86 with the highest level in 1922 and the lowest in 1949. In general, water level trends show multi-year rise or decline episodes. Even the very dry year of 1955 had a slight water level rise apparently because it followed three strong recharge years.

Certain short-term fluctuations are also noteworthy. Winter water levels since 1976 show consistent and progressive rises of about 1 foot during the October to April period. Recharge is only partly the reason. A major part of that rise reflects time necessary for water levels depressed by pumping to recover. This means that winter water level comparisons over a year of accelerated pumpage from the previous year should be slightly depressed in comparison to years of comparable pumpage. Conversely, such comparisons over a year of decelerated pumpage should rise in comparison to comparable pumpage years.

CONTINUITY EQUATION

The continuity equation is a basic mathematical formula which expresses the conservation of mass for a system. In ground water studies, the system is a reservoir, aquifer or geographic area. The ground water components of the hydrologic cycle are summarized in the equation:

$$R - D = \Delta S \qquad (1)$$

Where:

R = recharge to the system
D = discharge from the system, and
ΔS = change in storage in the system.

Over a sufficiently long period of time under solely natural conditions, ground water reservoirs are in a state of dynamic equilibrium. That means the average recharge equals the average discharge and storage change is zero. This condition is termed steady state. These conditions occur when climatic and geologic conditons, which influence the reservoir, are stable.

This basic assumption is expressed in the equation:

$$R_o = D_o \qquad (2)$$

Where:

R_o = mean recharge to the system under natural conditions, and
D_o = mean discharge from the system under natural conditions.

Ground water recharge can be highly variable on an annual basis. This is particularly true in drier areas where large variations in precipitation occur. The range of annual recharge can vary from nil during drought years to several times the average under abnormally wet conditions.

The link between ground water recharge and discharge is storage. Ground water storage accumulates over eons in response to climatic and geologic changes and can be many hundreds of times the average annual recharge. In large ground water reservoirs, discharge is strongly influenced by total storage. Such storage results largely from long-term recharge conditions. This means that under natural conditions, ground water discharge routinely occurs near the long-term average recharge rate.

As development occurs, pumpage by wells becomes a discharge superimposed upon a previously stable system. A new balance may come about by an increase in recharge, or a decrease in natural discharge, or loss of storage, or some combination of these. This expansion of the basic continuity equation gives:

$$(R_o + \Delta R_o) - (D_o + \Delta D_o) - P - \Delta S = 0 \qquad (3)$$

Where:

ΔR_o = a change in the mean recharge (induced recharge)
ΔD_o = a change in the mean natural discharge, and
P = pumping discharge.

Early in the development of a large ground water reservoir in a semi-arid region, most of the pumping discharge is derived from loss of storage. The decline of water levels in the basin will reflect this reduction in storage and can continue for many years. The precise response of the reservoir depends on many factors but significant early development will be dominated by the following equation since natural recharge and discharge will be little changed:

$$P = - \Delta S. \qquad (4)$$

As reservoir development continues at a significant level, discharge conditions will evolve. Pumpage will become more closely linked to discharge reductions and, as possible, recharge additions. Reductions in storage will be supplanted by these new sources of water for pumpage. Combining equations 2 and 3 shows this as:

$$\Delta R_o - \Delta D_o - P - \Delta S = 0 \qquad (5)$$

A new equilibrium occurs in a ground water reservoir when ΔS becomes zero. On the average, all discharge is again equal to all recharge. The general trend of water levels is flat but at deeper levels than prior to development, the deeper levels being necessary to increase recharge and reduce natural discharge. The decrease in discharge plus the increase in recharge is termed capture. The following equation describes a system where sufficient capture has occurred to result in new steady state conditions:

$$\Delta R_o - \Delta D_o - P = 0 \qquad (6)$$

In most cases the change in recharge is small or zero. Therefore, the new balance must be achieved by a change in discharge. Since the potential change in discharge is less than or equal to natural discharge and natural discharge cannot be expected to exceed natural recharge, sustained pumpage cannot realistically exceed natural recharge.

The time necessary for the re-establishment of steady state conditions can be great. The size of the reservoir and the location of development within it are important factors. It is conceivable that a new equilibrium in large reservoirs could easily require decades or centuries to establish.

RESERVOIRS

In the Fort Rock Basin, there is one dominant ground water reservoir. It has been termed the main ground water reservoir by Miller (1984). This reservoir is the source of all well water for irrigation and most other uses. The significant diagnostic features of the main ground water reservoir are:

1. Water levels in wells are highly modulated, showing sluggish natural fluctuations of less than 1.1 feet annually (Appendix II). The wettest years on record show natural rises of about one foot annually while the driest years display natural declines of about one-half foot.

2. The potentiometric surface in the basin lowlands has a head range from 4285 to 4300 feet (Plate 3). Changes in elevation of the surface are very uniform from place to place over time (Plate 4). The highest heads occur in the Silver Lake Valley. Limited data suggest that upland heads can exceed 5000 feet.

3. In the basin lowlands, the reservoir is found in numerous, highly transmissive aquifers in several formations. Well yields vary with construction, but with adequate depth can produce more than 1000 gpm.

4. Water occurs under confined or unconfined conditions but never perched.

In certain areas of the Fort Rock Basin, other ground water reservoirs occur. They have been termed upper ground water reservoirs by Miller (1984). Such reservoirs appear scattered and much smaller than the main ground water reservoir. Water from these reservoirs provides baseflow to the perennial streams from the southwest uplands to Silver Lake. Such waters are perched above the main reservoir in streambed alluvium. In some areas, upper reservoirs provide water for stock and domestic purposes. Some upper reservoirs are probably tributary to the main reservoir. The principal features of the upper ground water reservoirs are:

1. Water levels commonly display natural fluctuations of more than 1.1 feet annually (Appendix II).

2. The potentiometric heads range from 4295 to more than 4400 feet. When juxtaposed with heads in the main reservoir, they are always at least several feet higher.

3. The reservoirs are generally found in poorly transmissive aquifers away from stream courses and in moderately transmissive aquifers near stream courses. Well yields are small to moderate, not exceeding about 200 gpm.

4. Water occurs under confined, unconfined and perched conditions.

POTENTIOMETRIC SURFACE

Ground water moves from areas of higher energy to areas of lower energy. The energy of ground water is typically measured as the elevation of the water level in a well. Therefore, the potentiometric head is an elevation determined from a knowledge of land surface elevation at a well and the depth to water in the well. The narrow range of potentiometric heads in the Fort Rock Basin has necessitated in wellhead leveling at more than 30 wells.

A potentiometric surface is a representation of potentiometric head through a reservoir or aquifer. Contours on that surface connect points of equal head. Ground water movement is basically lateral with flow directions crossing contours at right angles (Plate 3).

The potentiometric surface of the main ground water reservoir in the Fort Rock Basin displays little relief. With the possible exception of the deep well at 31S/15E-32ab, elevations range from 4285 to 4300 feet within the basin. The reasons for this flatness are probably numerous. They seem to include very high aquifer transmissivities within the basin and a lack of significant flow barriers.

Changes of the potentiometric surface are fairly uniform with time. This is noted on individual hydrographs (Appendix II) and the 10-year change map (Plate 4). Such uniformity suggests that the aquifers of the main ground water reservoir are highly transmissive over hundreds of square miles and react as a single entity with regard to long-term effects.

Flow directions on the potentiometric surface indicate three areas of ground water discharge from the basin. Subsurface outflow occurs to the Deschutes Basin on the northwest across a width of more than 30 miles. Additional subsurface outflow moves south to the Summer Lake Basin where it discharges in dramatic fashion from large springs and flowing wells. Some of this flow may move from the uplands of the eastern Silver Lake Valley without passing through the lowlands of the basin. Finally, ground water discharges in eastern Christmas Valley, apparently through evapotranspiration. In that area, confined conditions with increasing head with depth are noted by wells at 27S/20E-9cc and a flowing well at 26S/20E-6bc.

Pumping discharge is not evident from the potentiometric surface (Plate 3). This is because the effects of pumpage on the natural system have been small and widespread. An effect of pumpage can be seen on the 10-year potentiometric change map on which a drop of 2 feet is noted in areas of pumpage (Plate 4).

The higher heads in the Silver Lake Valley suggest that it is an important recharge area. There is a possibility that subsurface inflow occurs from south of the basin to the Silver Lake Valley. It is supported by the presence of a gradient of more than 200 feet from the Klamath Marsh area to Silver Lake. However, a lack of intervening well data and opposite long-term trends (Plate 4) suggest that inflow is not significant. Furthering this view, is the fact that water levels in the Fort Rock Basin respond within a year to recharge conditions and do not lag the many years one might expect if water were moving in from that distance. The Silver Lake Valley is an important recharge area due to precipitation which falls there and any subsurface recharge to it is small, based on current data and understanding.

A comparison of the potentiometric surface with land surface contours shows that the perennial streams and Silver Lake are perched above the main ground water reservoir. The ability of water level declines in the main reservoir to induce recharge from the surface sources is probably minimal. Some natural leakage from Silver Lake (elevation about 4310) was inferred based on water chemistry considerations (Phillips and Van Danburgh, 1971). In general, the main ground water reservoir and surface water in the basin are distinct.

WELL HYDRAULICS

Most irrigation wells in the main ground water reservoir are easily capable of pumping 1000 gpm. Such wells are typically about 12 inches in diameter, more than 200 feet deep and have water levels of about 30 feet below land surface. Although local conditions can vary widely, most completed wells are capable of producing several times the rate at which they are pumped.

Although well logs, pumpage estimates and well inventories reveal much about local wells, three detailed aquifer tests were conducted to examine more precisely the way that ground water is transmitted and stored. Each test lasted several days, involved several wells and was associated with a long-term observation well. A list of test wells is given in Table 2.

TABLE 2

List of Wells Monitored During the Aquifer Tests in the Fort Rock Basin

Well Location	Owner	Remarks	
27S/15E-4ac(1)	Parks	Pumped well	Fort Rock Valley
27S/15E-4ac(2)	Parks	Observation well	
26S/15E-33d	Gray	Observation well	
26S/15E-34cc	Parks	Observation well	
27S/18E-6db	Carrico	Pumped well	Christmas Valley
27S/18E-6ac	Carrico	Observatin well	
27S/18E-6ad	Carrico	Observation well	
28S/15E-30bb	Emery	Pumped well	Silver Lake Valley
28S/14E-24ab	Cliff	Observation well	
28S/14E-25bb	ZX Ranch	Observation well	
28S/15E-19ab	Iverson	Observation well	
28S/15E-19da	Emery	Observation well	
28S/15E-19db	Emery	Observation well	
28S/15E-20ca	Emery	Observation well	
28S/15E-30ab	Emery	Observation well	
28S/15E-30ca	Emery	Observation well	

Transmissivity values varied widely from a low of 70,000 gpd/ft to a high of 2,750,000 gpd/ft. Drawdown and recovery data suggested the presence of recharge and discharge boundaries. These were interpreted as displaying areal changes in transmissivity in the aquifer. Testing showed the presence of highly transmissive conditions.

Storage coefficient was very difficult to determine based on the typical large distances between pumping and observation wells. However, the Fort Rock test rendered values of 0.10 and 0.12. These values reflect storage in unconfined conditions and are believed to reflect aquifer conditions generally.

Hydraulic testing and long-term hydrograph data show that interference effects between irrigation wells are slight. Well spacing, pumping rates and reservoir size are all important items for interference generation. Under conditions found in the basin, total interference effects would rarely be more than a few feet.

QUALITY

Water quality analyses of Fort Rock Basin ground waters are available from four principal sources. Trauger (1950) reported chloride, hardness and temperature for dozens of wells. Hampton (1964) developed principal constituent analyses on 9 wells. Miller (1984) listed about 30 analyses of varying breadth which were available from farm lending institutions. Water well reports typically note water temperature and this investigation tested 14 well waters for principal constituents (Appendix I).

WATER CHEMISTRY

The chemical quality of ground water in the Fort Rock Basin is generally good or excellent for irrigation, domestic, stock and other purposes. Localized conditions can produce salty water or water with a rotten egg smell (hydrogen sulfide). These conditions occur more frequently in shallow wells which penetrate lacustrine sediments.

Dissolved solids are a measure of dissolved minerals in water. For irrigation, dissolved solids less than 500 milligrams per liter (mg/l) are generally good for all uses while more than 3000 mg/l is poor. Among sampled waters, a range from 89 to 922 was found with most water showing less than 250 mg/l.

A simple and quick approximation of dissolved solids comes from the specific conductance of a water sample. This measure of the ability of water to conduct an electric current is reported in micromhos per centimeter at 25°C. For most natural waters, the specific conductance multiplied by a factor between 0.55 and 0.75 gives a good estimate of the dissolved solids. This empirical relationship is a function of the specific dissolved solids which are involved. Sampled waters display a range from 111 to 1230 with most less than 300.

Water hardness causes the formation of an insoluble curd with soap. It is chiefly due to the presence of calcium and magnesium in solution. It is analyzed as the amount of dissolved calcium carbonate which would be needed to produce such a hardness. Analyses of 14 ground waters in the Fort Rock Basin showed 7 were soft (0 to 60 mg/l of $CaCO_3$), 3 were moderately hard (61 to 120), and 4 were hard (121 to 180).

Ground water in the Fort Rock Basin is usually a sodium bicarbonate type. High concentrations of sodium salts can develop alkali soils in which little or no vegetation will occur. However, soil clays which carry a good excess of calcium or magnesium ions till easily and have good permeability. Irrigation waters need a favorable ratio of sodium to calcium and magnesium in order to maintain good soil characteristics. A complex ratio which categorizes the

suitability of irrigation water is the sodium-adsorption ratio (SAR). All sampled waters but one show low sodium (alkali) hazard by the SAR. The one exception shows medium hazard.

Boron is a chemical constituent of particular concern to irrigators. Boron is necessary in small quantities for normal growth of all plants, but in larger concentrations it becomes toxic. In concentrations greater than 1 mg/l, it may be toxic to sensitive plants. Some authors report that in concentrations over 2 mg/l, it may be toxic even to tolerant plants like alfalfa under certain conditions. All water samples except two in this study contained less than 1 mg/l. Concentrations of 2.5 and 4.0 mg/l were discovered in waters from two wells which have irrigated alfalfa successfully for many years.

Two carbon 14 analyses were conducted on water samples for this study. Such analyses are often used to estimate the age of ground water, the time since recharge of that water occurred. Well 29S/16E-16aa in the Fort Rock Basin contained carbon which was 73 percent modern and Well 30S/17E-7bd in northern Summer Lake Basin was 33 percent modern. Using a carbon 14 half-life of 8033 years, these translate to apparent ground water ages of 2500 and 8800 years, respectively. It is believed that further isotopic investigation would lower these ages through corrections for carbon exchange. Corrected ages in any case should be many hundreds of years old.

WATER TEMPERATURES

In the course of this study, water temperatures from about 40 wells in the Fort Rock Basin were measured. Most were made while pumping occurred but some unused wells were dip sampled for this purpose. Water temperatures ranged from 50°F to 97°F. Most of the temperatures were between 50°-60°F. In general, shallow ground water temperatures are closely linked to the mean annual air temperature in the recharge area.

Ground water temperatures increase with depth in the earth at an average rate of about 1°F per 100 feet. Variations from this average are common. Variable well depths notwithstanding, there appears to be a distinct thermal anomaly several square miles in areal extent on the north flank of Hayes Butte. A stock well of unknown depth at 26S/15E-32dc pumps water of 97°F, which is the warmest in the basin. This area apparently represents only an infusion of heat and not water to the ground water reservoir, since it is not coincident with a discernible potentiometric rise. No surface manifestations of this anomaly are apparent.

GROUND WATER MODELS

Two regression models were generated in order to quantify water level fluctuations under essentially natural conditions. The models are compared and contrasted both conceptually and statistically. Regression information later serves as input for reservoir analysis and assessment of appropriation limitations.

CONCEPTUAL MODEL

A conceptual model details the important features and assumptions upon which a system is analyzed. In this case, the main ground water reservoir of the Fort Rock Basin is the system. The various features are usually addressed individually in the text but are summarized here. Subsequent refinements in the conceptual model will appear in the conclusions.

The main ground water reservoir in the Fort Rock Basin is a dynamic hydrologic system which receives recharge, yields discharge and maintains storage. Water level changes reflect net changes in storage resulting from changing recharge and discharge conditions (Equation 1). Annual water level changes throughout the reservoir are uniform and can be approximated by those at the Parks well at 27S/15E-4ac(1).

Prior to 1972, the main ground water reservoir was only nominally stressed by pumping (<20,000 AF/yr). This means that a nearly natural ground water system was operative. This system on a long-term basis was in dynamic equilibrium such that the average recharge and average discharge were the same. The period 1972-1975 showed progressively more pumping stress (20,000-40,000 AF/yr) and water levels were lower in response to this artificial discharge. The period since 1976 has shown significant annual pumpage (40,000-92,000 AF/yr). Estimated future pumping rates are 70,000-90,000 AF/yr.

Water level changes are sensitive to recharge conditions in the basin. Precipitation and streamflow act as indicators of recharge conditions and are not a function of water levels in the main ground water reservoir. A comparison of precipitation or streamflow values during the water year to water level changes over the calendar year provides sufficient lag time to relate natural water level responses to climatic conditions that produced the response. It is assumed that linearity reflects water level changes to precipitation or streamflow.

Under natural conditions, the main ground water reservoir is of sufficient size that annual discharge is unaffected by variability in recharge. Water levels change very little. Therefore, the hydraulic gradient producing subsurface outflow and depth to water allowing evapotranspiration are nearly constant.

PRECIPITATION MODEL

In the Fort Rock Basin several stations have recorded daily precipitation (Plate 1). The Fremont station at 26S/13E-10b provides the best long-term data prior to 1972. More than 60 years of data are available (Appendix IV). For certain months, the precipitation data may be lacking or partial at Fremont. In those instances, substitutions from nearby lowland stations are made. On a water year basis, precipitation at Fremont has ranged from 3.53 to 21.94 inches, averaging 10.69 inches. (figure 8). Although the average is nearly the same as that on a calendar year basis, the range is expanded from 6.45 to 19.57 inches (figure 3).

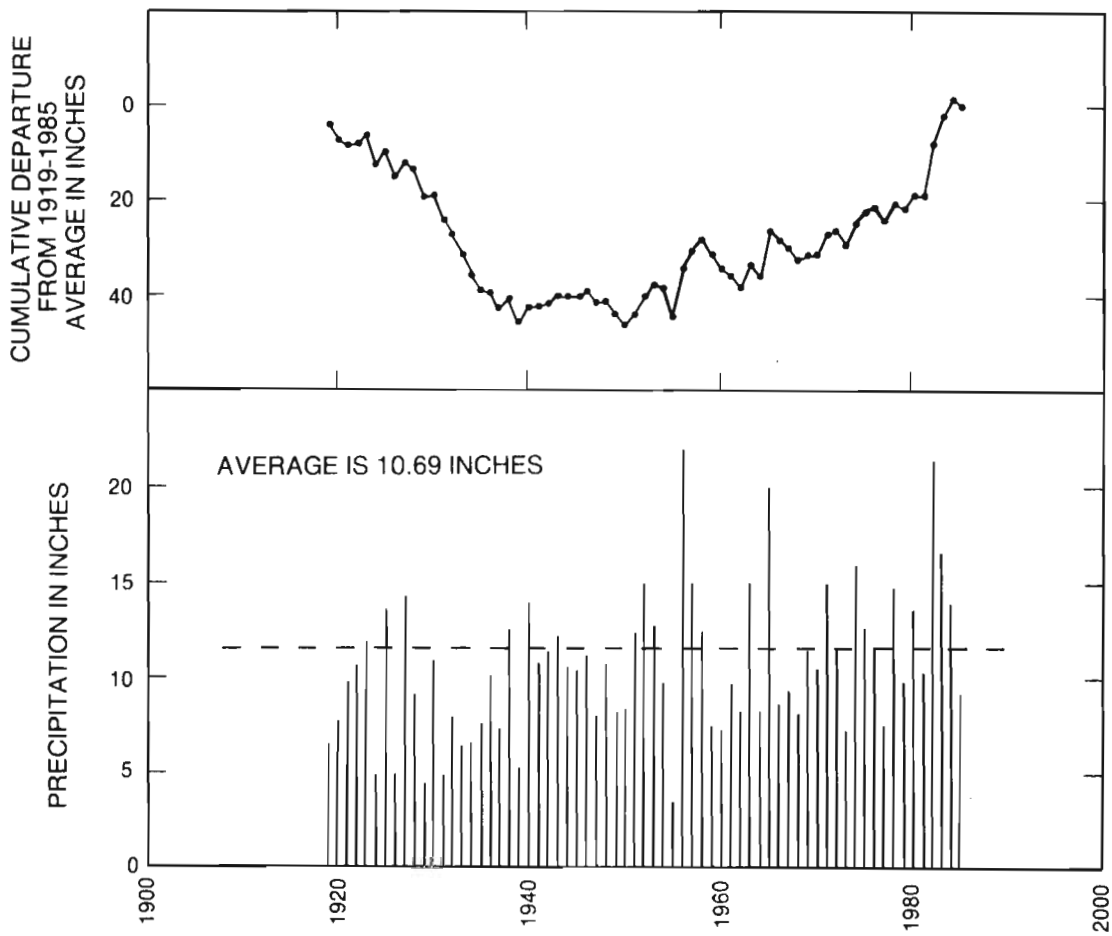


Figure 8: Water Year Precipitation and Cumulative Departure from Average Precipitation in Inches: 1919-1985 (Fremont, Oregon).

A regression model of water year precipitation and annual water level change at the Parks well consists of 31 data sets (figure 9). These data sets are for years prior to 1972 for which measurements are judged to be adequate to record both variables. Some of the

data were precisely measured while others were estimated (Appendix VI). The mean precipitation of the 31 years is 11.13 inches while mean water level change is +0.13 foot.

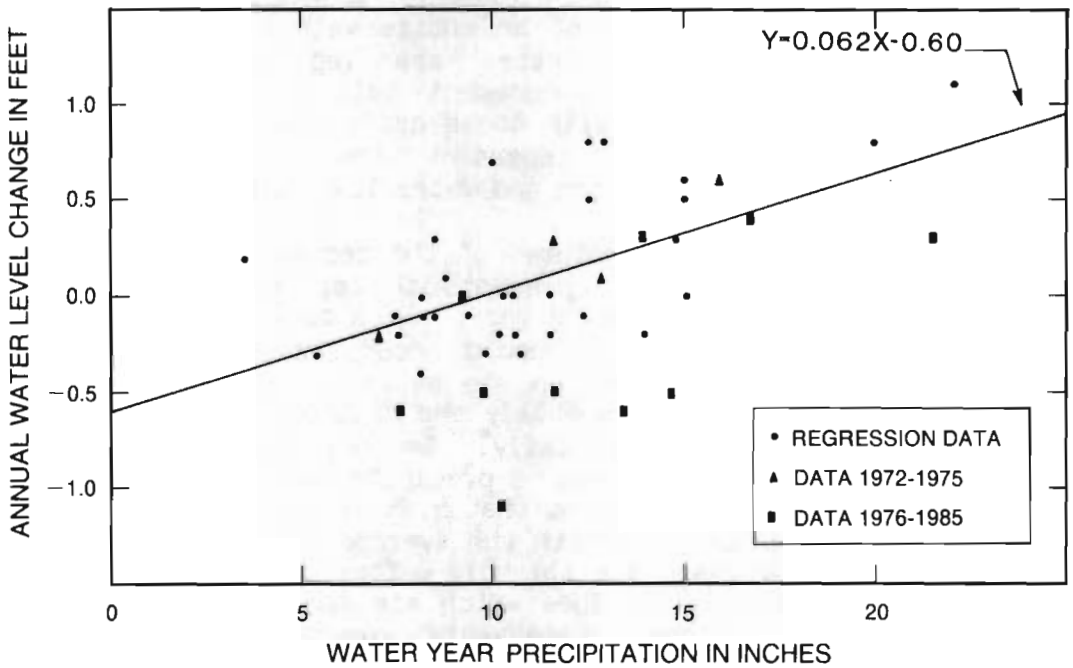


Figure 9: Regression of Calendar Year Water Level Change at Well 27S/15E-4ac(1) and Water Year Precipitation at Fremont, Oregon: 1936, 1939-45, 1949-71.

The precipitation model utilizes water year precipitation as the independent variable and annual water level change as the dependent variable (Beard, 1962). Values for precipitation range from 3.53 to 21.94 inches while water level changes range from -0.4 to +1.1 foot.

The least square regression equation is:

$$Y = 0.062X - 0.60 \qquad (7)$$

Where:

Y = annual water level change in feet, and
X = water year precipitation in inches.

The regression slope is 0.062 and the Y-intercept is -0.60. The correlation coefficient of the regression to the data is 0.62 (a perfect direct correlation is 1.0, no correlation is 0.0 and a perfect inverse correlation is -1.0). This level of correlation suggests that there is a direct relationship between the variables yet there is unexplained variation as noted by the point scatter around the regression line.

There are probably several reasons for the point scatter. Measurement errors for both variables are likely sources of error. Water level errors in particular are compounding since a poor January reading influences the change for both the preceeding and up-coming years. The precipitation at one station cannot perfectly reflect regional precipitation availability for recharge since there is areal precipitation variation. Likewise, a single well will not perfectly reflect the response of an entire watershed to basinwide recharge. Other perturbing factors are lag time variations, seasonality of precipitation, antecedent soil moisture conditions and pumping influences. Even with these error factors, the purpose of this regression is to represent the average long-term relationship between precipitation and water level changes.

There are several important features of the regression. First, the Y - intercept of -0.60 foot represents the estimated water level change during a zero precipitation year. This decline is the effect of natural discharges alone and would occur under severe drought conditions. This suggests that on the average, recharge creates a water level rise of 0.60 foot annually and discharge creates a water level decline of 0.60 foot annually. Second, the X-intercept of 9.68 inches represents the estimated precipitation during a year of no water level change. This means that 9.68 inches is the long-term average precipitation and that both the average of record (figure 8) and the average of 31 years are slightly wetter than normal. Third, precipitation has displayed values which are more than 200 percent of the theoretical average. Conversely, precipitation has never been less than 65 percent of this average. This suggests that there should be more below average years than above average years due to the greater weighting of the above average years. In fact, only 11 of the 31 regression years display precipitation which is below the theoretical average.

Data for the periods 1972-75 and 1976-85 usually fall below the regression line. The earlier period data are very similar to the regression while those of the later period are usually more the 0.5 foot below the regression. These data are more scattered than one might expect in light of pumping increases.

STREAMFLOW MODEL

In the Fort Rock Basin, streamflow on Silver Creek is the only ongoing stream gaging record. It contains more than 70 years of data (Appendix V). This flow consists of gaging both live and diverted flows. The Silver Creek gages are located south of the town of Silver Lake (Plate 1). Silver Creek drains a largely forested area of 180 square miles.

Regulation of Silver Creek flow above the gages has existed since 1922 at Thompson Valley Reservoir at 30S/14E-29 (capacity 17,400 AF) and Diversion Reservoir at 29S/14E-5 (capacity 800 AF). Carryover storage at Thompson Valley Reservoir is generally small compared to total annual flow (Appendix V). However, during dry years, stored

water releases have accounted for up to 79 percent of the creek flow (1977) and during wet years storage increases have reduced flows by up to 20 percent (1978). Basically, storage is accrued during wet years and depleted during dry years. Carryover storage at the Diversion Reservoir is not recorded but appears negligible.

Since storage data at Thompson Valley Reservoir are only consistently available since 1966, this report uses uncorrected flow values. Those data on a water year basis show a range from about 1,700 to 63,000 AF, averaging 22,500 AF (figure 10). In general, the use of these data will dampen the scatter of flows from the mean average since that is the purpose of the reservoir.

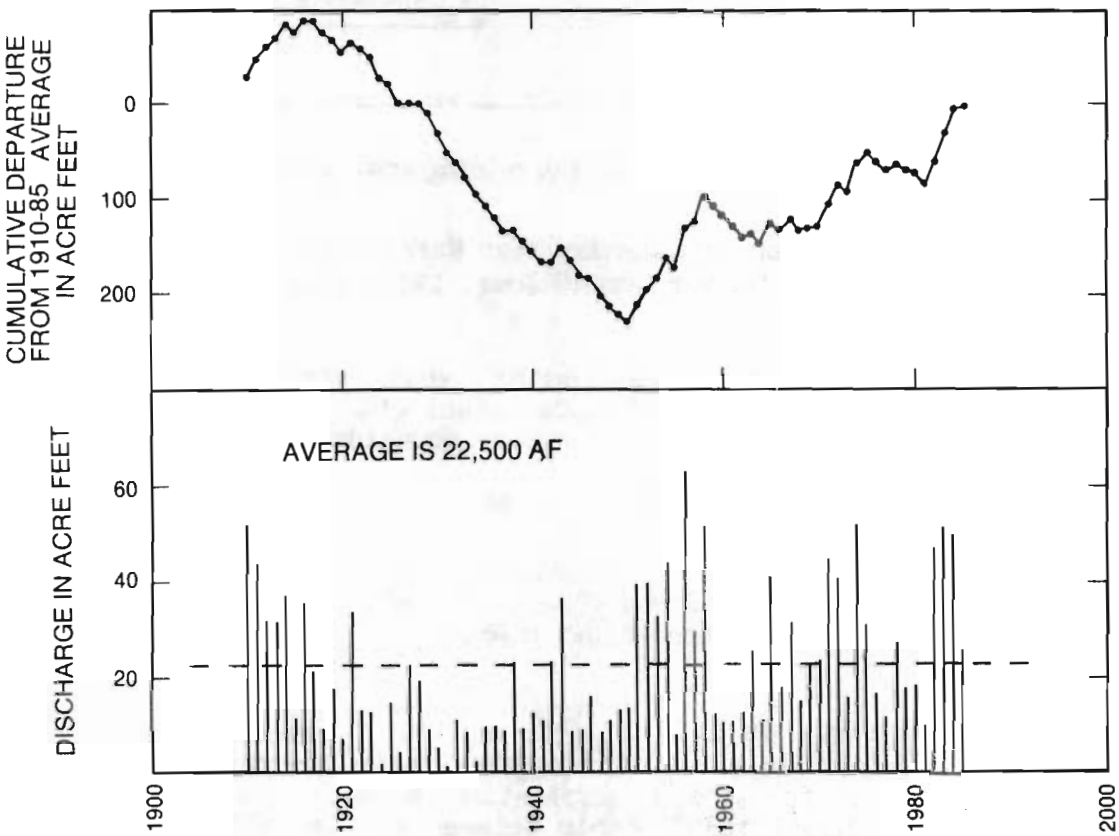


Figure 10: Discharge and Departure from Average Discharge for Water Years in Acre-Feet: 1910-1985 (Silver Creek, Lake County, Oregon).

A regression model of water year streamflow on Silver Creek and annual water level change at the Parks well consists of 31 data sets (figure 11). The years are the same as those in the precipitation regression (figure 9). Again, they are for years prior to 1972 for which measurements are judged to be adequate to record both variables. The mean streamflow of the 31 years is 24,044 AF while mean water level change is +0.13 foot. Values for streamflow range from 8,580 to 62,750 AF while water level changes range from -0.4 to +1.1 foot.

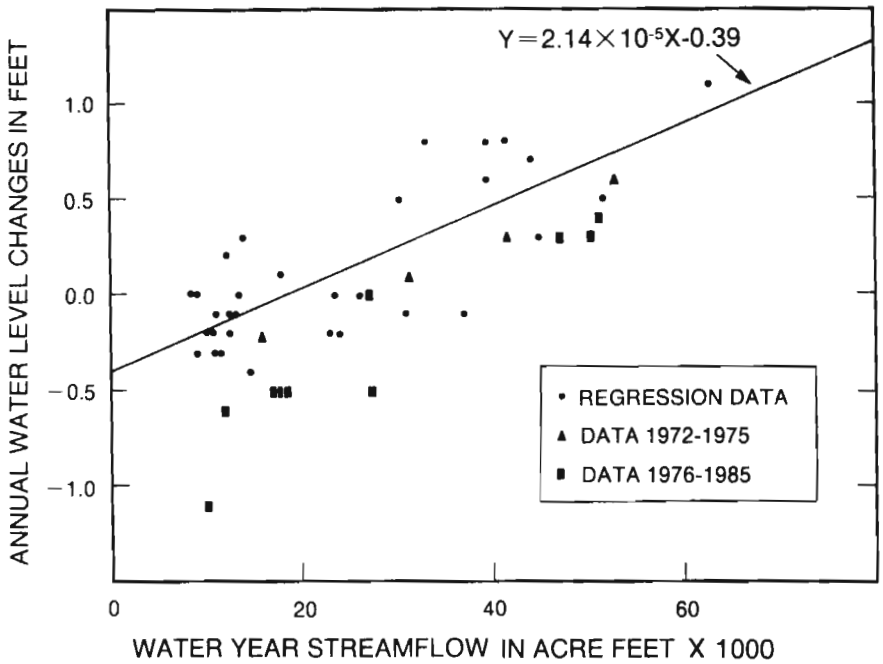


Figure 11: Regression of Calendar Year Water Level Change at Well 27S/15E-4ac(1) and Silver Creek Flow: 1936, 1939-45, 1949-71.

The precipitation model uses water year streamflow as the independent variable and annual water level change as the dependent variable (Beard, 1962). The least square equation is:

$$Y = 2.14 \times 10^{-5} X - 0.39 \qquad (8)$$

Where:

Y = annual water level change in feet, and
X = water year streamflow in AF.

The regression slope is 2.14×10^{-5} and the Y-intercept is -0.39. The correlation coefficient of the regression to the data is 0.79 in contrast to 0.62 for the precipitation model. The correlation suggests a good direct relationship between the variables but there is some unexplained variation.

Point scatter from the regression probably occurs for several reasons. Measurement errors for both variables are likely sources of error. Areal variations in recharge in a basin may be approximated by natural streamflow from a subbasin but will not be perfect. Other factors include lag time variation, surface reservoir storage, changes in watershed characteristics and pumping influences.

There are several important features of the regression. First, the Y - intercept of -0.39 foot represents the estimated water level change during a year of severe drought. This suggests that,

typically, recharge generates a water level rise of 0.39 foot annually and discharge generates a water level decline of 0.39 foot annually in the main ground water reservoir. Second, the X - intercept of 18,224 AF is the estimated streamflow during a year of no water level change. This flow is a theoretical long-term average suggesting that both the average of record (figure 10) and the average of 31 regression years are slightly wetter than this average. Third, streamflow values range from 47 percent to 344 percent of the theoretical average. The large above average field suggests that, theoretically, more years experience below average flows due to the weighting of certain above average years. Sixteen of the 31 regression years display streamflows below the theoretical average.

Data from 1972-75 consistently fall below the regression. Data from 1976-1985 consistently fall further below the regression. This arrangement agrees well with the expected trend of data due to increased pumping. As small as these deviations from the regression line are, they show the persistant effect of pumping on water levels.

MODEL ANALYSIS

The results of the streamflow regression model are more credible than those of the precipitation regression model. The correlation coefficient shows that it is statistically superior. Conceptually, streamflow integrates the effect of precipitation over an area, giving a better indication of available moisture than point precipitation. Although recharge is derived from precipitation, both streamflow and recharge are the residual products of evapotranspiration and soil moisture processes on the precipitation.

By judging the streamflow model to be better than the precipitation model, the Y - intercept of -0.39 foot is judged more accurate as an indication of natural discharge than is -0.60 foot. The maximum observed pre-1972 drop is -0.4 foot in 1968. This approximates the theoretical maximum. Conceptually, precipitation during summer months and at low intensity during winter months would have little recharge potential due to the strong influence of evapotranspiration, localized occurrence, and sublimation. Practically, water year precipitation less than 3.5 inches may have no recharge value.

The mean streamflow of record and of the 31 regression years are greater than the X - intercept theoretical average for equilibrium conditions. The average annual water level change is +0.16 foot which is also greater than the theoretical average for equilibrium conditions. The prevailing assumption of long-term equilibrium suggests that these data are a positively skewed subset from longer-term natural conditions. That conclusion is maintained in this report. However, there is the possibility that streamflow data of record reflect evolving climatic changes which produce greater streamflow than previously. Under that scenario, a new climatic stability would eventually result in a new water level change

relationship with streamflow as storage increases and the recharge/discharge levels increase. In the evolving process, water level changes would be a lagging indicator of climatic (streamflow) conditions.

Natural recharge results in an average annual water level rise of 0.39 foot while natural discharge, through simultaneous processes, results in an average drop of 0.39 foot. Based on a storage coefficient of 11 percent, 0.39 foot of water level in the porous media of the reservoir equals a water layer of about one-half inch.

Net water level changes annually under natural conditions are approximated by equation 8. Using this equation and streamflow data, one can simulate theoretical water levels (figure 12).

Data since 1976 show a clear departure from the theoretical levels. This is the result of high pumping rates over the period. From January 1976 to January 1986, the difference between simulated and observed levels is a drop of about 4.7 feet. While some of this drop is due to increased residual drawdown in January for recent years, it would not be reasonable to project less than a 4 feet theoretical drop for the decade. Such a drop coincides closely with the calculated natural discharge over 10 years. Therefore, a close match exists between current pumpage levels and average recharge.

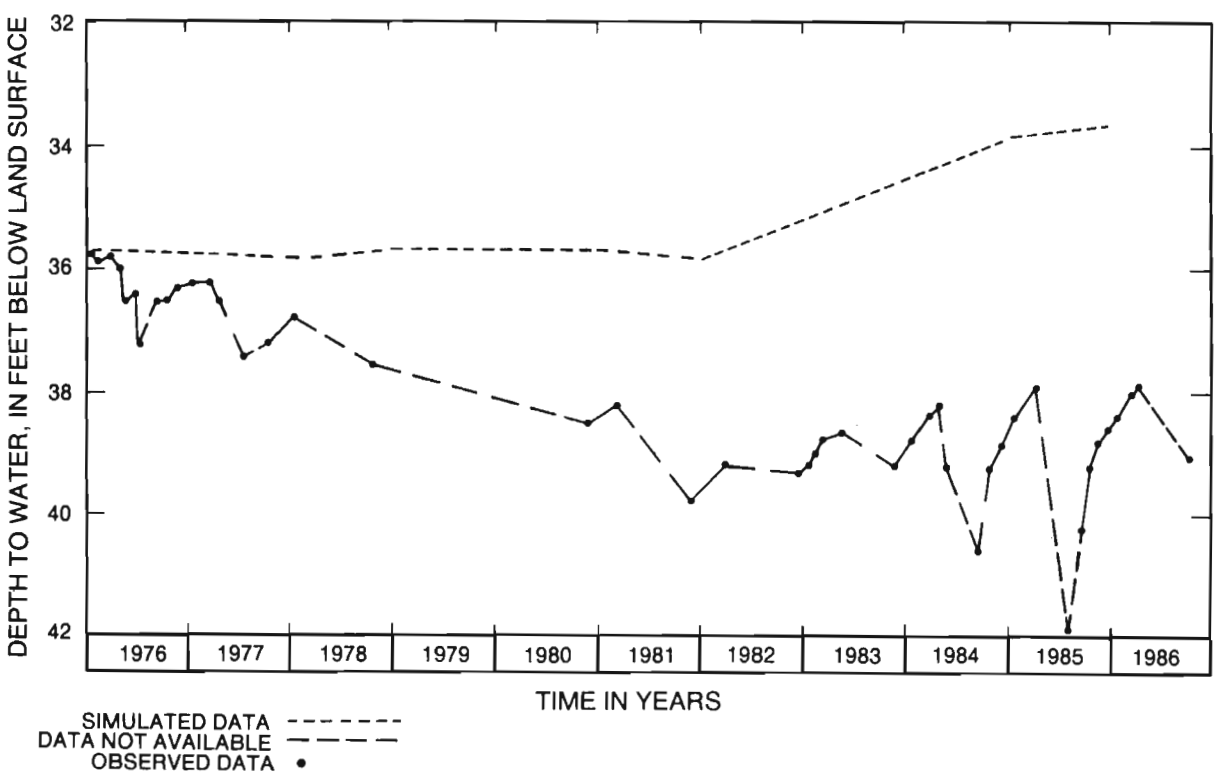


Figure 12: Simulated and Observed Water Levels at Well 27S/15E-4ac(1).

RESERVOIR ANALYSIS

Reservoir analysis is closely linked to regression information and the conceptual model. These look at storage changes in the reservoir in terms of water level changes. The link between water level and water volume requires strong pumpage stress over several years. Storage coefficient determinations offer lesser value in this move since they can be variable and site specific.

DEVELOPMENT STAGES

As ground water development occurs, new stress (discharge) is placed on a natural system in quasi-equilibrium. The basic goal for development of a ground water reservoir within its capacity is to modify the system such that otherwise "wasted" water is salvaged for a beneficial use. In its most complete sense, this means that pumpage never exceeds average recharge to the system. Commonly, this requires a permanent depletion of some water from storage in order to reduce natural outflow from the system. This depletion is part of a transition process which results in progressively less natural discharge. In some areas, this depletion allows for increased recharge of formerly rejected recharge water. However, in the Fort Rock Basin, the general lack of surface water would seem to preclude a significant recharge augmentation by this mechanism. This is commonly the case in semi-arid areas. Subsequent equations for various development stages rely on the continuity equation discussion.

PRE-DEVELOPMENT

The pre-development stage is the natural condition of the reservoir. This stage is one of long-term equilibrium and is expressed on volume and water level change bases as:

$$R_o - D_o = \Delta S = 0 \qquad (1 \,\&\, 2)$$

$$\text{and} \quad Y = 2.14 \times 10^{-5} X - 0.39 \qquad (8)$$

As noted earlier, this condition formed over geologic time and basically displays a balance between geologic and climatic conditions. Both natural discharge and storage are at maximum levels and will appear highly buffered. Natural recharge will change greatly each year depending on annual weather conditions as gaged by streamflow in Silver Creek (figure 13). This stage was apparent in the Fort Rock Basin prior to 1972 when pumpage was low.

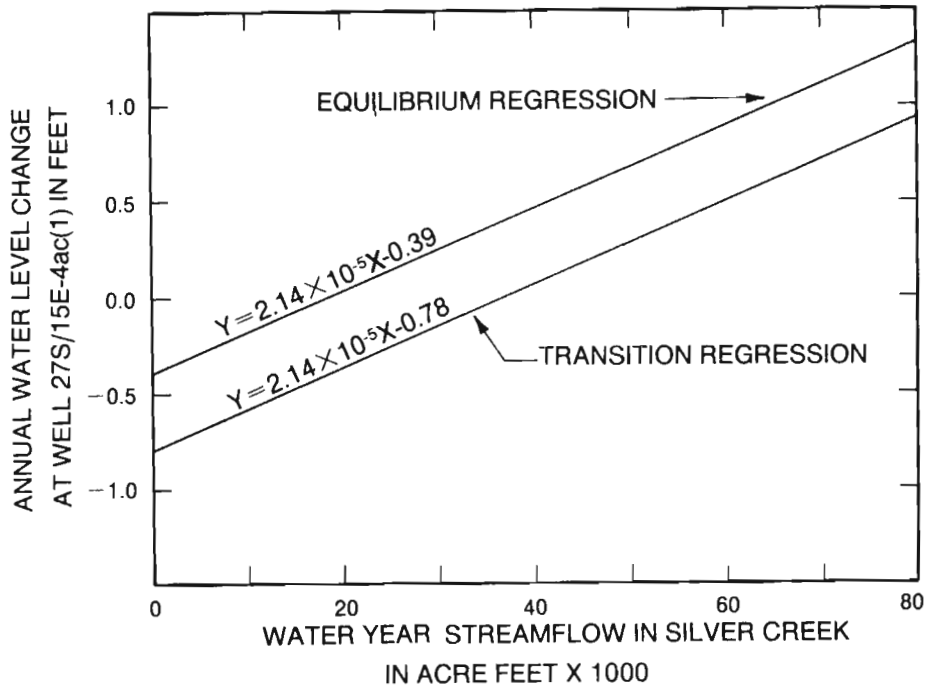


Figure 13: Ground Water Equilibrium/Transition Regressions for the Fort Rock Basin.

TRANSITIONAL

Transitional is a stage in which pumping occurs from the quasi-equilibrium reservoir at a rate which closely approximates both natural recharge and discharge. This can be viewed as a full appropriation/use period during which the otherwise natural system evolves. It may be expressed on a volume basis by the end members:

$$R_o - D_o - P = R_o - 2D_o = \Delta S \qquad (5) \text{ (Initial Condition)}$$

$$\text{and } \Delta R_o - \Delta D_o - P = \Delta S = 0 \qquad (6) \text{ (Final Condition)}$$

On a water level change basis the end members use:

$$Y = 2.14 \times 10\text{-}5X - 0.78 = -0.39 \qquad (9) \text{ (Initial Condition)}$$

$$\text{and } Y = 2.14 \times 10\text{-}5X - 0.39 = 0 \qquad (8) \text{ (Final Condition)}$$

This stage is one of general storage depletion. Losses from storage will, on the average, be larger early in the period and decrease later in the period as net natural discharge decreases. Since pumpage is equal to natural discharge early in the period, a total discharge equal to double natural discharge exists (figure 13). The

ground water reservoir will be at maximum transition or flux from equilibrium conditions. The change in storage (ΔS) on the average is equal but opposite in sign to natural discharge (D_o). This gives an average Y value of -0.39. This stage has been apparent in the main ground water reservoir since 1976 when pumpage increased to current levels (figure 14).

Later in this stage, total discharge will drop as reductions in storage permit pumpage to supplant natural discharge. This evolution is from 2 to 1 times original natural discharge and from declines of 0.39 to 0.00 foot per year. The length of this stage is unclear but is probably decades based on head differences between the main ground water reservoir and discharge points.

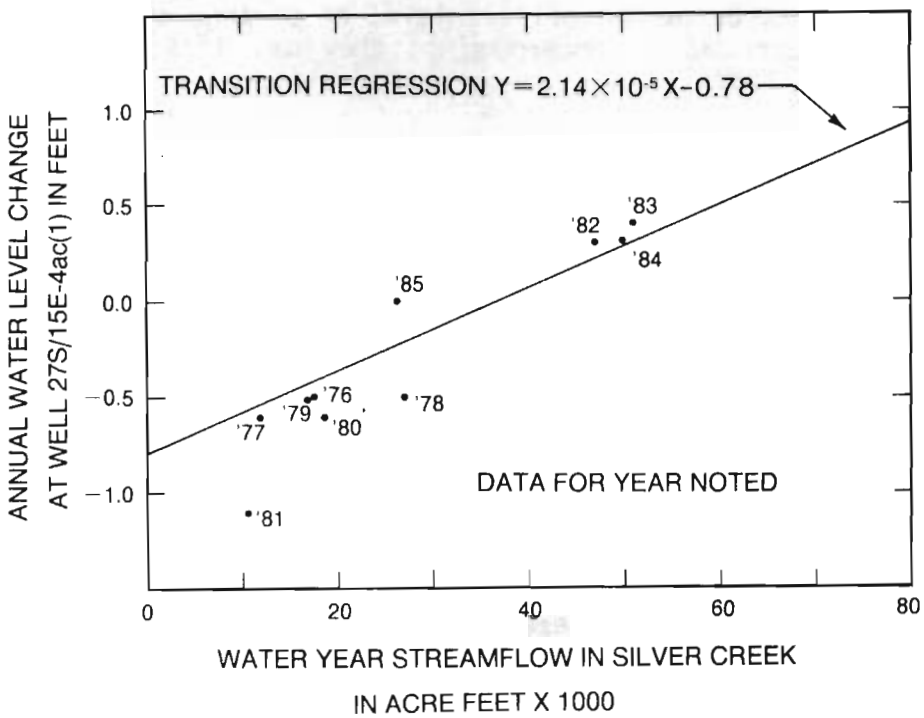


Figure 14: Early Ground Water Development Model at Full Appropriation for the Fort Rock Basin.

RESTORED EQUILIBRIUM

This stage is a complete modification of the ground water flow system such that equilibrium conditions are restored. This condition is like the pre-development stage except that storage is sufficiently depleted to allow pumpage to replace natural discharge. This stage is expressed as:

$$\Delta R_o - \Delta D_o - P = \Delta S = 0 \qquad (6)$$

$$\text{and} \quad Y = 2.14 \times 10^{-5} X - 0.39 \qquad (8)$$

The quantity of storage depletion necessary to arrive at this stage could easily be several tens of times the average annual recharge. If such a condition is obtained, water levels will lie consistently below the root zone of phreatophytes, below the capillary fringe of bare soil and just below the orifice level of springs and seeps. The latter are of particular concern since they may interfere with the water rights of others.

DEVELOPMENT OVERVIEW

The outline for development suggests that current conditions are indeed in the transitional stage. If pumpage continues at current rates of about 80,000 AF/yr, water levels will decline about 0.4 foot/yr in relation to those predicted by the streamflow model. It is difficult to predict the exact declines which will occur as modification of the natural system progresses. Speculation on certain factors is worthy of note.

Ground water is currently being withdrawn at a rate of about 80,000 AF/yr. This rate could change quickly since pumpage is the creation of economic factors. It is possible that pumpage could expand based on current water right permits. However, it is also possible that pumpage will drop if the general farm economy deteriorates further. In lieu of future knowledge, it appears wise to assume that pumpage will remain near current levels.

The assumption that all natural discharges can be supplanted by pumpage is improbable. The natural discharge through subsurface outflow to the northern part of the Summer Lake Basin is the subject of appropriation there through springs and wells (Appendix VIII). Determining the full extent of those rights of appropriation requires a water rights adjudication. An unacceptable change in water availability with regard to those water rights could serve to restrict pumpage in the Fort Rock Basin.

It was noted previously that augmented recharge is not anticipated as storage depletion occurs. However, it seems possible that this depletion could expand the size of the reservoir by breaking down ground water flow boundary divides. The likely places for this are on the north, northeast, east and southeast (Plate 3). The divides in those areas are very low, suggesting that declines in the Fort

Rock Basin might induce water which would otherwise flow to other basins to flow to the Fort Rock Basin by gradient reversal. Although this action would slow decline rates in the Fort Rock Basin the recharge available from those areas is probably limited. Further, that water may already be subject to appropriation in other areas.

To state that all natural discharges from the main ground water reservoir are closely matched by current pumpage (about 80,000 AF/yr) may be an over simplification. It is estimated that subsurface discharge to the Summer Lake Basin alone exceeds 90,000 AF/yr. In addition, subsurface discharge to the Deschutes Basin exceeds 10,000 AF/yr and phreatophytes within the Fort Rock Basin could evapotranspire up to 40,000 AF/yr. In all, it appears that recharge to the main ground water reservoir is something like 140,000 AF/yr.

Water level changes in the lowland may not totally reflect reservoir recharge and discharge, but only that portion of total recharge which reaches the lowlands. It is likely that some discharge to the Summer Lake Basin is derived from the uplands of the Silver Lake Valley where very few water level data are available. Apparently, recharge from these uplands flows both to the Fort Rock Basin lowlands and to the Summer Lake Basin. That portion flowing to the basin lowlands plus the quantities recharged elsewhere in the basin comprise the total recharge to the lowland area. It is this quantity that is approximated by current pumpage. Additional unmonitored recharge which flows to the Summer Lake Basin would stabilize ground water levels in the Fort Rock Basin at current pumping rates without eliminating all discharge to the Summer Lake Basin.

CONCLUSIONS

There is a main ground water reservoir in the Fort Rock Basin which contains an abundance of generally good-quality water. This reservoir is the source of all ground water for irrigation and most other purposes in the basin. Pumpage from the reservoir since 1976 has averaged about 75,000 AF annually. Prior to 1972, annual pumpage was less than 20,000 AF. Pumpage through this century is unclear but will probably exceed 50,000 AF annually.

In the basin lowlands, water levels in the main ground water reservoir display changes of less than 1.1 feet annually and altitudes of 4285 to 4300 feet. These water level changes are very similar throughout the basin and reflect the recharge/discharge balance to the volcanic and sedimentary aquifers of the reservoirs. Prior to 1972, water level fluctuations resulted largely from the operation of natural conditions and were in a state of long-term quasi-equilibrium. Subsequent fluctuations reflect the effect of significant pumpage on those conditions.

Pumpage from the main ground water reservoir is approximately equal to the average recharge to the reservoir as monitored in the lowlands. Continued pumpage at this annual rate of about 80,000 AF will continue the current state of long-term disequilibrium. Restoration of long-term equilibrium conditions will probably require more than 100 years. Average decline rates will slowly evolve from 0.4 to 0.0 foot per year during the transition back to equilibrium. During this restoration period, water levels in the reservoir should decline less than 70 feet from current levels. This drop is expected to result in reduced subsurface discharge to the Deschutes and Summer Lake Basins and reduced evapotranspiration by phreatophytes in the Fort Rock Basin.

Water level and water supply changes in the main ground water reservoir occur slowly. Declines could continue for decades at current rates without notice by well owners. Each foot of water level in the reservoir represents about 200,000 AF in storage. The slow depletion of ground water storage allows understanding of reservoir conditions before conflicts arise among users.

Limitations on new appropriations would help prevent overdraft of the main ground water reservoir. This could be most quickly approached by limiting new water right permits from the reservoir. This action would place a theoretical limit on pumpage. Ongoing monitoring of pumpage and water levels in wells is needed to show conditions of future use.

SELECTED BIBLIOGRAPHY

Allison, I.S., 1979, Pluvial Fort Rock Lake, Lake County, Oregon: Oregon Department of Geology and Mineral Industries Special Paper 7, 72 pp.

Antevs, Ernst, 1938, Rainfall and tree growth in the Great Basin: American Geographical Society Special Publication 21, 85 pp.

Beard, Leo R., 1962, Statistical Methods in Hydrology. U.S. Army Engineer District, Corps of Engineers, 115 pp.

Bowen, R.G., and Peterson, N.V., 1970, Thermal Springs and wells, in Oregon: Oregon Department of Geology and Mineral Industries Miscellaneous Paper 14.

Brown, S.G., 1957, Occurrence of ground water near Ana Springs, Summer Lake Basin, Lake County, Oregon: U.S. Geological Survey Open-File Report, 26 pp.

Castle, E., and Dwyer, C., 1956, Irrigation possibilities in the Fort Rock area: Oregon State College, Agricultural Experiment Station Circular of Information No. 558, 23 pp.

Chow, V.T., ed. 1964, Handbook of Applied Hydrology. McGraw-Hill, New York, 1418 pp.

Colbath, G.K. and Steele, M.J., 1982, The geology of economically significant lower Pliocene diatomites in the Fort Rock Basin near Christmas Valley, Lake County, Oregon: Oregon Department of Geology and Mineral Industries, Oregon Geology, V. 44, No. 10, pp. 111-118.

Donath, F.A., 1962. Analysis of Basin-Range structure, south-central Oregon: Geological Society of America Bulletin, V. 73, pp 1-16.

Eakin, T.E., Price, D., and Harrill, J.R., 1976, Summary appraisals of the nation's ground-water resources - Great Basin region: U.S. Geological Survey Professional Paper 816-G, 27 pp.

Freeze, R.A. and Cherry, J.A., 1979, Groundwater. Prentice-Hall, Englewood Cliffs, N.J., 604 pp.

Garifo, S.E., 1985, An investigation of institutional impacts on allocation of water supplies for irrigation: an Oregon example: Oregon State University, Agricultural Experiment Station Special Report 745, 31 pp.

Graumlich, L., 1985, Long-term records of temperature and precipitation in the Pacific Northwest derived from tree rings: University of Washington doctoral dissertation, unpublished, 198 pp.

Hall, M.J., 1982, Utilizing LANDSAT-3 return beam vidicon (rbv) imagery to identify and map irrigated agriculture lands - Fort Rock and Christmas Valleys, Lake County, Oregon: American Society of Photogrammetry, Proceedings of the Second Technology Exchange Week, Panama, January 25-29, 1982.

Hampton, E.R., 1964, Geologic factors that control the occurrence and availability of ground water in the Fort Rock Basin, Lake County, Oregon: U.S. Geological Survey Professional Paper, 383-B, 29 pp.

Johnsgard, G.A., 1963, Temperature and the water balance for Oregon Weather Stations. Oregon State University, Agricultural Experiment Station Special Report 150, 127 pp.

Keen, F.P., 1937, Climatic cycles in eastern Oregon indicated by tree rings: Monthly Weather Rev., V. 65, No. 5, pp. 183-188.

Meinzer, O.E., 1927, Plants as indicators of ground water: U.S. Geological Survey Water-Supply Paper 577, 91 pp.

Miller, D.W., 1984, Appraisal of ground-water conditions in the Fort Rock Basin, Lake County, Oregon: Oregon Water Resources Department, Open-File Report, 157 pp.

National Oceanic and Atmoshperic Administration, 1984, Climatological data annual summary, Oregon: U.S. Department of Commerce, Ashville, North Carolina, V. 90, No. 13, 34 pp.

Newcomb, R.C., 1953, Ground water available for irrigation in the Fort Rock Basin, northern Lake County, Oregon: U.S. Geological Survey Open-File Report, 5 pp.

Newton, V.C., Jr., and Baggs, D., 1971, Geologic evaluation of the Alkali Lake disposal site: Oregon Department of Geology and Mineral Industries, Open-File Report, 58 pp.

Parks, H.M., about 1926/undated, A prospectus of the development of the Fort Rock Valley, Lake County, Oregon: unpublished, 60 pp.

Peterson, N.V., and Groh, E.A., 1961, Hole-in-the-ground, central Oregon: Oregon Department of Geology and Mineral Industries, The Ore.-Bin, Volume 23, No. 10, pp. 95-100.

Peterson, N.V., and McIntyre, Jr., 1970, The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 66, 70 pp.

Phillips, K.N., Newcomb, R.C., Swenson, H.A., and Laird, L.B., 1965 Water for Oregon: U.S. Geological Survey Water-Supply Paper 1649, 150 pp.

Phillips, K.N., and Van Denburgh, A.S., 1971, Hydrology and geochemistry of Abert, Summer, and Goose Lakes, and other closed-basin lakes in south-central Oregon: U.S. Geological Survey Professional Paper 502-B, 81 pp.

Piper, A.M., Robinson, T.W., and Parks, C.F., Jr., 1939, Geology and ground-water resources of the Harney Basin, Oregon, with a statement on Precipitation and tree growth, by L.T. Jessup: U.S. Geological Survey Water-Supply Paper 841, 189 pp.

Priest, G.R., Vogt, B.F., and Black, G.L., 1983, Survey of potential geothermal exploration sites at Newberry volcano, Deschutes County, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-83-3, 36 pp.

Reed, J.E., Bedinger, M.S., Gonthier, J.B., Langer, W.H., McFarland, W.D., and Mulvihill, D.A., 1984, Maps showing ground-water levels, springs, and depth to ground water, Basin and Range province, Oregon: U.S. Geological Survey Water-Resources Investigations Report 83-4120-B.

Reed, J.E., Bedinger, M.S.. Gonthier, J.B., and McFarland, W.D., 1984, Maps showing ground-water units and number of large capacity wells, Basin and Range province, Oregon: U.S. Geological Survey Water-Resources Investigations Report 83-4120-A.

Russell, I.C., 1884, A geological reconnaissance in southern Oregon: U.S. Geological Survey Fourth Annual Report, pp. 431-464.

Steiger, L.D., and Associates, Inc., 1979, Lake County atlas, a county comprehensive plan supplement: 141 pp.

Stott, W.J., 1952, Investigation of saline deposits in southern Oregon: Bonneville Power Administration Study Contract No. 16 p-7748 to University of Portland, 60 pp.

Thompson, T.H., Chappell, R., Gonthier, J.B., and McFarland, W.D., 1984, Maps showing distribution of dissolved solids and dominant chemical type in ground water, Basin and Range province, Oregon: U.S. Geological Survey Water-Resources Investigations Report 83-4120-C.

Trauger, F.D., 1950, Basic ground-water data in Lake County, Oregon: U.S. Gelogical Survey Open-File Report, 287 pp.

U.S. Geological Survey, 1984, Water resources data for Oregon Water Year 1983: U.S. Geological Survey Water-Data Report OR-83-1, 202 pp.

Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle. Lake and Klamath Counties, Oregon: U.S. Geological Survey Mineral Investigations Field Studies Map MF-260.

Walker, G.W., Peterson N.V., and Greene, R.C., 1967, Reconnaissance geologic map of the east half of the Crescent Quadrangle, Lake, Deschutes, and Crook Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations, Map I-493.

Walker, G.W., 1977, Geologic map of Oregon east of the 121st meridian: U.S. Geological Survey Miscellaneous Geologic Investigations, Map I-902.

Waring, G.A., 1908. Geology and water resources of a portion of south-central Oregon: U.S. Geological Survey Water Supply Paper 220, 85 pp.

Weissenborn, A.E., ed., 1969, Mineral and water resources of Oregon: Oregon Department of Geology and Mineral Industries Bulletin 64, 462 pp.

Wells, F.G. and Peck, D.L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geological Survey Miscellaneous Geologic Investigations, Map I-325.

APPENDIX I

CHEMICAL ANALYSES OF WATER FROM WELLS

CHEMICAL ANALYSES OF WATER FROM WELLS

[Use: D, domestic; I, irrigation; S, stock; W, wildlife. Results are given in milligrams per liter unless otherwise indicated. Analyses were made by Oregon Department of Environmental Quality]

Well Number	Owner	Use	Depth of Well (ft.)	Principal Aquifer	Date of Collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Alkalinity As $CaCO_3$	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved Solids Residue at 180°C	Calculated Dissolved Hardness as $CaCO_3$	Specific Conductance (micromhos at 25°C)	pH
25S/14E -15bc	F. Goodwin	I,D	256	Fort Rock Formation	7/25/84	52	41	<.05	0.13	11	7	28	3.6	92	21	5	0.3	0.05	0.1	166	58	230	8.1
25S/16E -26bc	M. Ward	S	278	Paulina Basalt	7/22/84	59	48	0.09	0.03	23	14	22	4.9	136	10	16	0.1	0.07	<.1	210	115	320	8.2
25S/18E -5bb	L. Schrock	I	280	Paulina Basalt	7/29/85	51	25	0.08	<.05	12	13	30	5.1	134	13	5	0.2	<.02	0.2	173	83	280	8.6
25S/19E -31dc	O. White	I,D	225	Fort Rock Formation	7/23/84	54	15	<.05	<.02	16	23	77	11.6	202	63	13	0.2	<.02	0.4	344	135	580	8.8
26S/14E -20cc	G. Boatwright	D,S	192	Fort Rock Formation	7/29/85	52	31	0.07	<.05	8	4	9	2.0	58	1	1	0.1	0.31	<.1	89	37	111	8.4
26S/15E -6ab	J. Kittredge	I	317	Fort Rock Formation	7/29/85	59	46	0.08	<.05	17	8	35	3.0	98	32	23	0.2	<.02	0.5	217	74	310	8.5
26S/16E -27ac	K. Johnson	I	1002	Picture Rock Basalt	7/29/85	71	43	0.06	<.05	2	2	29	2.6	65	6	9	0.3	0.18	0.2	131	14	164	8.7
27S/15E -4ac	M. Parks	I	257	Fort Rock Formation	7/24/84	63	53	<.05	<.02	34	22	170	14.8	256	140	120	0.6	0.77	4.0	729	175	1130	7.9
27S/16E -13ab	R. Morehouse	I	560	Fort Rock Formation	7/29/85	64	41	0.16	<.05	9	4	23	1.8	59	5	2	0.3	<.02	0.2	99	37	124	8.7
27S/16E -26cd	M. Bedinger	I	755	Picture Rock Basalt	7/29/85	56	40	0.14	<.05	3	3	26	1.7	56	19	3	0.2	0.05	0.1	119	21	149	8.7
27S/18E -6db	C. Carrico	I	244	Fort Rock Formation	7/22/84	61	49	<.05	0.15	92	31	130	9.2	205	430	29	0.2	0.12	2.5	922	357	1239	7.8
27S/19E -18cc	ZX Ranch	I	255	Picture Rock Basalt	7/29/85	68	55	0.10	0.12	24	23	86	9.1	122	150	48	0.6	<.02	1.2	478	150	700	8.0
28S/15E -19da	G. Emery	I	189	Hayes Butte Basalt	7/29/85	53	43	0.11	<.05	8	5	11	2.8	66	2	1	0.1	0.21	<.1	104	39	129	7.8
29S/16E -16aa	G. Carlon	I	680	Picture Rock Basalt	7/19/84	57	39	<.05	<.02	6	4	13	2.6	61	1	1	0.1	0.17	<.1	100	32	120	8.3
30S/17E -7bd	Game Comm.	W	445	Picture Rock Basalt (?)	7/19/84	66	37	<.05	<.02	3	2	61	4.8	131	6	10	0.2	0.02	0.6	202	13	290	8.9

APPENDIX II

RECORDS OF WELLS

Record of Wells Location: 23S/16E-35cd

Dates and Water Levels in Feet Below Land Surface Datum

11-20-76	435.00(W)
03-04-81	433.55
11-23-81	434.23
07-20-82	434.29
03-11-83	434.20
07-27-83	431.70(R)
11-22-83	433.53
03-18-84	434.26
07-25-84	434.54
08-18-85	437.20(R?)

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T23S/R16E-35cd

Owner: U.S. Bureau of Land Management Well Completion Date: 1976

Well Depth: 505 ft. Casing Size: 8 in. Casing Depth 498 ft.

Land Surface Elevation at Well: 4729 ft. Determination: Estimate from topo

Water Use: Stock Water Temperature: 58°F on well report

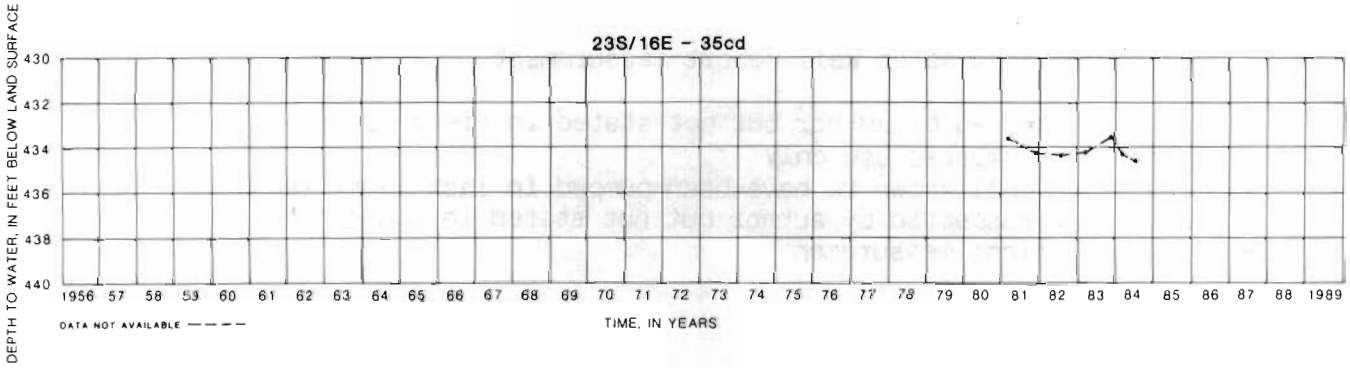
Yield: 25 gpm Drawdown: (0) ft. Test duration: 4 hrs. Test Date: 1976

Other Well Data: Water Well Report

Remarks: This well is known as the "Squaw Mountain Well." The casing is perforated from 418 to 498 feet. The yield test drawdown of 0 feet is not possible but probably reflects nominal drawdown. Due to factors surrounding the great depth to water in this well, measurements are probably only accurate to within 1/2 foot. The precision of the waer well report measurement in 1976 is uncertain.

Generalized Log:

Top Soil	0 to 7 feet	Gray Claystone	185 to 205 feet
Black Granite (?)	7 to 32 feet	Brown Conglomerate	205 to 215 feet
Red Cinders	32 to 35 feet	Red Cinders	215 to 290 feet
Black Granite (?)	35 to 46 feet	Gray Claystone	290 to 382 feet
Red Cinders	46 to 57 feet	Red Cinders	382 to 389 feet
Soft Lava	57 to 98 feet	Gray Sandstone	389 to 435 feet
Hard Gray Rock	98 to 137 feet	Red Cinders	435 to 470 feet
Red Cinders	137 to 166 feet	(Water-bearing)	
Soft Lava	166 to 180 feet	Sand and Gravel	470 to 498 feet
Red Cinders	180 to 185 feet	(Water-bearing)	
		Sandstone	498 to 505 feet



Record of Wells Location: 24S/14E-17da(2)

Dates and Water Levels in Feet Below Land Surface Datum

07-00-40	228.00(W)
10-25-48	221.86(??)
03-05-81	224.57
11-24-81	225.40
03-18-82	222.96(??)
07-20-82	221.80(??)
11-19-82	225.54
03-11-83	225.35
07-28-83	224.85
11-22-83	223.98(??)
03-20-84	225.14
07-24-84	225.10
03-27-85	224.39(??)
07-30-85	225.60
07-31-85	225.62
09-15-85	225.44
10-16-85	225.25
11-18-85	225.16
04-30-86	224.88
07-18-86	224.50

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T24S/R14E-17da(2)

Owner: U.S. Forest Service Well Completion Date: 1940

Well Depth: 330 ft. Casing Size: 8 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4516.7 ft. Determination: Leveled

Water Use: Group Domestic Water Temperature: 50°F (10°C)

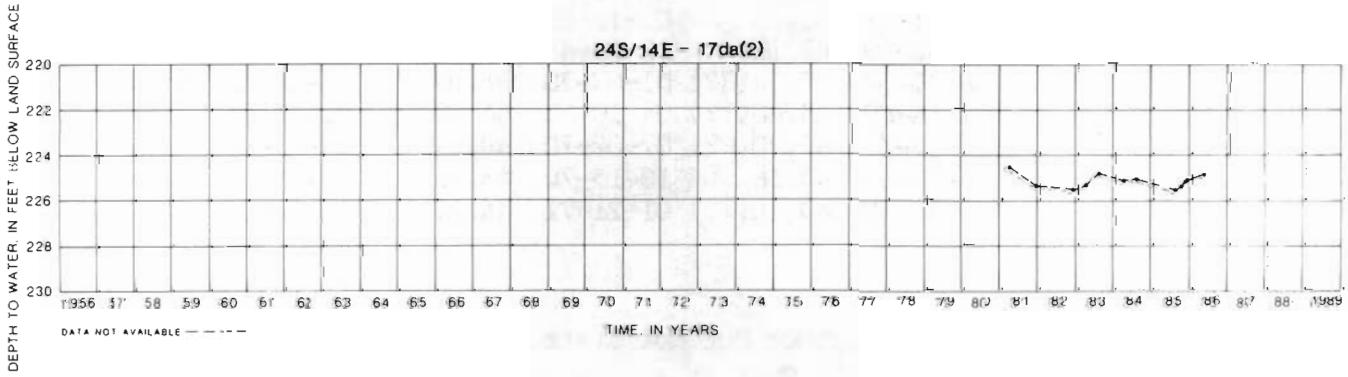
Yield: -- gpm Drawdown: -- ft. Test duration: -- hrs. Test Date: ---

Other Well Data: Water Well Report, Partial Water Chemistry Analysis

Remarks: This well is located at the Cabin Lake Ranger Station. Land surface elevation changes at the well since the 1940's are probably minor. Due to the great depth to water and wires in well, water level accuracy is probably within a few tenths of a foot. Well has reportedly yielded 15,000 gpd with little drawdown.

Generalized Log:

Soil	0 to 4 feet	Red Lava	152 to 160 feet
Soft Lava	4 to 73 feet	Hard Lava	160 to 184 feet
Pumice	73 to 82 feet	Red Lava	184 to 192 feet
Hard Lava	82 to 92 feet	Lava	192 to 235 feet
Cinders	92 to 93 feet	Crevice	235 feet
Hard Lava	93 to 102 feet	(Water-bearing)	
Cinders	102 to 109 feet	Hard Lava	235 to 328 feet
Hard Lava	109 to 152 feet	Red Cinders	328 to 330 feet
		(Water-bearing)	



Record of Wells Location: 25S/14E-15bc

Dates and Water Levels in Feet Below Land Surface Datum

09-04-32	45.30	01-20-54	46.20	01-12-61	43.40	04-13-71	45.05(??)
11-27-35	46.84	04-18-54	46.07	04-28-61	43.39	07-14-71	43.97
09-02-36	47.04	07-13-54	49.40(P?)	05-04-61	42.80(??)	10-18-71	43.92
08-28-38	47.30	09-03-54	45.60	07-04-61	43.40	07-10-72	43.74
12-14-38	47.40	10-15-54	45.50	09-15-61	44.32(??)	10-11-72	43.79
03-22-39	47.49	12-23-54	45.37	01-05-62	43.65	04-25-73	43.63(P)
06-21-39	47.58	02-19-55	45.35	03-19-62	43.60	07-09-73	43.90(P)
09-28-39	47.63	05-02-55	44.27(??)	07-11-62	43.74	10-01-73	43.88
12-07-39	47.68	07-19-55	47.22(P?)	09-26-62	44.00	07-01-74	43.43
05-18-40	46.79(??)	09-15-55	46.11(R?)	10-08-62	43.83	10-07-74	40.88(??)
10-06-40	47.86	09-23-55	45.26	01-10-63	43.92	04-07-75	43.14
12-21-40	47.88	10-27-55	44.96(??)	04-08-63	43.83	07-08-75	43.34
03-29-41	48.02	11-06-55	45.27(??)	07-09-63	43.79	09-29-75	43.32
06-06-41	48.05	04-06-56	48.47(??)	10-09-63	43.85	01-12-76	43.19
09-25-41	48.14	05-13-56	44.80	01-09-64	43.87	04-13-76	43.10
01-09-42	48.29	05-15-56	44.80	04-08-64	43.90	10-04-76	43.36
10-24-42	48.36	08-22-56	44.40	07-09-64	44.04	01-11-77	43.24
05-23-43	48.53	08-27-56	44.37	10-06-64	44.16	10-04-77	43.87
09-15-43	48.32	10-15-56	46.74(??)	01-13-65	44.00	01-18-78	44.19(??)
06-12-45	48.67	12-03-56	49.83(??)	04-07-65	43.52	04-20-78	43.67
10-12-45	48.76	04-16-57	43.92	07-14-65	43.36	10-02-78	44.76
07-12-46	48.68	04-29-57	43.87	10-13-65	43.16	06-30-80	49.16(P)
05-11-47	48.81	05-24-57	43.89	01-19-66	43.14	10-13-80	46.77(R?)
10-09-47	48.84	08-10-57	43.71	04-06-66	43.03	11-24-80	45.35(PD)
03-18-48	48.95	08-19-57	44.37(??)	07-07-66	43.04	03-05-81	45.20
08-05-48	48.77	10-02-57	50.39(??)	10-06-66	43.19	11-23-81	46.39
10-22-48	52.88(??)	10-22-57	47.10(??)	01-12-67	43.12	03-18-82	46.16(R)
03-13-49	49.15(??)	01-14-58	47.02(??)	04-06-67	43.20	11-18-82	46.25(PD)
07-04-49	48.80	04-21-58	44.66(??)	07-13-67	43.23	03-11-83	45.94
08-26-49	49.37(??)	04-24-58	43.38	10-04-67	43.26	07-28-83	50.60(P)
11-14-49	48.80	08-08-58	45.31(P?)	01-10-68	43.30	11-22-83	45.86
02-18-50	48.88	09-04-58	45.09(P?)	04-10-68	43.37	01-10-84	45.68(R)
07-12-50	48.59	09-27-58	46.22(??)	07-10-68	43.47	03-18-84	45.44
11-04-50	48.57	10-13-58	44.76(??)	10-10-68	43.67	07-25-84	49.23(P)
03-23-51	48.98(??)	12-09-58	43.12	01-16-69	43.74	11-28-84	45.49(R)
09-05-51	47.80	04-23-59	42.98	04-10-69	43.74	01-17-85	45.29
12-18-51	48.07(??)	05-13-59	42.95	07-11-69	43.92	03-27-85	45.03
04-15-52	47.60	07-02-59	43.10	10-10-69	44.04	07-30-85	50.67(P)
06-18-52	47.29	08-30-59	43.34(R?)	01-07-70	44.07	11-20-85	45.49
09-06-52	47.06	01-16-60	43.40(??)	04-10-70	44.03	01-15-86	45.32
04-01-53	49.17(??)	06-13-60	43.70(R?)	07-02-70	44.09	04-09-86	44.97
07-18-53	46.55	10-14-60	43.36	10-15-70	44.22	07-18-86	45.45
10-16-53	46.36	10-26-60	43.10(??)	01-21-71	44.27	10-16-86	45.42

(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T25S/R14E-15bc

Owner: Frank Goodwin Well Completion Date: 1923

Well Depth: 256+/- ft. Casing Size: 18 in. Casing Depth 45+/- ft.

Land Surface Elevation at Well: 4337.7 ft. Determination: Leveled

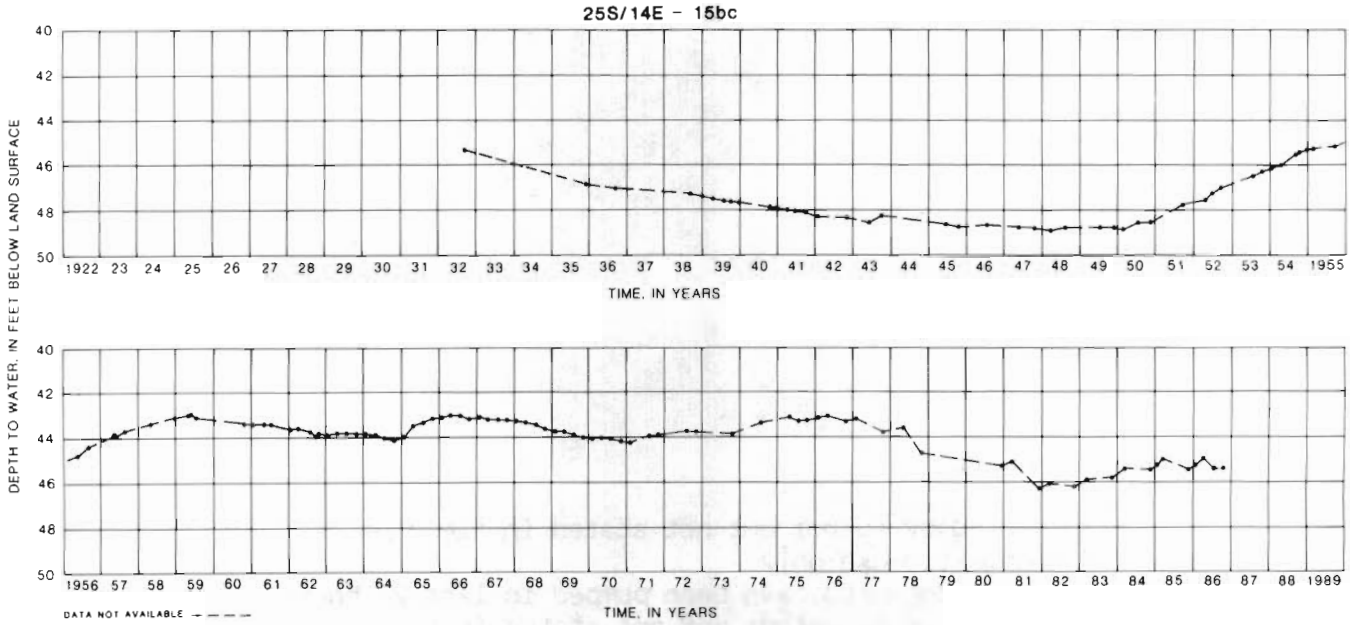
Water Use: Irrigation, Domestic, Stock Water Temperature: 52°F (11°C)

Yield: 1000+/- gpm Drawdown: 5+/- ft. Test duration: -- hrs. Test Date: 07/30/85

Other Well Data: Water Chemistry Analysis

Remarks: This well is known as the "Crampton Well." It is one of four test wells drilled by the State of Oregon in the early 1920's. Although no initial water level measurement was recorded, comparisons with the other three wells suggest a level of 43 feet in 1923. An oil layer was often reported on the water surface when measured. On November 20, 1985, the layer was determined to be 0.19 feet thick. The well contains both turbine and submersible pumps. The submersible pump is used occasionally for domestic and stock use.

Generalized Log: Coarse Basaltic Agglomerate is main water production zone. No other materials log information available.



Record of Wells Location: 25S/14E-29da(1)

Dates and Water Levels in Feet Below Land Surface Datum

07-20-56	42.00(W)	04-13-71	42.56
08-28-56	41.68	07-14-71	42.56
10-16-56	41.54	10-18-71	42.38
04-30-57	41.28	04-10-72	42.24
08-19-57	74.45(P)	10-11-72	42.51
10-22-57	41.46	10-01-73	41.99(??)
04-21-58	41.09	10-07-74	45.86(??)
10-13-58	72.14(P)	04-07-75	42.20
05-13-59	40.94	09-29-75	42.52
10-16-59	41.34	01-12-76	41.97
04-28-60	40.98	04-13-76	41.93
10-26-60	41.58	10-04-76	42.49
05-04-61	40.94	01-11-77	42.11
10-16-61	41.08	04-13-77	42.11
03-19-62	41.04	10-04-77	42.93
10-08-62	41.57	01-18-78	42.61
01-10-63	41.34	04-20-78	42.80
04-08-63	41.29	10-02-78	45.40(??)
07-09-63	41.74	04-02-79	43.00
10-09-63	41.56	03-17-80	46.24(??)
01-09-64	41.23	10-13-80	44.33
04-08-64	41.30	11-24-80	44.10
07-09-64	41.74	03-05-81	44.00
10-06-64	41.56	11-23-81	45.02
01-13-65	41.45	03-18-82	44.83
04-07-65	40.95	11-18-82	44.83
10-13-65	40.64	03-11-83	44.57
01-19-66	40.58	11-22-83	44.45
04-06-66	40.54	03-19-84	44.08
01-12-67	40.71	11-28-84	44.20
04-06-67	40.74		
10-04-67	41.21		
01-10-68	40.92		
04-10-68	40.91		
10-10-68	41.37		
01-16-69	41.26		
04-10-69	41.42		
07-11-69	41.56		
10-10-69	41.89		
01-07-70	41.50		
04-10-70	41.45		
10-15-70	42.73		
01-21-71	42.61		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T25S/R14E-29da(1)

Owner: Banfield Vet. Hospital Inc. Well Completion Date: 1956

Well Depth: 310 ft. Casing Size: 14 in. Casing Depth 86 ft.

Land Surface Elevation at Well: 4336.8 ft. Determination: Leveled

Water Use: Irrigation formerly Water Temperature: 50°F

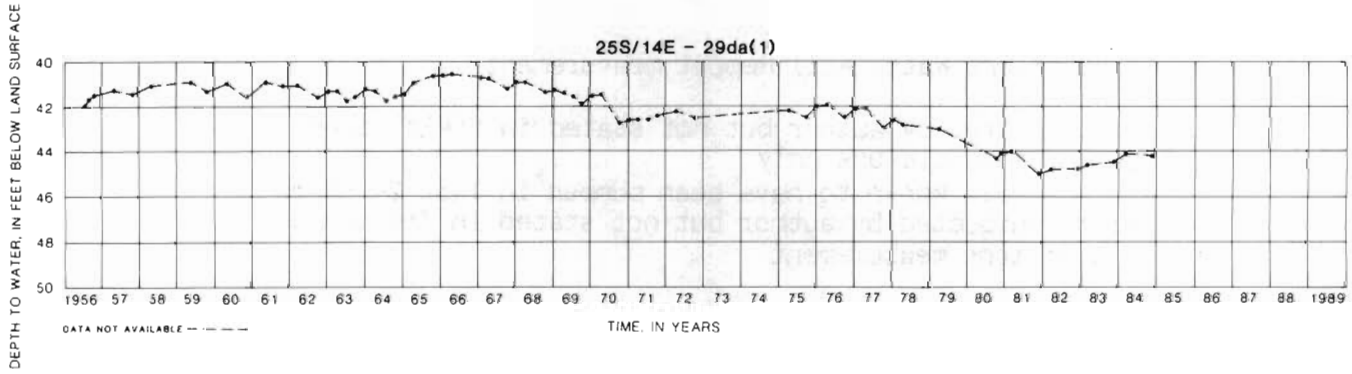
Yield: 800 gpm Drawdown: 41 ft. Test duration: -- hrs. Test Date: 10/57

Other Well Data: Water Right File, Water Well Reports

Remarks: This well was abandoned about 12/84 and replaced by a well 30 feet south which is designated as T25S/R14E-29da(2). Please see that Record of Wells for continuation of water level data in this locale. An oil layer was consistently reported on the water surface in the old well during the late 70's and 80's. The thickness of that layer was never measured. The abrupt water level drop in 1970 may be the result of a measuring point change which was not cited in the field notes. A 10-inch liner was installed in the well to a depth of 342 feet in 1970. That deepening report suggests an unreported deepening of the well previously.

Generalized Log:

Surface (soil)	0 to 3 feet	Brown Clay	94 to 120 feet
Hard Pan	3 to 5 feet	Black Sand	120 to 145 feet
Yellow Clay	5 to 48 feet	Brown Clay	145 to 285 feet
Black Sand	48 to 80 feet	Sand and Gravel	285 to 308 feet
Blue Clay	80 to 90 feet	Brown Clay	308 to 310 feet
Black Sand	90 to 94 feet		



Record of Wells Location: T25S/R14E-29da(2)

Dates and Water Levels in Feet Below Land Surface Datum

03-27-85	43.01
09-15-85	43.56
10-16-85	43.39
11-20-85	43.34
03-11-86	42.95
04-09-86	42.83

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T25S/R14E-29da(2)

Owner: Banfield Vet. Hospital Inc. Well Completion Date: 12/84

Well Depth: 438 ft. Casing Size: 14 in. Casing Depth 230 ft.

Land Surface Elevation at Well: 4336.1 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: ----

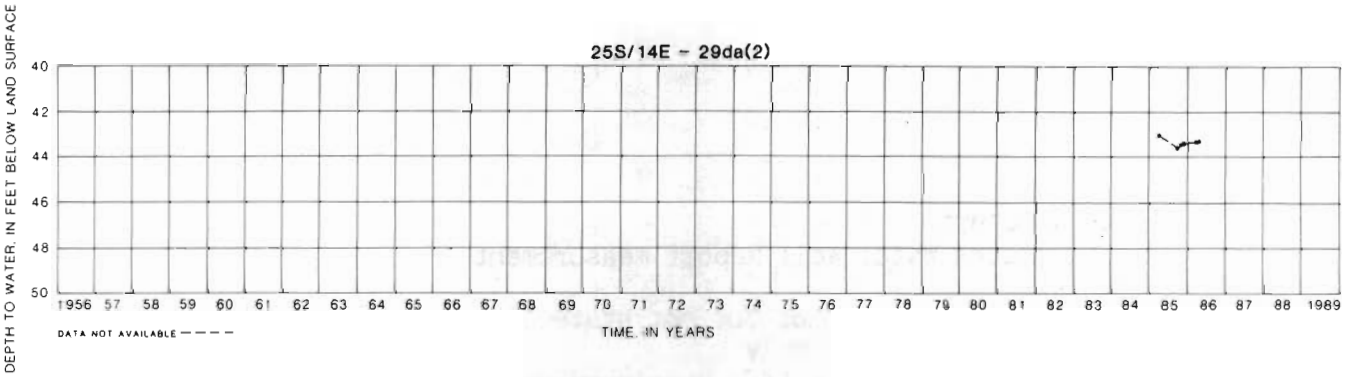
Yield: 1400 gpm Drawdown: -- ft. Test duration: 1 hr. Test Date: 1984

Other Well Data: Water Well Report

Remarks: This well replaces T25S/R15E-29da(1) which is about 30 feet north. An oil layer developed on the water surface during 1985 which was measured to be 1.27 feet thick on 10/16/85.

Generalized Log:

Light Soft Sand	0 to 1 foot	Hard Shale	230 to 305 feet
Light Cemented Sand	1 to 24 feet	Soft Shale	305 to 345 feet
Yellow Clay	24 to 26 feet	Very Hard Basalt	345 to 391 feet
Green Clay	26 to 30 feet	Porous Lava	391 to 400 feet
Hard Blue Shale	30 to 77 feet	Hard Rock	400 to 402 feet
Gray Shale	77 to 90 feet	Red Lava (Water-bearing)	402 to 425 feet
Soft Light Green Pumice with Clay	90 to 97 feet	Hard Brown Basalt	425 to 436 feet
Black Sand	97 to 230 feet	Hard Brown Broken Basalt	436 to 438 feet



Record of Wells Location: T25S/R16E-26bc

Dates and Water Levels in Feet Below Land Surface Datum

10-15-48	218.05
12-06-49	216.83
03-05-81	213.88
11-17-82	214.73
03-11-83	214.80
07-27-83	219.60(R)
11-22-83	213.55
03-18-84	214.81
05-24-84	214.86
07-22-84	222.28(P)
03-26-85	213.68
07-30-85	214.65
09-15-85	213.84
11-20-85	213.37
05-01-86	223.06(P)

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T25S/R16E-26bc

Owner: Maurice Ward Well Completion Date: pre-1949

Well Depth: 278 ft. Casing Size: 6 in. Casing Depth 6 ft.

Land Surface Elevation at Well: 4506 ft. Determination: Topo Listing

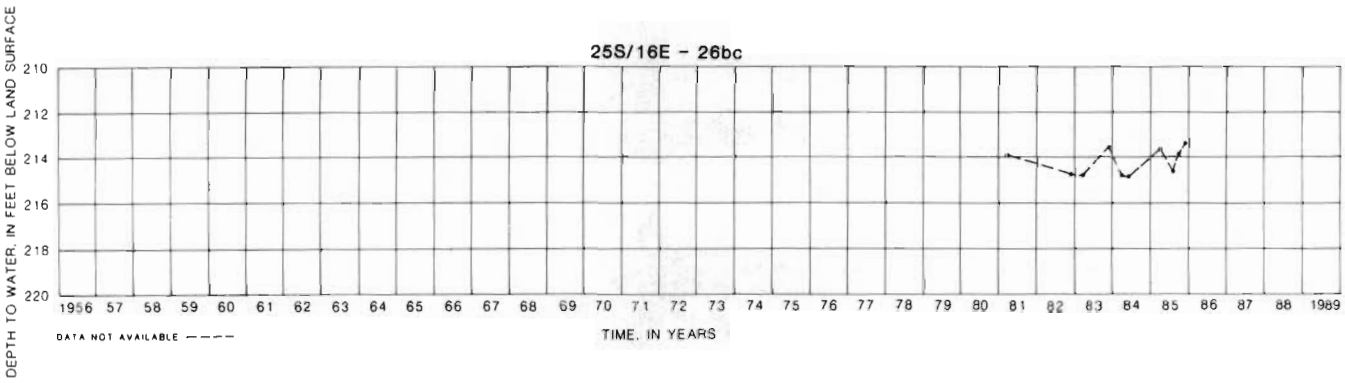
Water Use: Stock Water Temperature: 59°F (15°C)

Yield: 1 gpm Drawdown: 7 ft. Test duration: -- hrs. Test Date: 1984

Other Well Data: Partial Water Chemistry Analysis

Remarks: This well is known as the "Ward Well." This well reportedly produces water from quicksand. Materials penetrated by the well should be dominated by volcanics, principally lava flows. The reasons for the water level bounces are unclear but probably include: measurement error, recharge effects, and bore-hole effects with cascading recharge.

Generalized Log: None available.



Record of Wells Location: 25S/18E-9cc

Dates and Water Levels in Feet Below Land Surface Datum

05-25-63	39.00(W)	11-19-85	36.99
07-10-68	33.30	01-14-86	36.12
10-09-68	33.41	03-11-86	35.28
01-15-69	33.39	04-08-86	34.78
04-09-69	33.46	07-17-86	36.74
07-10-69	33.56	10-16-86	37.03
10-09-69	33.67		
01-06-70	33.74		
04-09-70	33.70		
07-02-70	33.82		
10-14-70	33.79		
04-13-71	33.94		
07-14-71	33.93		
10-18-71	34.00		
04-11-72	33.78		
07-11-72	33.94		
10-12-72	33.87		
04-26-73	33.81		
07-10-73	34.02		
10-02-73	34.08		
07-02-74	34.07		
09-11-79	35.70		
07-01-80	36.81		
11-25-80	36.09		
03-04-81	35.15		
11-22-81	37.57		
03-17-82	35.40		
07-20-82	37.67		
11-17-82	36.65		
03-10-83	35.55		
07-27-83	38.64		
09-08-83	39.35		
11-21-83	36.48		
03-17-84	35.05		
05-24-84	35.63		
07-18-84	38.72		
09-20-84	40.41		
11-27-84	36.60		
03-26-85	35.04		
07-28-85	40.22		
09-14-85	39.95		
10-11-85	37.97		

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T25S/R18E-9cc

Owner: Eric and Irene Clignett Well Completion Date: 1963

Well Depth: 260 ft. Casing Size: 12 in. Casing Depth 18 ft.

Land Surface Elevation at Well: 4326.7 ft. Determination: Leveled

Water Use: None Water Temperature: 53°F (12°C)

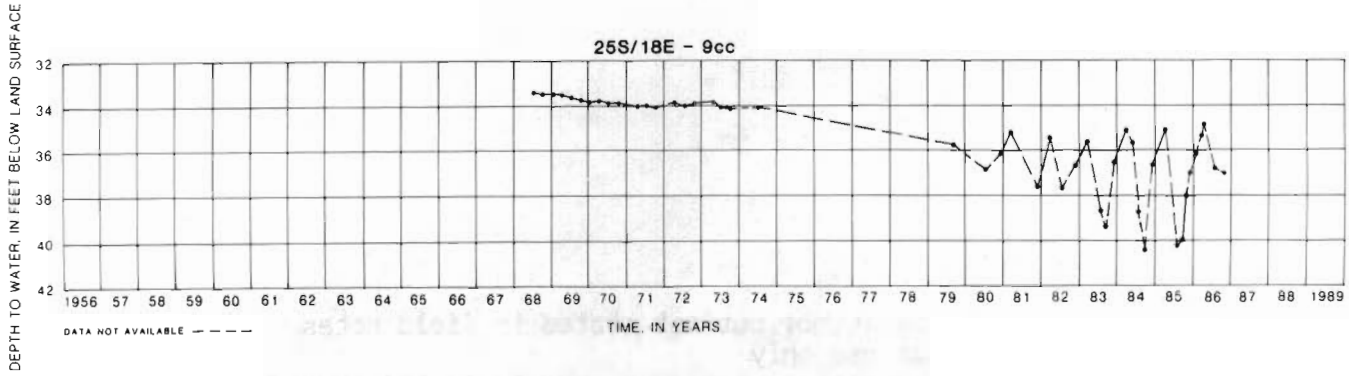
Yield: 1500 gpm Drawdown: 56 ft. Test duration: 30 hrs. Test Date: 1963

Other Well Data: Water Well Report

Remarks: This was an observation well between 1968 and 1974. Due to lack of development, it was dropped. In 1979 it was restored as an observation well in order to monitor the effects of development in "The Sinks" area. Water level decline and seasonal interference reflect this development. This well responds to the nearby sinking of Peters Creek which flows certain years due to spring snowmelt.

Generalized Log:

Soil	0 to 5 feet	Red Cinders	82 to 85 feet
Blue Clay	5 to 15 feet	Black Lava	85 to 90 feet
Hard Lava	15 to 49 feet	White Gravel (Water-bearing)	90 to 93 feet
Soft Lava	49 to 51 feet	Hard Lava	93 to 120 feet
Hard Lava	51 to 56 feet	Lava with Cinders	120 to 197 feet
Porous Lava	56 to 57 feet	Porous Lava	197 to 227 feet
Hard Rock	57 to 65 feet	Black Sandstone	227 to 256 feet
Red Cinders	65 to 66 feet	Black Sand	256 to 260 feet
Black Lava	66 to 82 feet		



Record of Wells Location: 25S/19E-31dc

Dates and Water Levels in Feet Below Land Surface Datum

05-09-63	14.00(W)	01-12-77	14.07
10-08-63	14.18	04-14-77	14.00
01-08-64	14.03	07-05-77	14.85
04-07-64	14.16	10-05-77	14.88
07-08-64	14.32	01-19-78	14.28
10-07-64	14.32	04-21-78	13.86
01-13-65	13.40	10-03-78	14.92
04-06-65	12.57	07-01-80	15.76
07-13-65	12.96	11-25-80	15.70
10-12-65	13.10	03-04-81	15.25
01-18-66	13.15	11-22-81	16.91
04-05-66	13.27	03-17-82	15.10
07-06-66	13.27	07-20-82	16.55
10-05-66	13.58	11-17-82	16.35
01-11-67	13.50	03-10-83	15.57
04-05-67	13.41	07-27-83	18.15(P)
07-12-67	13.58	11-21-83	16.30
10-03-67	13.95	01-10-84	15.74
01-09-68	13.58	03-17-84	15.29
04-09-68	13.69	05-24-84	15.77
07-10-68	14.03	07-17-84	18.92(P)
10-09-68	13.82	11-27-84	16.22
01-15-69	13.77	01-17-85	15.78
04-09-69	13.62	03-26-85	15.19
07-10-69	13.78	07-28-85	18.97
10-09-69	14.09	09-14-85	18.65
01-06-70	13.97	10-11-85	17.67
04-09-70	13.80	11-19-85	16.76
07-02-70	14.19	01-14-86	16.08
10-14-70	14.14	03-11-86	14.99
04-13-71	14.09	04-08-86	14.63
07-14-71	14.34	05-01-86	13.65(??)
10-18-71	14.32	10-16-86	16.83
04-17-72	13.95		
07-10-73	14.19		
10-02-73	13.91		
10-08-74	14.45		
04-08-75	13.96		
09-30-75	14.70		
01-13-76	14.09		
04-14-76	13.94		
07-07-76	14.62		
10-05-76	14.55		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T25S/R19E-31dc

Owner: O.E. White Well Completion Date: 1963

Well Depth: 225 ft. Casing Size: 12 in. Casing Depth 20 ft.

Land Surface Elevation at Well: 4306.2 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 54°F (12°C)

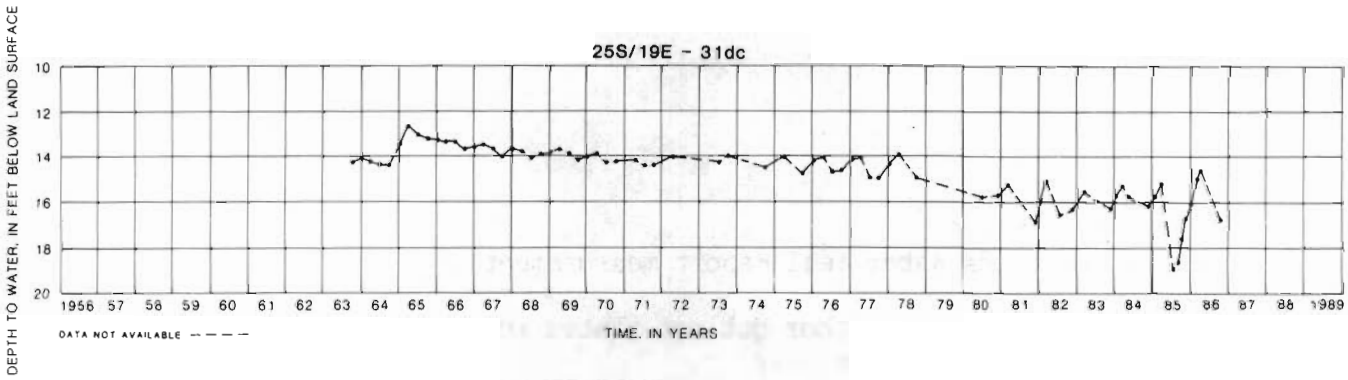
Yield: 2375 gpm Drawdown: 6 ft. Test duration: 6 hrs. Test Date: 1963

Other Well Data: Water Well Report, Water Right File, Water Chemistry Analysis

Remarks: Water levels can rise more quickly in this well due to heavy winter precipitation than do levels in most Fort Rock Basin observations wells. In this regard please note early 1965, early 1982, and early 1986. Although an oil layer has been noted on the water in this well since 1972, the effect on water levels is probably slight. An oil thickness determination in November, 1985, suggested a layer less than one foot.

Generalized Log:

Soil, Sand and Clay	0 to 18 feet	Porous Lava	120 to 190 feet
Hard Blue Clay	18 to 20 feet	Lava	190 to 210 feet
Blue and Brown Clay	20 to 72 feet	Porous Lava	210 to 222 feet
Lava	72 to 120 feet	Hard Gravel (Water-bearing)	222 to 225 feet



Record of Wells Location: 26S/13E-4ab

Dates and Water Levels in Feet Below Land Surface Datum

00-00-10	196
00-00-32	201(??)
10-18-84	196.15
05-14-86	195.67

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R13E-4ab

Owner: Cornelius Dalebout Well Completion Date: 1910

Well Depth: 220 ft. Casing Size: 6 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4488.6 ft. Determination: Leveled

Water Use: Domestic, stock Water Temperature: ---

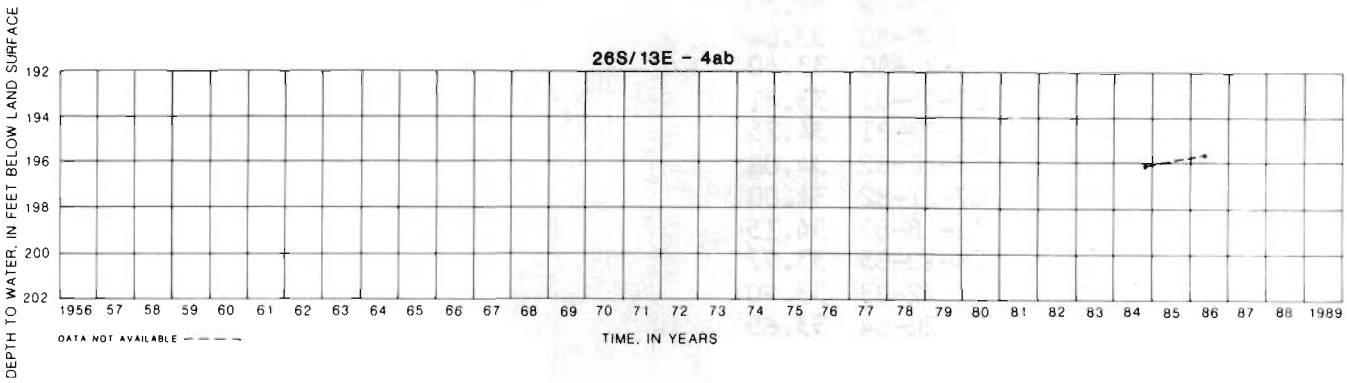
Yield: --- gpm Drawdown: -- ft. Test duration: -- hrs. Test Date: ---

Other Well Data: Water Well Report

Remarks: This is known as the "McCallum Well." It was originally drilled to about 198 feet and deepened in 1932 to 220 feet.

Generalized Log:

Gravel	0 to 10 feet	Sand and Gravel	105 to 120 feet
Clay and Tuff	10 to 60 feet	Rock	120 to 160 feet
Rock	60 to 75 feet	Basalt	160 to 220 feet
Basalt	75 to 105 feet	(Water-bearing)	



Record of Wells Location: 26S/14E-3bb

Dates and Water Levels in Feet Below Land Surface Datum

10-12-48	37.42	04-10-69	32.01	07-21-84	33.71
09-05-51	38.50(R?)	07-11-69	32.14	11-28-84	33.81
05-17-56	33.70(R?)	10-10-69	32.15	03-27-85	33.51
08-29-56	32.60	01-07-70	32.21	07-30-85	33.60
10-16-56	32.56	04-10-70	32.21	09-15-85	33.87
04-30-57	32.17	07-02-70	32.25	11-20-85	33.77
08-19-57	32.10	10-15-70	32.33	04-09-86	33.42
10-24-57	31.94	01-21-71	32.33	07-18-86	33.06(??)
04-22-58	32.52(R?)	07-14-71	32.18		
10-13-58	31.81	10-18-71	32.13		
05-12-59	31.29	04-10-72	31.94		
10-16-59	31.48	07-10-72	34.26(R)		
04-28-60	31.60	10-11-72	31.80		
05-04-61	31.56	04-25-73	34.37(P)		
10-16-61	31.74	07-09-73	34.76(P)		
03-19-62	31.79	10-01-73	32.15		
07-11-62	32.00	07-01-74	35.65(P?)		
10-08-62	32.01	10-07-74	36.37(P?)		
01-10-63	32.04	04-07-75	31.43		
04-08-63	32.04	07-08-75	31.73		
07-09-63	31.98	09-29-75	31.70		
10-09-63	32.00	01-12-76	31.52		
01-09-64	32.03	04-13-76	31.48		
04-08-64	32.10	07-06-76	31.83		
07-09-64	32.14	10-04-76	31.60		
10-06-64	32.23	01-11-77	31.77		
01-13-65	32.19	04-13-77	31.73		
04-07-65	31.73	07-05-77	31.69		
07-14-65	31.58	10-04-77	31.89		
10-13-65	31.38	01-18-78	32.08		
01-19-66	31.32	04-20-78	28.30(??)		
04-06-66	31.27	10-02-78	32.96(??)		
07-05-66	31.29	04-03-79	32.30		
10-06-66	31.32	06-30-80	33.04		
01-12-67	31.33	11-24-80	33.40		
04-06-67	31.32	03-05-81	33.41		
07-13-67	31.42	11-23-81	34.25		
10-04-67	31.48	03-18-82	34.08		
01-10-68	31.48	07-21-82	34.00		
04-10-68	31.56	11-18-82	34.15		
07-10-68	31.72	08-10-83	33.97		
10-10-68	31.82	11-22-83	33.90		
01-16-69	31.94	03-20-84	33.65		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R14E-3bb

Owner: Shorty Gustafson Well Completion Date: pre-1949

Well Depth: 60 ft. Casing Size: 6 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4326.3 ft. Determination: Leveled

Water Use: None Water Temperature: 52°F (11°C)

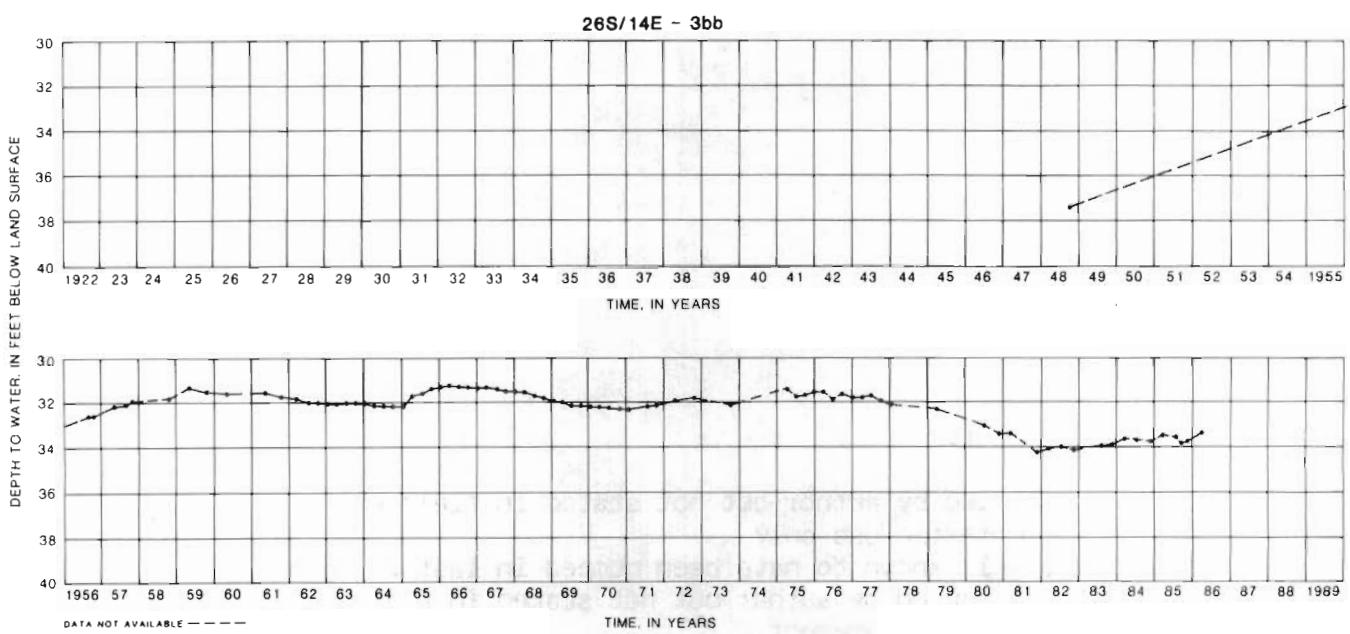
Yield: --- gpm Drawdown: -- ft. Test duration: -- hrs. Test Date: ---

Other Well Data: Partial Water Chemistry Analysis

Remarks: A gasoline layer has occurred on the water surface since 1980. The layer thickness was 1.8 feet on 08-11-83 and 0.8 foot on 11-20-85. All water level measurements are depth to the liquid surface (water or gasoline) and no correction is applied. The liquid level drop, which would take place by removing the gasoline, is probably very small.

Generalized Log: None available. A well less than 100 feet away lists the following materials which probably approximate those penetrated by this well.

Soil	0 to 5 feet	Green Claystone	59 to 67 feet
Sand and Gravel	5 to 20 feet	Gray and Brown Gravel (Water-bearing)	67 to 72 feet
Brown Clay	20 to 28 feet		
Green and Brown Clay	28 to 59 feet		



Record of Wells Location: 26S/14E-20cc

Dates and Water Levels in Feet Below Land Surface Datum

11-08-40	65.85(R)	04-09-69	61.43
10-14-48	68.59(??)	07-10-69	61.48
05-23-56	62.20	10-09-69	61.60
08-28-56	61.80	01-06-70	61.72
10-16-56	61.77	04-09-70	61.52
05-01-57	61.38	07-01-70	61.65
08-19-57	61.22	10-15-70	61.77
10-24-57	61.25	04-12-71	61.65
04-22-58	61.08	03-20-84	63.14
10-14-58	60.75	07-25-84	63.27
05-13-59	60.93	10-19-84	63.42
10-16-59	60.72	03-27-85	62.81
04-28-60	60.67	07-29-85	63.77
10-25-60	60.50(??)	10-16-85	63.69
05-04-61	61.01	01-15-86	63.20
10-17-61	61.26	04-10-86	62.66
03-19-62	60.98(??)	07-18-86	63.23
07-11-62	61.56		
10-08-62	61.50		
01-07-63	61.50		
04-08-63	61.42		
07-09-63	61.41		
10-09-63	61.49		
01-09-64	61.46		
04-08-64	61.57		
07-09-64	61.65		
10-08-64	61.70		
04-07-65	61.01		
07-14-65	60.88		
10-13-65	60.75		
01-19-66	60.72		
04-06-66	60.63		
07-07-66	60.62		
10-06-66	60.67		
01-12-67	60.73		
04-06-67	60.73		
07-13-67	60.80		
10-04-67	60.88		
01-10-68	60.85		
04-10-68	60.88		
07-11-68	61.10		
10-10-68	61.29		
01-16-69	61.40		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R14E-20cc

Owner: Mrs. G.R. Boatwright Well Completion Date: 1922

Well Depth: 192 ft. Casing Size: 12 in. Casing Depth 100+/- ft.

Land Surface Elevation at Well: 4355.8 ft. Determination: Leveled

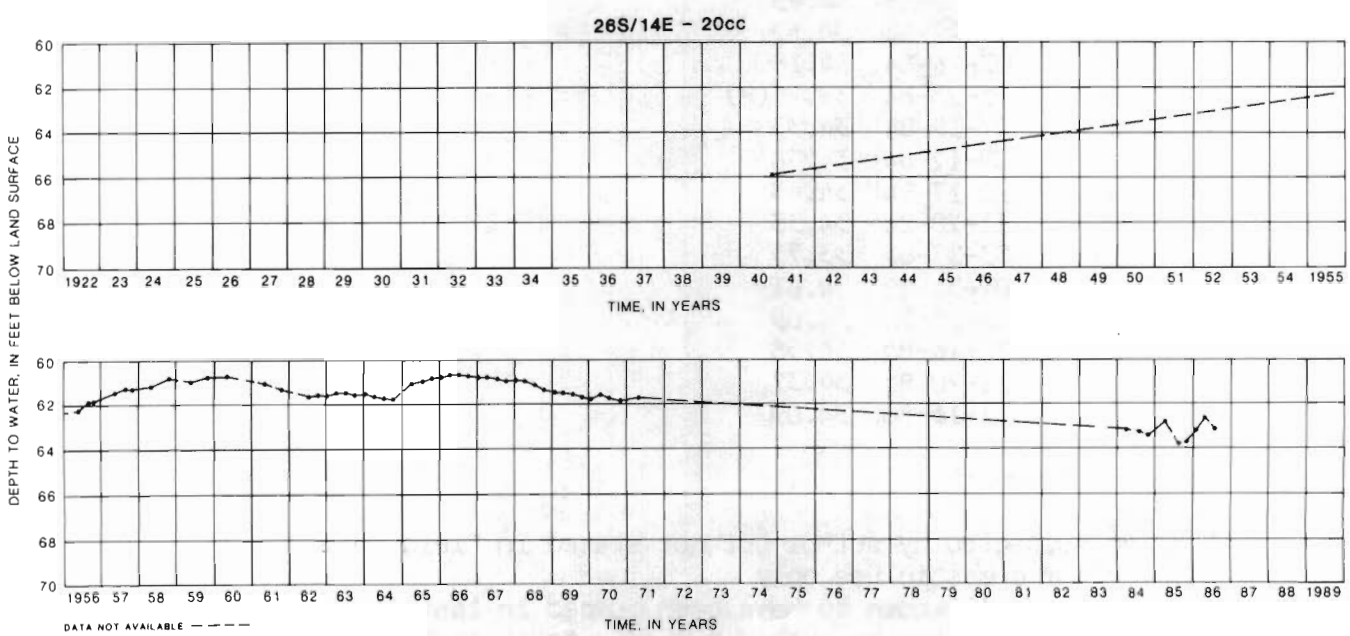
Water Use: Domestic Water Temperature: 52°F (11°C)

Yield: 1100 gpm Drawdown: 22 ft. Test duration: -- hrs. Test Date: 1957

Other Well Data: Water Right File, Water Chemistry Analysis

Remarks: This well is known as the "Sprague Well." It is one of four test wells drilled by the State about 1922 in the Fort Rock Valley. The water level measurements from the 1940's have been modified slightly from published records in order to standardize measuring point corrections.

Generalized Log: None available. Nearby wells in Section 19 contain logged materials which should approximate those found at this well. Basalt lavas are the dominant material.



Record of Wells Location: 26S/14E-23bb

Dates and Water Levels in Feet Below Land Surface Datum

05-13-59	31.84	07-10-72	32.61	04-10-86	33.69
10-16-59	32.07	10-11-72	33.15(R?)	07-18-86	34.38
04-28-60	32.10	04-25-73	32.90	10-16-86	34.31
10-25-60	32.24	07-09-73	32.91		
05-03-61	32.41	10-01-73	32.85		
10-17-61	32.44	07-01-74	31.97		
03-22-62	32.50	10-07-74	32.00		
07-11-62	32.94	04-07-75	31.51(??)		
10-08-62	32.78	07-08-75	31.96		
01-07-63	33.02	09-29-75	32.03		
07-09-63	32.80	01-12-76	31.81		
10-09-63	33.01	04-13-76	31.77		
01-09-64	32.76	07-06-76	32.09		
04-08-64	32.96	10-04-76	32.11		
07-09-64	32.96	01-11-77	32.00		
10-08-64	33.02	04-13-77	31.99		
01-13-65	32.95	07-05-77	32.43		
04-07-65	31.64	10-04-77	32.68		
07-14-65	32.32	01-18-78	32.60		
10-13-65	32.50(R?)	04-20-78	32.42		
01-19-66	32.00	10-02-78	32.99		
04-06-66	31.91	04-02-79	32.98		
07-07-66	31.94	06-30-80	33.94		
10-06-66	32.00	11-26-80	34.23		
01-12-67	32.00	03-05-81	33.86		
04-06-67	32.00	03-18-82	34.93		
07-13-67	32.10	07-21-82	34.95		
10-04-67	32.14	11-18-82	34.96		
01-10-68	32.12	03-11-83	34.66		
04-10-68	32.22	07-28-83	34.95		
07-11-68	32.42	11-22-83	34.53		
10-10-68	32.51	03-16-84	34.18		
01-16-69	32.62	05-25-84	39.28(P)		
04-09-69	32.68	07-19-84	34.33		
07-10-69	32.76	09-17-84	34.78		
10-09-69	32.86	10-17-84	34.43		
01-06-70	32.90	11-28-84	34.33		
04-09-70	32.84	03-27-85	33.75		
07-01-70	32.97	07-31-85	34.81		
01-20-71	33.05	09-15-85	34.65		
04-12-71	32.94	10-16-85	34.58		
07-14-71	32.86	11-20-85	34.37		
04-10-72	32.52	11-15-86	34.09		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R14E-23bb

Owner: U.S.B.L.M. Well Completion Date: 1959+/-

Well Depth: 121 ft. Casing Size: 8 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4327.3 ft. Determination: Leveled

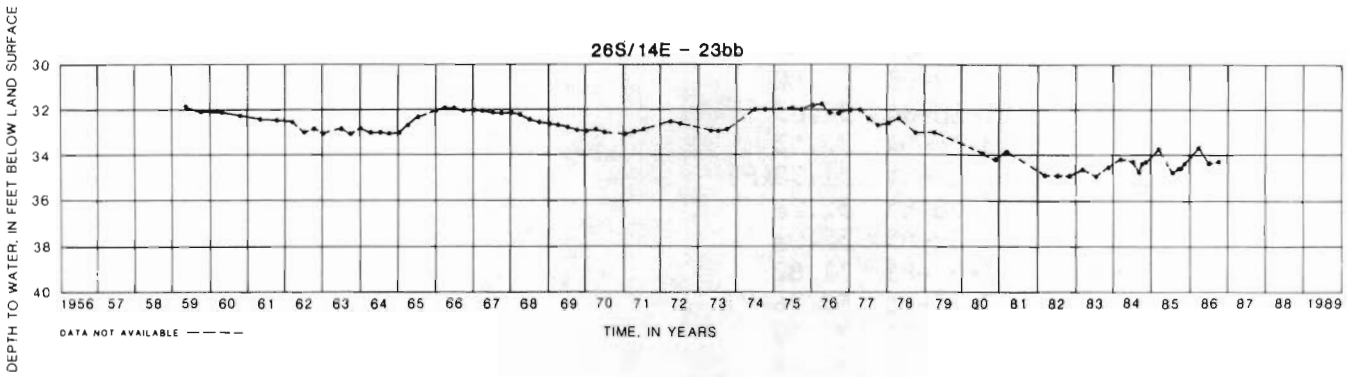
Water Use: Stock Water Temperature: 54°F (12°C)

Yield: 20 gpm Drawdown: 5 ft. Test duration: 1/4 hrs. Test Date: 1984

Other Well Data:

Remarks: This well is known as the "Thomas Well." Due to a lack of information, the precise materials penetrated by this well are unclear. In any case, the water level response displays the characteristics of the main ground water reservoir.

Generalized Log: No log available.



Record of Wells Location: 26S/15E-6ab

Dates and Water Levels in Feet Below Land Surface Datum

05-24-56	35.40	10-15-70	31.98	03-11-86	31.89
08-27-56	34.87	01-21-71	31.96	04-09-86	31.79
10-16-56	34.84	04-13-71	31.83	10-16-86	33.35(??)
04-30-57	35.67(??)	07-14-71	31.55		
10-22-57	35.58(??)	10-18-71	31.40		
04-22-58	36.05(??)	04-10-72	31.22		
05-12-58	33.10(??)	10-12-72	31.55		
10-13-58	34.49(??)	04-26-73	31.04		
04-28-60	33.53	10-02-73	31.26		
10-26-60	33.45	10-08-74	30.85		
05-04-61	33.87	04-08-75	30.71		
10-17-61	33.78	09-30-75	30.82		
03-22-62	34.01	01-13-76	30.47		
07-12-62	34.06	04-14-76	30.40		
10-08-62	33.59	10-05-76	30.70		
01-10-63	33.80	01-12-77	30.60		
04-08-63	33.60	04-14-77	30.60		
10-09-63	33.23(??)	10-05-77	31.11		
01-09-64	33.96	01-19-78	31.10		
04-08-64	34.04	10-01-79	31.82		
07-09-64	34.30	03-17-80	31.39		
10-06-64	34.21	07-02-80	45.35(?)		
01-13-65	34.22	10-13-80	66.23(P?)		
04-07-65	33.72	11-24-80	32.59		
07-14-65	33.32	03-05-81	32.48		
10-13-65	32.96	11-23-81	33.61		
01-19-66	32.93	03-18-82	33.35		
04-06-66	32.85	07-21-82	32.70(??)		
07-07-66	32.72	11-18-82	33.22		
01-12-67	32.47	03-11-83	32.95		
04-06-67	32.52	07-28-83	51.88(P)		
07-13-67	32.40	11-22-83	32.80		
10-04-67	31.64	01-10-84	32.63		
01-10-68	31.65	03-18-84	32.43		
04-10-68	31.67	07-22-84	51.30(P)		
07-10-68	31.79	11-28-84	32.26		
10-10-68	31.87	01-17-85	32.09		
01-16-69	31.98	03-27-85	31.82		
04-10-69	32.07	07-29-85	52.36(P)		
10-10-69	32.06	09-15-85	32.57		
01-07-70	32.10	10-11-85	32.44		
04-10-70	32.05	11-20-85	32.28		
07-02-70	32.00	01-15-86	32.09		

(W) - Water Well Report
(P) - Pumping
(?) - Questionable per field notes
(P?) - Pumping suspected by author but not stated in field notes
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R15E-6ab

Owner: Jack Kittridge Well Completion Date: 1955

Well Depth: 317 ft. Casing Size: 16 in. Casing Depth 119 ft.

Land Surface Elevation at Well: 4329.0 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 59°F (15°C)

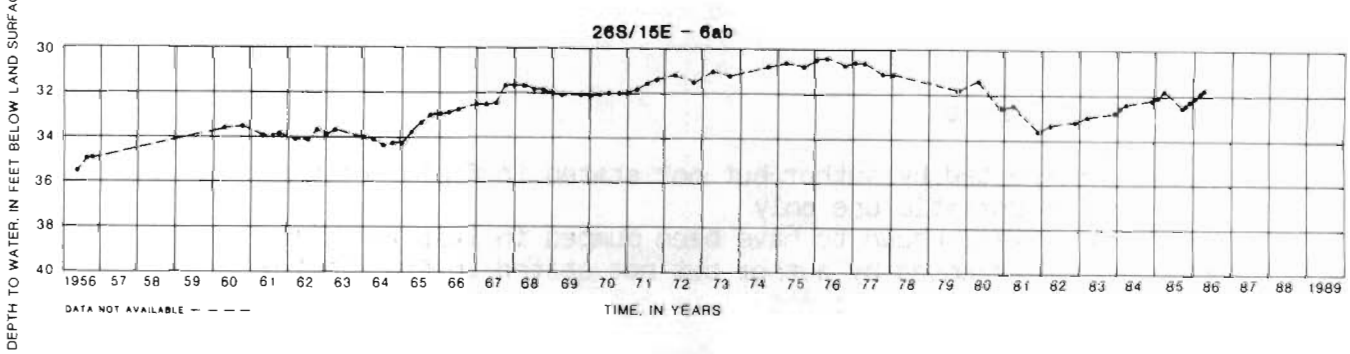
Yield: 800 gpm Drawdown: 41 ft. Test duration: 6 hrs. Test Date: 1955

Other Well Data: Water Chemistry Analysis, Water Right File, Water Well Report

Remarks: Oil has been frequently noted on the water surface. On October 11, 1985, the oil layer was measured as 34.46 feet. The specific gravity of this oil was determined as 0.87 in March 1986. For these values the depth to water would be 4.48 feet deeper than measured liquid. The rate of oil accumulation with time is unclear but is believed to have increased steadily since 1966. The odd rise in 1967 is probably the result of a rapid accumulation between July and October. Due to the oil problem, the hydrograph displays very rough similarities with other basin hydrographs. All depth to water measurements listed are more accurately depth to liquid (oil or water).

Generalized Log:

Soil	0 to 4 feet	Tuff	101 to 170 feet
Gravel, fine	4 to 8 feet	Tuff with Sand layers	170 to 196 feet
Sandy Loam	8 to 32 feet	Tuff	196 to 220 feet
Clay	32 to 40 feet	Lava Rock and Sand	220 to 234 feet
Black Sand	40 to 53 feet	Tuff	234 to 245 feet
Clay	53 to 67 feet	Lava Rock and Gravel	245 to 265 feet
Black Sand	67 to 76 feet	Tuff	265 to 270 feet
Clay	76 to 80 feet	Gravel with streaks of loose sand	270 to 317 feet
Black Sand and Clay	80 to 97 feet		
Hard Sand	97 to 101 feet		



Record of Wells Location: 26S/15E-17dd

Dates and Water Levels in Feet Below Land Surface Datum

09-21-21	24.00	04-09-70	25.24
00-00-40	30.00	10-15-70	25.33
09-27-49	30.52	01-20-71	25.28
05-17-56	26.00	04-12-71	25.27
08-28-56	25.10(??)	03-21-84	27.50
10-16-56	25.86	07-25-84	30.55
04-30-57	25.52	10-17-84	29.35
08-20-57	25.50	03-26-85	26.90
10-24-57	25.31	10-16-85	27.66
04-23-58	25.04	11-20-85	27.50
10-14-58	28.94(P)	01-15-86	27.28
05-13-59	25.85(R?)	04-10-86	26.97
10-16-59	24.60	07-18-86	28.20
10-25-60	24.68		
05-03-61	24.32(??)		
10-17-61	24.93		
03-21-62	24.86		
07-11-62	25.15		
10-10-62	24.99		
01-09-63	24.99		
04-10-63	25.01		
10-09-63	25.00		
01-09-64	24.96		
04-08-64	25.07		
07-09-64	25.24		
10-08-64	25.19		
01-13-65	25.10		
04-07-65	24.64		
07-14-65	24.57		
10-13-65	24.35		
01-19-66	24.27		
04-06-66	24.20		
10-06-66	24.32		
01-12-67	24.30		
04-06-67	24.30		
07-13-67	24.54		
01-10-68	24.37		
04-10-68	24.48		
10-09-68	24.96		
01-15-69	24.97		
04-09-69	25.04		
10-09-69	25.27		
01-06-70	25.32		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R15E-17dd

Owner: Robert Tuttle Well Completion Date: 1921

Well Depth: 250 ft. Casing Size: 18 in. Casing Depth 220 ft.

Land Surface Elevation at Well: 4321.1 ft. Determination: Leveled

Water Use: None (irrigation formerly) Water Temperature: 68°F (20°C)

Yield: 800 gpm Drawdown: 2 ft. Test duration: 8 hrs. Test Date: 1921

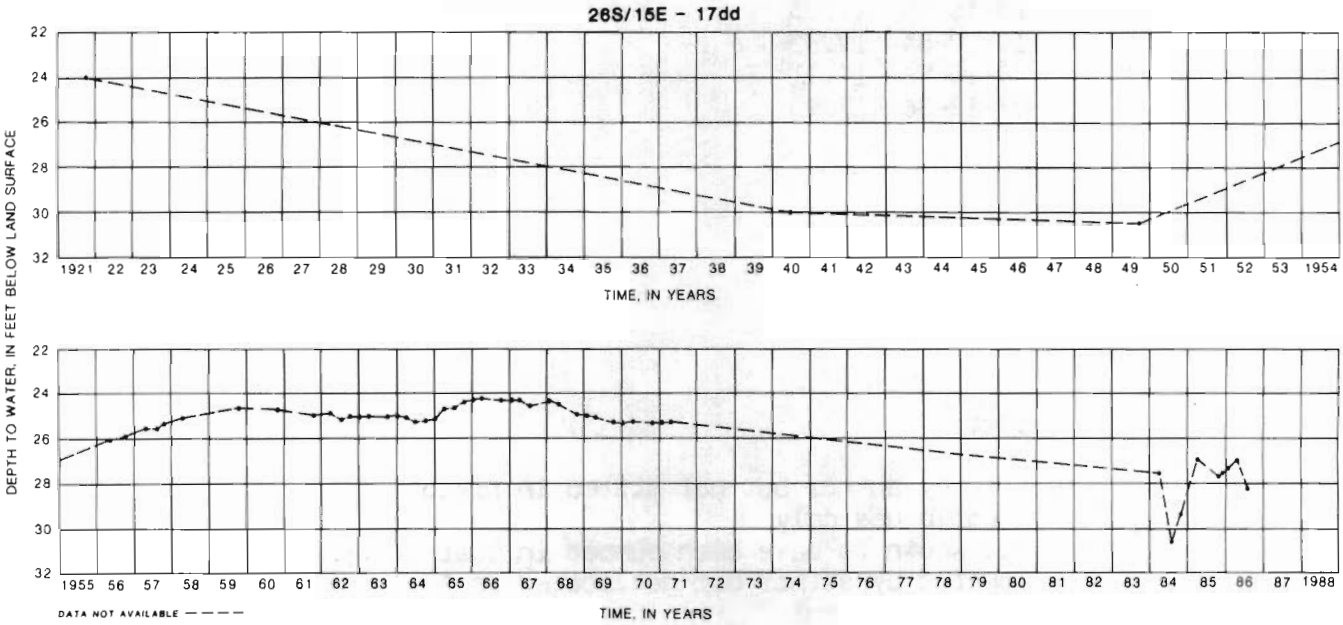
Other Well Data: Partial Water Chemistry Analysis, Water Right File

Remarks: This is known as the "Ernst Well." It is one of four test wells drilled by the State about 1922. Certain data suggest that the well is cased to only 24 feet. An oil layer of indeterminate thickness has been found on the water surface. It appears that the layer is thin enough to only slightly alter the depth to water measurement.

Generalized Log:

Soil and Sand	0 to 4 feet	Brown Clay	100 to 105 feet
Fine Sand	4 to 24 feet	Fine Sand	105 to 112 feet
Silt	24 to 32 feet	Coarse Sand	112 to 115 feet
Sand	32 to 58 feet	Fine Sand	115 to 120 feet
Coarse and Fine Sand	58 to 100 feet		

No record - materials reportedly similar to that encountered from 32 to 120 feet but with a 30 to 40-foot layer of coarse fragmented basalt tuff. 120 to 250 feet



Record of Wells Location: 26S/15E-20bb

Dates and Water Levels in Feet Below Land Surface Datum

05-13-59	15.06	07-14-71	15.81
10-16-59	15.18	10-18-71	16.06
04-28-60	15.20	04-10-72	15.43
10-25-60	15.26	07-10-72	15.72
05-03-61	15.32	10-11-72	16.27
10-17-61	15.27	04-25-73	15.45
03-21-62	15.70	07-09-73	15.80
07-11-62	15.89	10-01-73	15.84
10-10-62	15.71	07-01-74	15.47
01-09-63	15.80	10-07-74	15.46
04-10-63	15.85	04-07-75	15.11
07-09-63	15.72	07-08-75	15.48
10-09-63	15.73	09-29-75	15.48
01-09-64	15.81	01-12-76	15.22
04-08-64	15.77	04-13-76	15.09
07-09-64	15.83	07-06-76	15.56
10-08-64	15.90	10-04-76	15.53
01-13-65	15.75	01-11-77	15.31
04-07-65	15.29	04-13-77	15.32
07-14-65	15.22	07-05-77	15.83
10-13-65	15.03	10-04-77	16.07
01-19-66	14.99	01-18-78	15.94
04-06-66	14.92	04-20-78	15.80
07-07-66	14.89	10-02-78	16.41
10-06-66	14.97	04-02-79	16.18
01-12-67	14.93	06-30-80	17.30
04-06-67	14.92	03-18-84	17.50
07-13-67	15.10	07-19-84	18.62
10-04-67	15.14	10-17-84	17.82
01-10-68	15.07	11-28-84	17.65
04-10-68	15.14	03-26-85	17.09
07-11-68	15.42	10-16-85	17.85
10-09-68	15.47	11-20-85	17.63
01-16-69	15.55	04-10-86	17.11
04-09-69	15.57	07-18-86	17.93
07-10-69	15.68		
10-09-69	15.79		
01-06-70	15.82		
04-09-70	15.73		
07-01-70	15.92		
10-15-70	16.02		
01-20-71	15.93		
04-12-71	15.87		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R15E-20bb

Owner: U.S. Bureau of Land Management Well Completion Date: 1958

Well Depth: 37 ft. Casing Size: 6 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4310.6 ft. Determination: Leveled

Water Use: None Water Temperature: ---

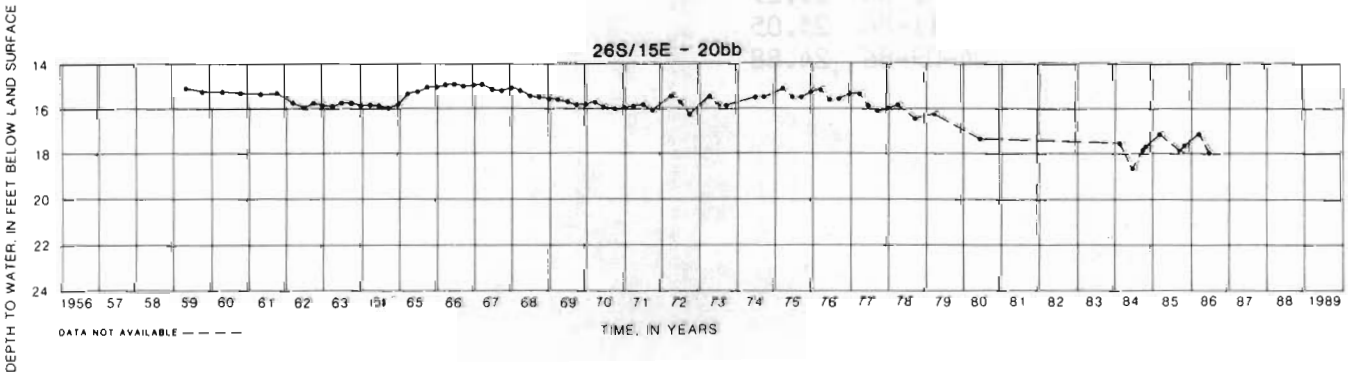
Yield: -- gpm Drawdown: -- ft. Test duration: -- hrs. Test Date: --

Other Well Data: --

Remarks: This well was used for stock water prior to 1961. The well was sounded to 37 feet total depth. The original well depth is unknown.

Generalized Log: None available. A well about one-half mile east at a similar elevation logs the following materials:

Blow Sand	0 to 2 feet
Packed Sand	2 to 19 feet
Cinder Rock	19 to 53 feet
Red Cinders	53 to 54 feet
Cinder Rock	54 to 108 feet



Record of Wells Location: 26S/15E-22ab(1)

Dates and Water Levels in Feet Below Land Surface Datum

09-04-32	24.66	01-09-63	23.37
11-27-35	26.29	04-10-63	23.35
09-02-36	26.41	07-09-63	23.39
08-28-38	26.81	10-09-63	23.39
12-14-38	26.88	01-09-64	23.35
03-22-39	27.03	04-07-64	23.39
06-21-39	26.77(??)	07-08-64	23.48
09-27-39	27.05	10-06-64	23.54
12-07-39	27.18	01-13-65	23.44
05-18-40	27.34	04-06-65	23.00
11-21-40	27.64	07-14-65	22.88
12-21-40	27.56	10-13-65	22.68
03-29-41	27.70	01-19-66	22.62
06-06-41	27.75	04-06-66	22.58
09-25-41	27.84	07-07-66	22.68
01-09-42	28.09	10-06-66	22.66
10-24-42	27.98	01-12-67	22.61
05-23-43	27.89	04-06-67	22.63
09-15-43	27.68	07-13-67	22.78
06-12-45	28.07	10-04-67	22.78
10-12-45	28.13	01-10-68	22.78
05-11-47	28.20	04-10-68	22.88
08-28-56	24.00	07-10-68	23.13
10-16-56	23.84	01-15-69	22.72
04-30-57	23.64	04-09-69	22.75
08-20-57	23.54	07-10-69	22.87
10-24-57	23.49	10-09-69	22.89
04-23-58	23.23	01-06-70	23.00
10-14-58	22.73	04-09-70	22.91
05-13-59	22.18	07-02-70	23.08
01-16-60	22.50	10-15-70	23.10
10-14-60	22.69	01-21-71	23.04
10-25-60	23.95(??)	03-21-84	25.29
01-12-61	22.65	03-11-86	25.05
04-28-61	22.76	04-09-86	24.88
05-03-61	23.15(??)		
07-04-61	22.82		
09-15-61	22.90		
01-05-62	23.02		
03-21-62	23.03		
07-11-62	23.41		
09-26-62	23.40		
10-10-62	23.35		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R15E-22ab(1)

Owner: Ted Tiahrt Well Completion Date: Unknown

Well Depth: 265 ft. Casing Size: 12 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4318.1 ft. Determination: Leveled

Water Use: None Water Temperature: ---

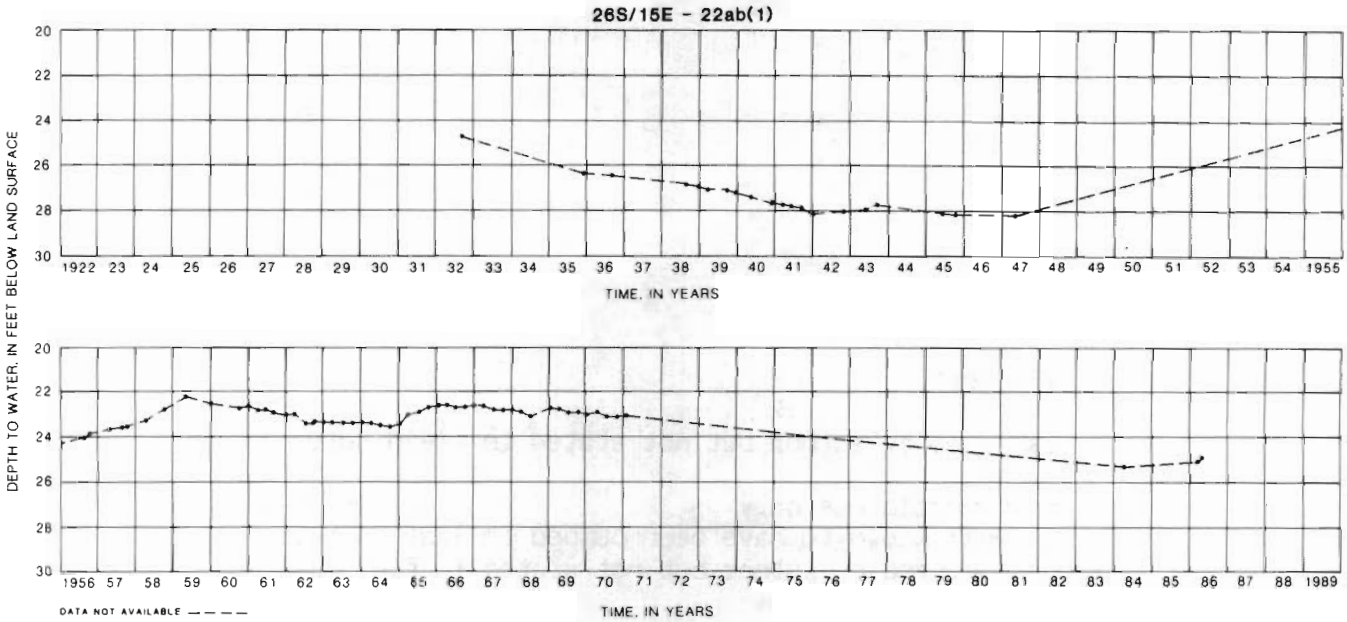
Yield: 450 gpm Drawdown: 20 ft. Test duration: -- hrs. Test Date: --

Other Well Data: Well Report

Remarks: There is brief information on the materials encountered when drilling this well. It is reported that drilling occurred only in sand and clay to an original depth of 262 feet. The well was reportedly cleaned and deepened to 265 feet in 1968. A slight water level rise across 1968 contrasts with general declines of about 0.4 foot that year and may be the result of a measuring point change due to well workover in October 1968. Some 1940 water level data was corrected from published USGS reports.

Generalized Log: Materials at this well should be comparable to those reported at a well which was 30 feet east. The log for that well is:

Soil and Sand	0 to 20 feet
Clay and Silt	20 to 60 feet
Packed Sand	60 to 60.5 feet
Soft Mucky Clay	60.5 to 98 feet



Record of Wells Location: 26S/15E-32bc(1)

Dates and Water Levels in Feet Below Land Surface Datum

08-29-56	32.72	07-21-82	35.75(NP)
10-16-56	32.53	11-18-82	34.70
04-30-57	33.10(??)	03-11-83	34.25
08-19-57	32.21	07-28-83	50.25(P)
10-24-57	31.84	11-22-83	34.36
04-22-58	31.66	03-21-84	33.80
10-14-58	31.36	07-25-84	35.65
05-13-59	31.33	11-28-84	33.97
10-16-59	31.22	03-27-85	33.30
04-28-60	31.26	07-31-85	36.05
10-25-60	31.45	11-20-85	34.02
10-17-61	31.73	04-10-86	33.15
03-21-62	31.72	07-18-86	49.21
07-11-62	32.25(R?)		
10-10-62	31.93		
01-09-63	31.83		
04-10-63	31.81		
07-09-63	31.99		
10-09-63	31.87		
01-09-64	31.82		
04-08-64	31.96		
07-09-64	32.24		
10-08-64	32.13		
01-13-65	31.98		
04-07-65	31.48		
01-19-66	31.16		
04-06-66	31.08		
01-12-67	31.09		
04-06-67	31.06		
01-10-68	31.22		
04-10-68	31.40		
07-05-77	32.87		
10-04-77	32.49		
01-18-78	32.11		
04-20-78	32.00		
10-02-78	32.97		
04-02-79	32.51		
07-01-80	68.92(P)		
11-26-80	34.08		
03-05-81	33.78		
11-23-81	35.06		
03-18-82	34.48		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(NP) - Nearby Pumping
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R15E-32bc(1)

Owner: Robert Tuttle Well Completion Date: 19

Well Depth: 235 ft. Casing Size: 15 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4329 ft. Determination: Topo listing

Water Use: Irrigation Water Temperature: 69°F (21°C)

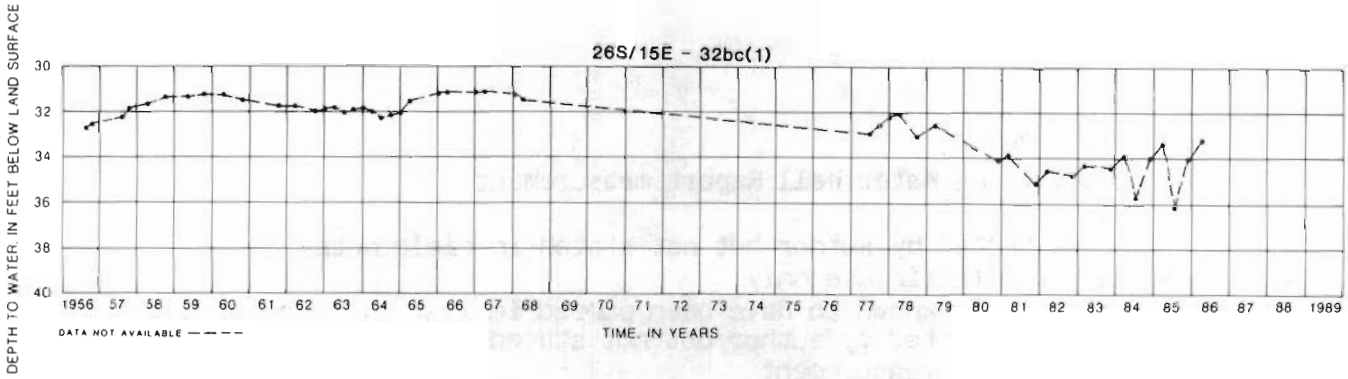
Yield: 1000+/- gpm Drawdown: 15 ft. Test duration: -- hrs. Test Date: 1983

Other Well Data: Water Well Report, Water Right File

Remarks: The water level record which is presented for this well is corrected for past errors of measuring point and well measured. A well about 100 yards to the west has also been measured frequently and displays a water level trace which is consistently one foot deeper than this well. Some records about 1962 had been confused between these wells.

Generalized Log:

Sandy Loam	0 to 8 feet	Gravel	47 to 50 feet
Hardpan	8 to 10 feet	Clay	50 to 196 feet
Talc	10 to 20 feet	Rock	196 to 200 feet
Clay	20 to 47 feet	Lava	200 to 235 feet



Record of Wells Location: 26S/16E-8bb

Dates and Water Levels in Feet Below Land Surface Datum

07-07-84	32.00(W)
03-26-85	28.55
11-20-85	29.32
01-15-86	29.02
04-09-86	28.62

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R16E-8bb

Owner: John O'Leary Well Completion Date: 07-07-84

Well Depth: 1480 ft. Casing Size: 14 in. Casing Depth 97 ft.

Land Surface Elevation at Well: 4321 ft. Determination: Estimate from Topo

Water Use: Irrigation Water Temperature: 65°F (18°C)

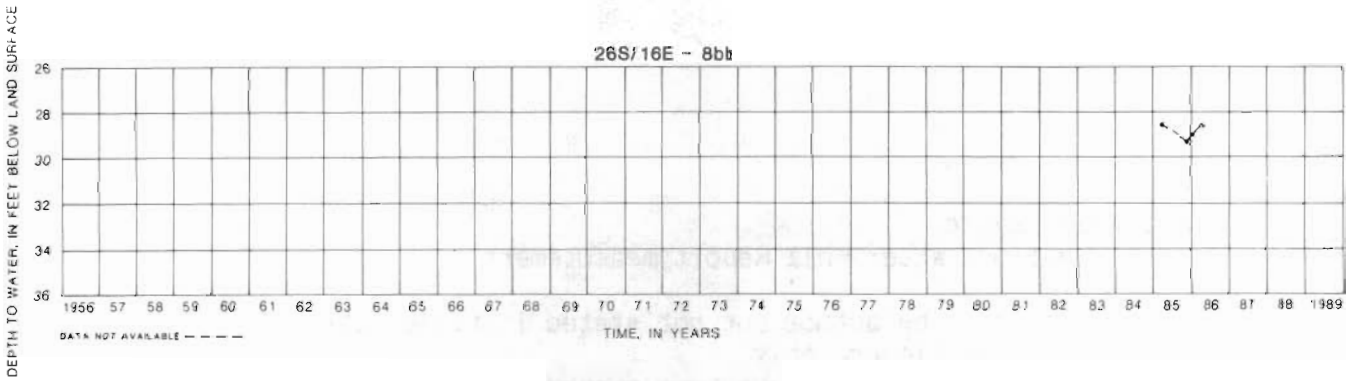
Yield: 800 gpm Drawdown: -- ft. Test duration: 1 hrs. Test Date: 1984

Other Well Data: Water Well Report, Water Right File

Remarks: This is the deepest water well in the Fort Rock Basin. The reported water temperature is indicative of the depth as most wells have water about 55°F. The water well report gives an extensive breakdown of materials encountered when the well was drilled. An oil layer of 0.26 foot was found in the well on November 20, 1985.

Generalized Log:

Sandy Soil	0 to 35 feet	Claystone	1243 to 1432 feet
Sandstone	35 to 52 feet	Basalt	1432 to 1480 feet
Basalt	52 to 1243 feet		



Record of Wells Location: 26S/16E-19bb

Dates and Water Levels in Feet Below Land Surface Datum

01-01-78	32.00(W)
07-12-78	21.00(W)
09-12-79	37.35
07-01-80	35.11
10-13-80	28.28
11-24-80	25.33
03-05-81	23.61
03-18-82	22.41
07-21-82	26.34
11-18-82	22.70
03-11-83	22.01
07-28-83	29.63
11-22-83	23.27
03-16-84	22.00
05-25-84	24.19
07-19-84	26.20
10-17-84	24.00
11-28-84	23.19
03-26-85	22.43
07-31-85	33.61
09-15-85	24.29
11-20-85	23.46
01-15-86	22.73
04-09-86	21.82
07-18-86	27.48
10-16-86	22.83

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R16E-19bb

Owner: Roy Forman Well Completion Date: 1978

Well Depth: 500 ft. Casing Size: 14 in. Casing Depth 107 ft.

Land Surface Elevation at Well: 4316.7 ft. Determination: Leveled

Water Use: None Water Temperature: 52°F (11°C)

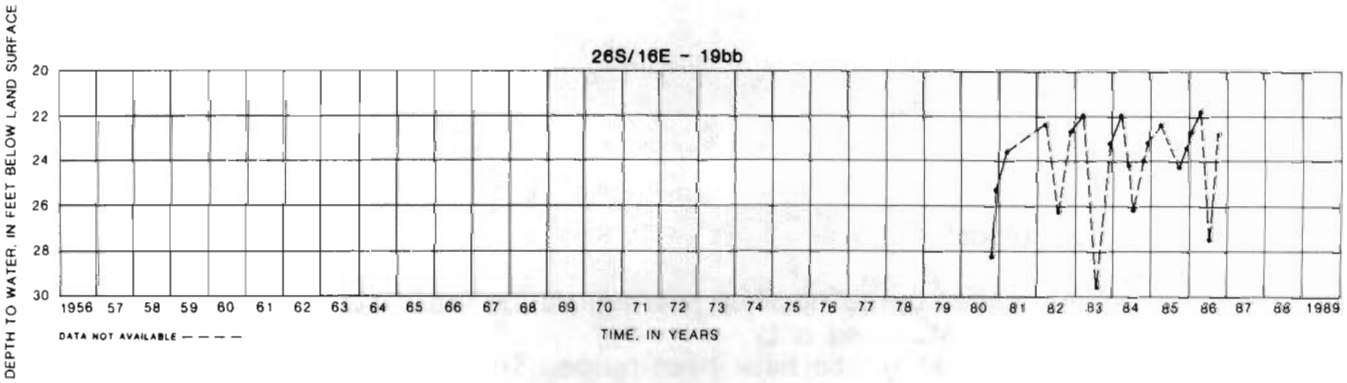
Yield: 1000 gpm Drawdown: -- ft. Test duration: 1 hrs. Test Date: 1978

Other Well Data: Water Well Reports

Remarks: This well was drilled to 320 feet in 1978 and immediately deepened to 500 feet. Summer water level measurements suggest that this well experiences interference effects of up to 17 feet due to pumping from surrounding wells. Cascading water is audible from the well at water levels as shallow as 24 feet. This reflects the fact that water occurs in the sediments at a shallow depth and that casing depth or integrity is less than the water well report indicates.

Generalized Log:

Soil	0 to 6 feet	Clay and Pumice	235 to 310 feet
Clay	6 to 30 feet	Sand	310 to 320 feet
Clay and Sand	30 to 37 feet	Claystone	320 to 324 feet
Rock	37 to 75 feet	Pumice and Clay	324 to 370 feet
Clay and Sandstone	75 to 125 feet	Claystone	370 to 372 feet
Basalt	125 to 160 feet	Pumice and Claystone	372 to 426 feet
Clay	160 to 180 feet		
Sandstone and Clay	180 to 235 feet	Pumice	426 to 500 feet



Record of Wells Location: 26S/18E-8ad

Dates and Water Levels in Feet Below Land Surface Datum

06-22-64	72.00(W)	05-01-86	61.01
07-10-68	58.65	10-16-86	62.42
10-09-68	58.81		
01-15-69	58.74		
04-09-69	58.69		
07-10-69	58.73		
10-09-69	58.87		
01-06-70	58.86		
04-09-70	58.75		
07-02-70	58.83		
10-14-70	59.03		
01-21-71	58.55(??)		
04-13-71	58.97		
07-14-71	58.99		
10-18-71	59.11		
04-11-72	58.90		
07-11-72	58.99		
10-12-72	59.18		
04-26-73	59.62		
07-10-73	59.91		
10-02-73	59.50		
07-02-74	58.28(??)		
10-08-74	59.26		
04-08-75	59.02		
07-09-75	59.00		
09-30-75	59.21		
01-13-76	59.14		
04-14-76	58.96		
07-07-76	59.13		
04-14-77	58.98		
04-21-78	59.83		
07-01-80	64.01(R)		
11-25-80	61.70(R)		
03-04-81	60.06		
11-22-81	61.75		
03-17-82	61.18		
11-18-82	61.70		
03-10-83	61.20		
07-28-83	63.24		
11-21-83	61.72		
03-17-84	61.14		
11-19-85	62.17		
01-14-86	61.40		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R18E-8ad

Owner: Wayne Maki Well Completion Date: 1964

Well Depth: 220 ft. Casing Size: 8 in. Casing Depth 21 ft.

Land Surface Elevation at Well: 4353.4 ft. Determination: Leveled

Water Use: Domestic Water Temperature: 58°F (14°C)

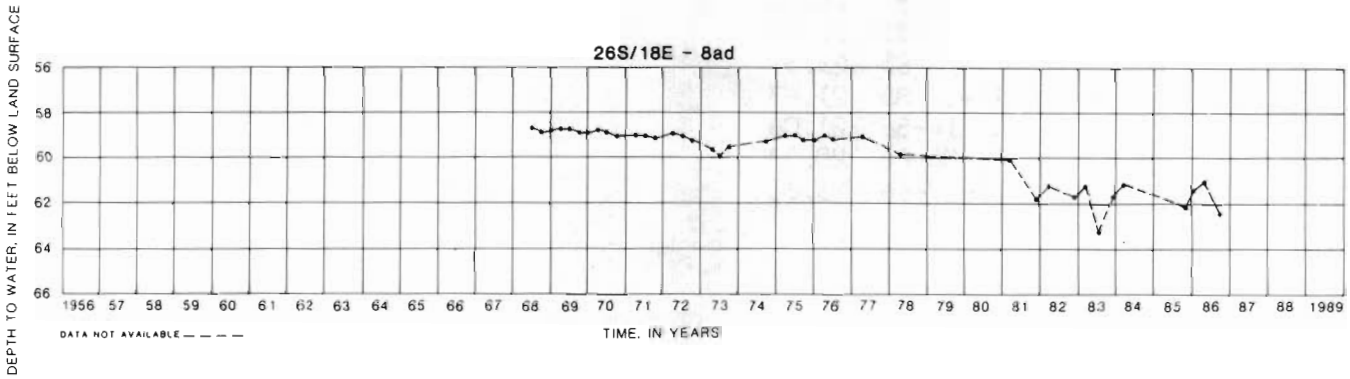
Yield: 20 gpm Drawdown: 2 ft. Test duration: 1 hrs. Test Date: 1964

Other Well Data: Water Well Report, Water Right File

Remarks: The water level measurement of 72 feet on the water well report is so deep in comparison with others that its accuracy is questioned.

Generalized Log:

Black Lava	0 to 17 feet	Green Clay with some Fine Sand	70 to 218 feet
Brown Clay	17 to 22 feet	Gravel with Coarse Sand	218 to 220 feet
Black Lava	22 to 42 feet		
Brown Clay	42 to 60 feet		



Record of Wells Location: 26S/18E-26ab

Dates and Water Levels in Feet Below Land Surface Datum

00-00-60	25.00(W)	04-08-75	19.85
04-09-63	19.80	07-09-75	19.97
07-08-63	20.00	09-30-75	20.38
10-08-63	20.13	01-13-76	19.91
01-08-64	19.92	04-14-76	19.87
04-07-64	19.82	07-07-76	20.09
07-08-64	19.88	10-05-76	20.22
10-07-64	20.01	01-12-77	20.03
01-12-65	19.46	04-14-77	19.85
04-06-65	19.52	07-05-77	19.98
07-13-65	19.51	10-05-77	20.42
10-12-65	19.53	01-19-78	20.04
01-18-66	19.26	04-21-78	19.90
04-05-66	19.20	10-03-78	20.72
07-06-66	19.32	04-03-79	20.10
10-05-66	19.44	07-30-79	20.37
01-11-67	19.21	10-01-79	19.92(??)
04-05-67	19.12	03-18-80	20.39
07-12-67	19.43	07-01-80	20.68
10-03-67	19.57	11-25-80	21.40
01-09-68	19.36	03-04-81	20.36
04-09-68	19.33	11-21-81	22.55
07-10-68	19.44	03-17-82	21.32
10-09-68	19.61	07-21-82	22.71
01-15-69	19.42	11-18-82	22.45
04-09-69	19.42	03-10-83	21.18
07-10-69	19.58	07-28-83	22.94
10-09-69	19.68	11-21-83	22.21
01-06-70	19.45	01-10-84	21.30
04-09-70	19.43	03-17-84	20.82
07-02-70	19.59	07-19-84	24.08
10-14-70	19.75	11-27-84	21.88
04-13-71	19.55	03-26-85	20.71
07-14-71	19.80	07-28-85	23.70
10-18-71	20.00	09-14-85	23.59
04-11-72	19.59	11-19-85	21.83
07-11-72	20.00	01-14-86	21.08
10-12-72	19.95	04-08-86	20.53
04-25-73	19.36	07-17-86	23.01
07-10-73	19.79		
10-02-73	20.05		
07-02-74	19.97		
10-08-74	20.31		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T26S/R18E-26ab

Owner: Bob Bothern Well Completion Date: 1960

Well Depth: 81+/- ft. Casing Size: 18 in. Casing Depth 8+ ft.

Land Surface Elevation at Well: 4311 ft. Determination: Topo listing

Water Use: None Water Temperature: 54°F (12°C)

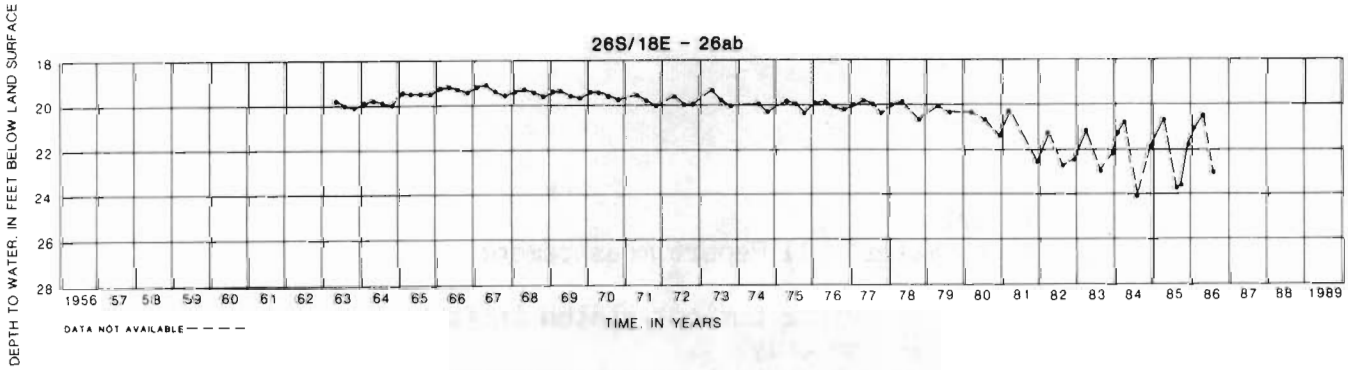
Yield: 1600 gpm Drawdown: 56 ft. Test duration: 22 hrs. Test Date: 1960

Other Well Data: Water Well Report, Water Right File

Remarks: The depth of the well was originally 275, however, caving has lowered it to about 80 feet. The original water level of 25 feet is questionable and probably a few feet too deep. The water well report states that the casing length is eight feet, yet field inspection shows a depth at least to the water level. Summer interference effects have increased in recent years.

Generalized Log:

Sand and Clay	0 to 220 feet
Loose Rock	220 to 225 feet
Sand and Clay	225 to 275 feet



Record of Wells Location: 27S/13E-23bd

Dates and Water Levels in Feet Below Land Surface Datum

07-26-80	180.00(W)
03-03-81	179.80
11-22-81	181.24
03-19-82	180.66
08-11-82	180.36
11-19-82	180.92
03-10-83	180.51
07-29-83	180.32(P)
11-23-83	180.25
03-22-84	179.65
07-21-84	179.82
11-26-84	180.74
03-25-85	179.38
07-30-85	180.66
09-13-85	180.33
11-21-85	180.19
01-13-86	179.82
05-01-86	179.05
07-16-86	179.77
10-15-86	180.33

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: T27S/R13E-23bd

Owner: Jim Crofoot Well Completion Date: July 26, 1980

Well Depth: 350 ft. Casing Size: 14 in. Casing Depth 25 ft.

Land Surface Elevation at Well: 4477.4 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 50°F (10°C)

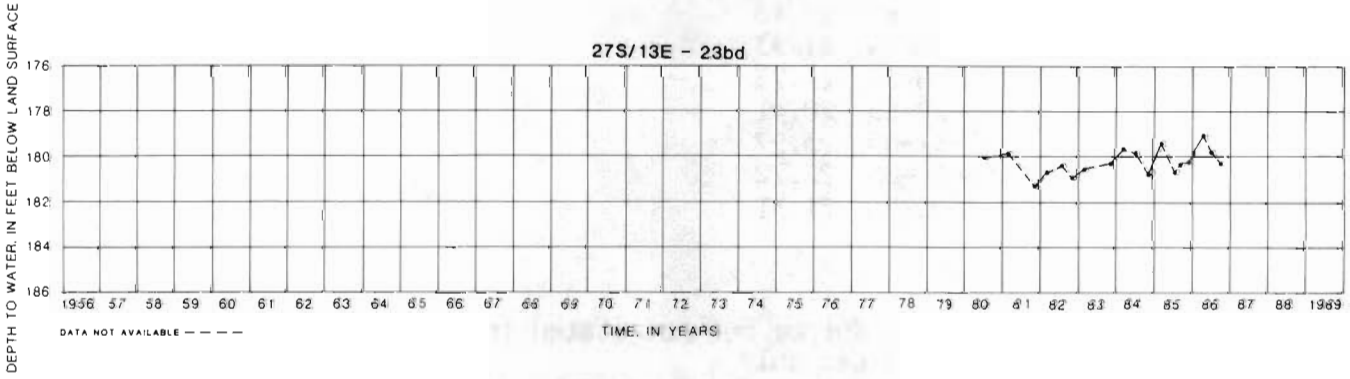
Yield: 1000 gpm Drawdown: -- ft. Test duration: 2 hrs. Test Date: 1980

Other Well Data: Water Well Report, Water Right File

Remarks: The water level of July 29, 1983 was made while irrigation pumping occurred at several hundred gallons per minute. These data indicate that drawdown was very small since all other measurements are about the same.

Generalized Log:

Brown Clay	0 to 21 feet	Broken Rock	210 to 265 feet
Basalt	21 to 65 feet	Hard Basalt	265 to 285 feet
Broken Rock	65 to 80 feet	"Crevice"	285 to 290 feet
Red Cinders	80 to 90 feet	Broken Lava	290 to 315 feet
Hard Rock	90 to 185 feet	Gravel	315 to 325 feet
Hard Basalt	185 to 210 feet	Hard Basalt	325 to 350 feet



Record of Wells Location: 27S/15E-2ad

Dates and Water Levels in Feet Below Land Surface Datum

02-00-51	24.00(W)	07-09-69	19.95	01-15-86	20.90
05-23-56	20.50	10-08-69	19.68	04-09-86	20.43
08-28-56	19.98	01-05-70	19.71	07-18-86	23.56
10-17-56	20.17	04-09-70	19.59		
05-01-57	19.84	07-01-70	20.45		
08-20-57	19.87	10-15-70	20.19		
10-24-57	19.48	01-20-71	19.81		
04-23-58	19.30	04-12-71	20.40(?)		
10-14-58	17.98(??)	07-14-71	20.09		
05-12-59	19.09	10-18-71	19.75		
05-12-59	40.70(P)	04-10-72	19.62		
10-14-59	18.96	07-10-72	17.81(??)		
04-27-60	18.95	10-11-72	19.95		
05-03-61	18.58(??)	10-01-73	19.93		
10-18-61	19.77	04-07-75	18.91		
03-21-62	19.50	09-29-75	19.85		
07-11-62	19.93	01-12-76	18.84		
10-10-62	19.70	04-13-76	19.32(??)		
01-09-63	19.67	10-04-76	19.06		
04-10-63	19.62	01-12-77	19.01		
07-09-63	19.75	04-13-77	19.21		
10-08-63	19.63	10-04-77	19.59		
01-08-64	19.66	01-19-78	19.10		
04-06-64	19.74	04-20-78	19.25		
10-07-64	19.80	07-01-80	22.66		
04-05-65	19.30	11-26-80	21.29		
07-13-65	19.19	03-05-81	20.95		
10-13-65	19.05	11-23-81	22.41		
01-18-66	18.92	03-18-82	21.62		
04-05-66	18.89	07-21-82	22.71		
07-06-66	19.32	11-18-82	21.81		
10-05-66	18.97	03-11-83	21.23		
01-11-67	18.93	07-28-83	24.22(R)		
04-05-67	18.90	11-22-83	21.67		
07-12-67	19.34	03-22-84	20.84		
10-03-67	19.13	07-22-84	23.48		
01-09-68	18.98	10-16-84	21.93		
04-09-68	19.19	11-28-84	21.25		
07-11-68	19.71	03-27-85	20.41		
10-10-68	19.67	07-31-85	23.97		
01-15-69	19.38	09-15-85	22.72		
04-08-69	19.48	11-20-85	21.31		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(?) - Questionable measurement per field notes
(??) - Author questions measurement

Record of Wells Location: T27S/R15E-2ad

Owner: Ernest Porter Well Completion Date: 1950

Well Depth: 255 ft. Casing Size: 18 in. Casing Depth -- ft.

Land Surface Elevation at Well: 4315.8 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: ---

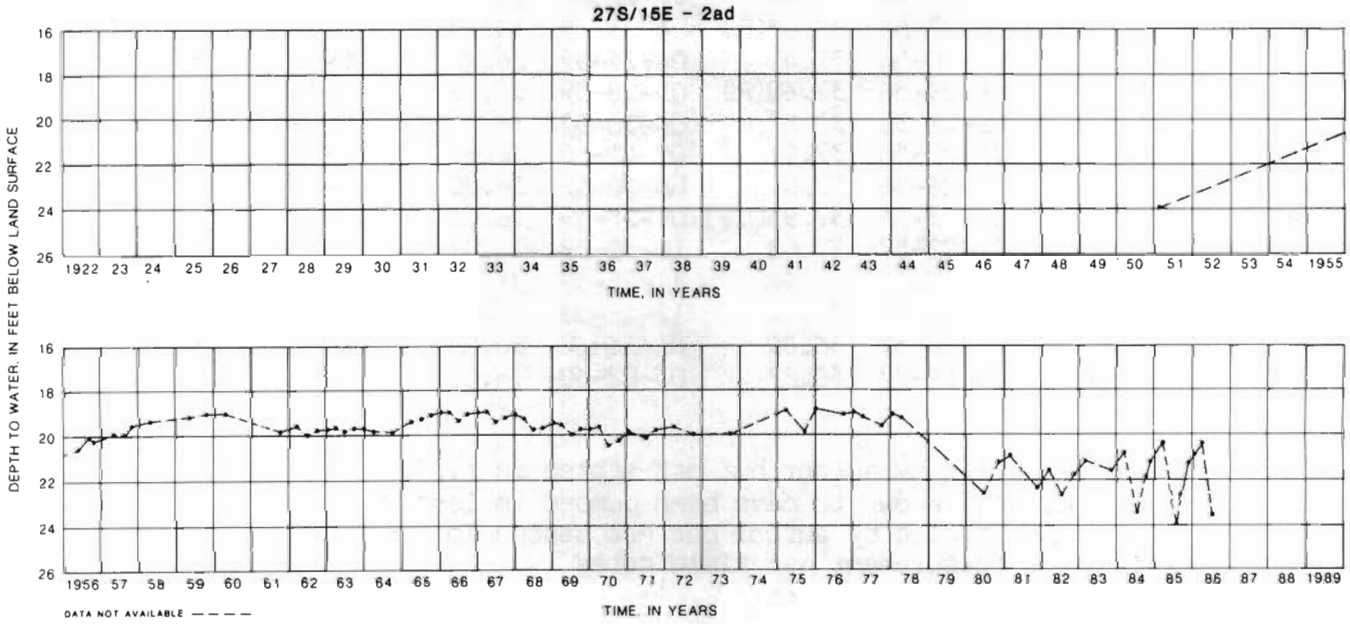
Yield: --- gpm Drawdown: -- ft. Test duration: -- hrs. Test Date: ---

Other Well Data: Water Well Report, Water Right File

Remarks: An oil layer of 5.29 feet was measured in the well on November 20, 1985. Assuming a specific gravity of 0.87, an actual depth to water measurement without the oil layer would be 0.69 feet deeper. Although oil has been noted on almost each measurement visit since 1961, it is believed that most has accumulated since 1976. This is based on the otherwise strong hydrograph similarity with other nearby observation well levels.

Generalized Log:

Soil	0	to	16 feet	Sand and Gravel	165	to	167
Sandstone	16	to	40 feet	Sand	167	to	170
Soapstone	40	to	55 feet	Gravel and Cinders	170	to	173
Sandstone	55	to	148 feet	Rock	173	to	174
Sand and Pumice	148	to	149 feet	Gravel and Cinders	174	to	187
Sand	149	to	155 feet	Unknown	187	to	255
Sandstone	155	to	165 feet				



Record of Wells Location: 27S/15E-4ac(1)

Dates and Water Levels in Feet Below Land Surface Datum

00-00-22	35.00	06-18-52	44.15(P)	05-01-57	39.23(P)	03-29-60	36.01
09-04-32	38.21	09-06-52	39.89	05-02-57	37.06(R)	04-26-60	36.00
11-27-35	39.58	12-27-52	39.77	05-24-57	39.30(P)	05-31-60	36.79
06-20-36	39.88	04-01-53	39.64	05-28-57	36.96	06-28-60	37.23(R)
06-20-36	42.18(P)	10-16-53	39.16	07-25-57	36.79	07-26-60	36.79
09-02-36	39.73	01-20-54	38.67(R?)	08-10-57	39.11(P)	08-29-60	36.45
08-28-38	40.11	04-14-54	38.82	08-29-57	36.92(R)	09-29-60	36.22
12-14-38	40.21	10-15-54	38.63	09-27-57	36.65	10-31-60	36.22
03-22-39	40.36	12-23-54	38.30	10-02-57	36.49	11-30-60	36.19
06-21-39	40.47	01-27-55	38.32	10-28-57	36.54	12-29-60	36.26
09-26-39	40.41	02-19-55	38.53(??)	12-02-57	36.54	01-12-61	36.22
12-07-39	40.54	02-23-55	38.28	12-26-57	36.47	01-31-61	36.26
05-18-40	43.09(P)	03-28-55	38.21	01-14-58	36.50	02-25-61	36.28
10-06-40	42.62(P?)	04-24-55	38.21	01-27-58	36.46	03-31-61	36.25
11-18-40	40.72	05-02-55	36.21(??)	02-25-58	36.40	04-28-61	36.39
12-21-40	41.25(??)	05-29-55	38.25	03-27-58	36.32	06-01-61	37.77(R)
03-29-41	40.92	06-26-55	38.61	04-25-58	36.35	06-28-61	47.20(?)
06-09-41	40.98	07-29-55	39.39(R)	04-29-58	36.33	07-04-61	36.71
09-25-41	40.90	08-28-55	38.33	05-29-58	36.95(R)	07-27-61	48.97(?)
01-09-42	41.10	09-15-55	38.12	06-27-58	36.60(R)	08-27-61	36.76
10-24-42	41.15	09-23-55	38.11	07-27-58	36.27	09-15-61	37.55(R?)
05-23-43	41.25	09-29-55	38.12	08-08-58	38.80(P)	11-30-61	36.46
05-23-43	44.51(P)	10-27-55	38.13	08-23-58	36.57	12-28-61	36.55
05-23-43	44.60(P)	11-29-55	38.14	09-04-58	39.65(P)	01-05-62	36.58
05-23-43	44.70(P)	12-29-55	38.16	09-27-58	36.05	01-29-62	36.65
09-15-43	43.84(P)	01-29-56	38.04	10-29-58	36.05	02-24-62	36.54
06-12-45	44.02(P)	02-25-56	37.87	11-25-58	36.02	03-21-62	36.82
10-12-45	41.22	03-30-56	37.76	12-09-58	35.98	03-28-62	36.60
07-12-46	41.64	04-16-56	37.80	01-02-59	35.94	05-01-62	36.65
05-11-47	42.13(R)	04-27-56	38.69(??)	01-27-59	35.95	05-28-62	39.30(?)
10-09-47	42.25(R?)	05-24-56	37.56	02-26-59	35.98	06-29-62	37.62(R)
03-18-48	41.59	05-27-56	37.58	03-25-59	35.92	07-30-62	39.07(R?)
08-05-48	43.36(P)	06-27-56	38.03(R)	04-23-59	36.23	08-28-62	40.05(??)
10-24-48	41.54	07-20-56	37.41	04-27-59	36.20	09-26-62	36.62
03-12-49	41.60	08-26-56	37.60(R)	05-28-59	36.68	10-10-62	36.74
07-04-49	44.45(P)	09-21-56	37.07	06-30-59	36.84(R)	10-29-62	36.79
11-14-49	41.47	10-27-56	37.01	07-02-59	36.64	11-29-62	36.62
02-18-50	41.52	11-26-56	37.07	08-30-59	36.20	01-03-63	36.72
07-12-50	44.31(P)	12-03-56	37.95(??)	09-28-59	36.02	01-09-63	36.71
11-04-50	41.27	01-02-57	37.00	10-30-59	36.07	02-08-63	36.70
03-23-51	41.10	01-27-57	36.98	11-28-59	36.08	02-27-63	36.70
09-05-51	40.54	02-27-57	36.94	12-28-59	36.07	03-29-63	36.63
12-18-51	40.40	03-26-57	36.89	01-16-60	36.03	04-10-63	36.66
04-15-52	40.26	04-16-57	36.87	03-02-60	36.02	05-02-63	36.65

(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(?) - Questionable measurement per field notes
(??) - Author questions measurement

Record of Wells Location: 27S/15E-4ac(1)

Dates and Water Levels in Feet Below Land Surface Datum

06-04-63	37.52	07-07-66	41.66(R)	10-22-69	36.60	03-26-73	36.10
06-28-63	37.24	07-30-66	36.10	11-21-69	36.70	04-12-73	36.15
07-09-63	36.98	08-29-66	36.58	12-17-69	36.80	05-17-73	37.10(R)
07-30-63	36.99	10-06-66	35.93	01-27-70	36.60	06-09-73	37.20
08-29-63	36.89	10-23-66	35.95	02-17-70	36.60	07-11-73	37.30
10-09-63	36.70	11-27-66	35.90	03-18-70	36.60	08-04-73	37.20
10-29-63	36.72	12-25-66	35.92	04-09-70	36.62	09-25-73	36.50
12-02-63	36.68	01-12-67	35.90	04-28-70	37.28	10-15-73	36.50
12-30-63	36.76	03-23-67	35.99	05-18-70	37.80	11-25-73	36.70
01-09-64	36.72	04-05-67	35.89	06-21-70	37.55	12-15-73	36.45
01-30-64	36.73	04-19-67	35.80	07-27-70	36.96	01-16-74	36.40
03-01-64	36.69	05-16-67	36.90	08-27-70	37.60	02-18-74	36.35
03-31-64	36.70	06-19-67	36.89	09-25-70	36.98	03-28-74	36.30
04-07-64	36.78	07-08-67	37.00	11-16-70	36.97	04-28-74	36.35
04-29-64	36.77	07-13-67	36.56	12-15-70	36.80	06-14-74	37.30(R)
05-27-64	37.66(R)	09-04-67	36.70(R)	01-17-71	36.80	08-07-74	37.15
07-30-64	36.85	09-21-67	35.90	02-21-71	36.70	10-27-74	36.20
08-29-64	37.50	10-04-67	35.99	03-17-71	36.75	11-10-74	36.00
10-02-64	36.07(??)	10-30-67	36.00	04-26-71	36.70	12-13-74	35.70
10-08-64	36.90	11-27-67	35.98	05-14-71	36.70	01-18-75	35.80
10-29-64	36.97	12-31-67	36.92(??)	06-26-71	37.20	02-10-75	36.00
12-02-64	36.93	01-10-68	36.04	07-15-71	37.80	03-09-75	36.00
12-29-64	36.49(??)	01-26-68	35.90	08-10-71	36.80	04-02-75	36.00
01-13-65	36.80	03-08-68	36.10	09-15-71	37.80	04-24-75	36.00
01-29-65	36.69	04-09-68	36.19	10-15-71	36.80	05-15-75	35.30(??)
02-26-65	36.49	05-27-68	36.99	10-18-71	36.58(??)	06-25-75	37.50(R)
03-29-65	36.40	06-13-68	37.10	11-14-71	36.60	08-20-75	37.60
04-06-65	36.32	07-19-68	36.98	12-20-71	36.55	12-31-75	36.00
04-29-65	36.33	08-00-68	36.90	01-27-72	36.25	01-13-76	35.73
05-27-65	38.33(R)	09-11-68	36.30	02-27-72	36.70(??)	02-12-76	35.90
06-20-65	37.45(R)	10-10-68	36.67	03-28-72	36.40	03-25-76	35.80
07-28-65	36.11	10-19-68	36.30	04-10-72	36.54(??)	04-14-76	35.98
09-01-65	36.40	11-27-38	36.25	04-20-72	36.40	04-30-76	36.00
10-05-65	36.14	01-15-69	36.37	05-04-72	36.50	05-14-76	36.50
10-13-65	36.13	03-13-69	36.95(??)	06-12-72	38.00(R)	06-21-76	36.40
10-29-65	36.13	04-10-69	36.49	07-10-72	37.60(R)	07-09-76	37.20
11-28-65	36.09	04-21-69	36.50	08-12-72	37.00	09-11-76	36.50
12-30-65	35.97	05-22-69	37.42	09-02-72	37.10	10-00-76	36.50
01-19-66	36.00	06-19-69	37.45	10-19-72	36.30	11-00-76	36.30
03-25-66	35.97	07-14-69	37.30	12-16-72	36.25	01-12-77	36.19
04-06-66	35.94	08-08-69	37.30	01-15-73	36.20	02-21-77	36.91(??)
04-26-66	35.98	09-16-69	37.26	02-20-73	36.20	03-20-77	36.20

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(?) - Questionable measurement per field notes
(??) - Author questions measurement

Record of Wells Location: 27S/15E-4ac(1)

Dates and Water Levels in Feet Below Land Surface Datum

04-14-77	38.49
07-06-77	37.37
10-05-77	37.19
01-19-78	36.74
10-03-78	37.57
07-02-80	39.64(R)
11-24-80	38.50
03-05-81	38.21
11-23-81	39.82
03-18-82	39.18
11-18-82	38.35(??)
12-14-82	39.28
01-12-83	39.16
02-08-83	39.01
03-11-83	38.73
05-18-83	38.63
07-28-83	41.57(R)
11-22-83	39.15
01-10-84	38.74
03-16-84	38.34
04-17-84	38.18
05-24-84	39.21
07-24-84	44.11(P)
09-16-84	40.62
10-16-84	39.24
11-29-84	38.85
01-17-85	38.41
03-27-85	37.90
07-31-85	41.90
09-15-85	40.21
10-11-85	39.23
11-20-85	38.81
12-18-85	38.57
01-15-86	38.34
03-11-86	38.03
04-10-86	37.81
07-17-86	43.43(P)
10-16-86	39.06

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(?) - Questionable measurement per field notes
(??) - Author questions measurement

Record of Wells Location: 27S/15E-4ac(1)

Owner: M.Y. Parks (The Poplars Ranch) Well Completion Date: 5/15/22 (?)

Well Depth: 257+ ft. Casing Size: 12 in. Casing Depth 14 ft.

Land Surface Elevation at Well: 4333.2 ft. Determination: Leveled

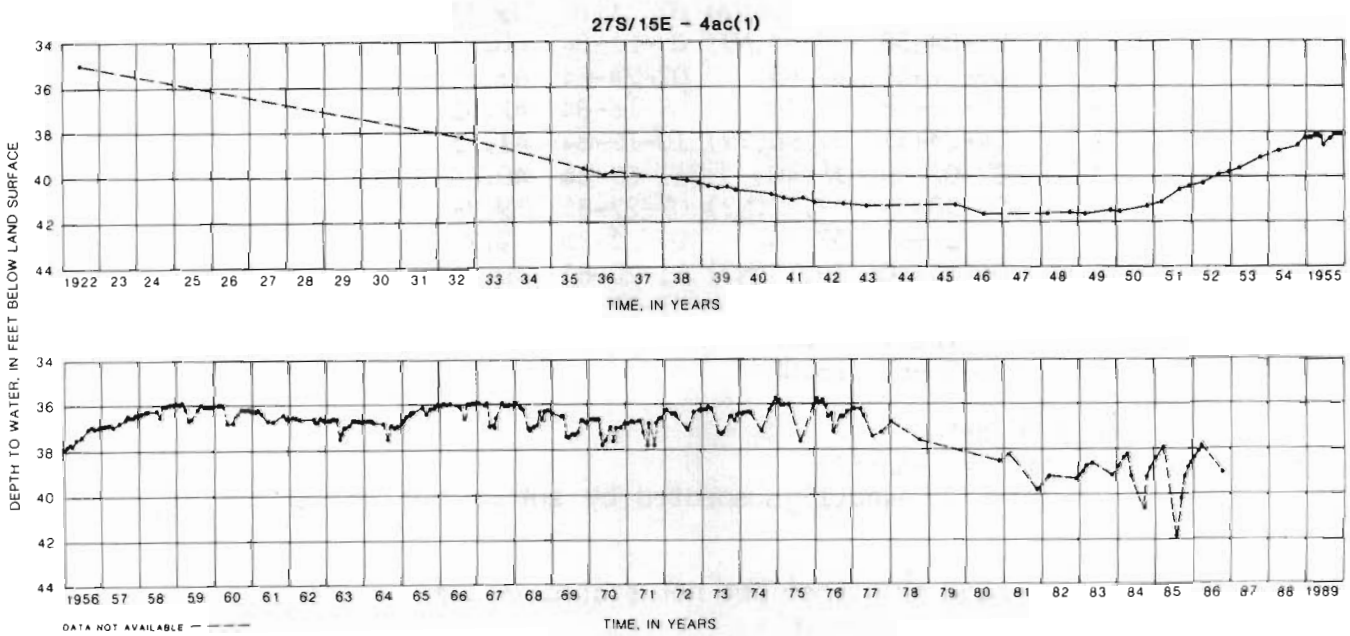
Water Use: Irrigation Water Temperature: 63°F (17°C)

Yield: 800 gpm Drawdown: 0.83 ft. Test duration: 4 hrs. Test Date: 1922

Other Well Data: Aquifer Test, Water Chemistry Analyses, Water Right File

Remarks: An unpublished report by a former head of the Oregon Department of Geology cites a water level of 35 feet below land surface about 1922. Water level data prior to 1946 have been changed from published USGS records to correct measuring point correction errors.

Generalized Log:	Not Available	0-160 feet
	Coarse Basaltic Agglomerate (lava and cinders, main water production zone)	160-180 feet
	Not available	180-257 feet



Record of Wells Location: 27S/15E-4ac(2)

Dates and Water Levels in Feet Below Land Surface Datum

09-04-32	39.62	09-06-52	41.59	07-04-61	38.22
11-18-35	41.05	12-27-52	41.16	09-15-61	38.09
09-02-36	41.14	04-01-53	41.04	03-21-62	38.11
08-28-38	41.55	07-18-53	41.24(N?)	07-11-62	38.46
12-14-38	41.64	01-20-54	40.28	09-26-62	39.45(P)
03-22-39	41.30(??)	04-14-54	40.60(??)	10-10-62	38.32(P)
06-21-39	41.94	07-13-54	40.40(N)	01-09-63	38.85(P)
09-27-39	41.89	09-03-54	42.25(??)	04-10-63	38.25
12-07-39	41.95	12-23-54	39.60(P)	07-09-63	38.60
05-18-40	42.52(N?)	02-19-55	39.73	10-09-63	38.29
10-06-40	42.00	05-02-55	39.63	01-09-64	38.34
11-18-40	42.10	07-19-55	38.90(??)	04-07-64	37.86(??)
12-21-40	42.13	09-15-55	41.27(??)	10-08-64	38.49
03-29-41	39.27(??)	09-23-55	39.52	01-13-65	38.37
06-12-41	42.97(N?)	10-27-55	39.53	04-06-65	37.90
09-25-41	42.29	04-06-56	39.40	07-14-65	38.69(N?)
01-09-42	42.49	05-24-56	38.50(??)	10-13-65	37.72
10-24-42	42.55	05-24-56	38.90(??)	01-19-66	37.57
05-23-43	42.73	08-22-56	40.78(N?)	04-06-66	37.53
09-15-43	42.27(N)	08-28-56	39.15	07-07-66	38.97(N?)
06-12-45	43.26(N)	12-03-56	38.59	10-06-66	37.61
10-12-45	43.07	04-16-57	38.53	01-12-67	38.58
05-11-47	43.09	05-24-57	39.06(N?)	04-05-67	37.53
10-09-47	42.92	08-10-57	38.93(N?)	07-13-67	38.08
03-18-48	43.00	10-02-57	36.61(??)	10-04-67	37.66
08-05-48	43.44(N?)	01-14-58	38.15	01-10-68	37.67
10-25-48	43.02	04-25-58	37.96	04-09-68	38.23(R)
03-12-49	43.03	08-08-58	38.06(N?)	07-11-68	39.34(R)
07-04-49	43.27(N)	09-04-58	38.36(N)	03-21-84	40.21
08-26-49	43.13	09-27-58	37.63	07-24-84	43.55(R)
11-14-49	42.89	12-09-58	37.60	09-16-84	42.35
02-18-50	42.92	04-23-59	37.90(??)	10-19-84	41.15
07-12-50	43.23(N)	07-02-59	38.40	11-29-84	40.66
11-04-50	42.69	08-30-59	37.82(N?)	03-27-85	39.78
03-23-51	42.49	01-16-60	37.64	09-15-85	42.21
09-05-51	41.94	06-13-60	39.15(N?)	11-20-85	40.74
12-18-51	41.85	10-14-60	37.85	03-11-86	40.00
04-15-52	41.75	01-12-61	37.82		
06-18-52	42.15(N?)	04-28-61	38.00		

(W) - Water Well Report
(N) - Nearby pumping at -4ac(1)
(N?) - Nearby pumping at -4ac(1) suspected by author but not stated in field notes
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering suspected by author but not stated in field notes
(?) - Questionable measurement per field notes
(??) - Author questions measurement

Record of Wells Location: 27S/15E-4ac(2)

Owner: M.Y. Parks (The Poplars Ranch) Well Completion Date: 1929+/-

Well Depth: 100 ft. Casing Size: 8 in. Casing Depth 50+/- ft.

Land Surface Elevation at Well: 4334.7 ft. Determination: Leveled

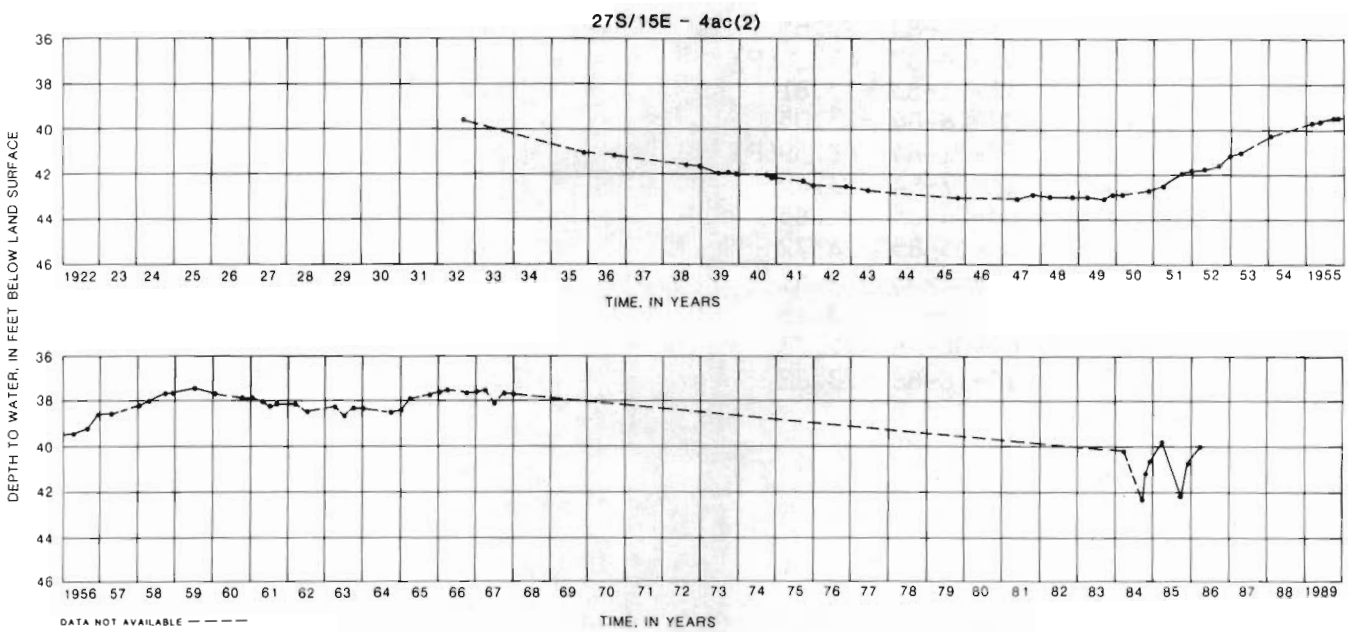
Water Use: Domestic and Stock Water Temperature: 58°F

Yield: 10+/- gpm Drawdown: 1.5+/- ft. Test duration: <1 hrs. Test Date: 9/17/84

Other Well Data: Partial Water Chemistry Analysis, Aquifer Test

Remarks: This well is equipped with a 1/2 hp submersible pump. Observtions of water level during the aquifer test at the irrigation well at T27S/R15E-4ac(1) which is about 140 feet away shows a strong hydraulic connection. These observations suggest that residual drawdown due to domestic/stock pumping is negligible.

Generalized Log: No log available.



Record of Wells Location: 27S/15E-13bb

Dates and Water Levels in Feet Below Land Surface Datum

09-27-49	23.43(W)	10-15-70	20.95
05-24-56	21.40	01-21-71	20.67
08-29-56	20.61(??)	04-25-73	20.55
10-17-56	20.88	10-01-73	21.07
05-01-57	59.49(P)	01-04-75	20.90(W)
08-20-57	20.19	04-07-75	20.37
10-23-57	20.40	01-12-76	20.48
04-23-58	20.21	04-13-76	20.48
10-14-58	19.92	10-04-76	21.11
05-12-59	20.01	01-11-77	20.65
10-14-59	20.05	04-13-77	21.51(??)
04-26-60	19.98	01-18-78	21.59
10-26-60	20.28	04-20-78	21.27
10-18-61	20.60	10-02-78	22.30
03-21-62	20.47	04-02-79	21.89
10-10-62	20.58	10-01-79	23.40
01-08-63	20.57	03-17-80	22.56
04-09-63	20.68	07-01-80	47.68(P)
07-10-63	20.71	10-13-80	24.25
10-07-63	20.63	11-25-80	23.57
01-07-64	20.78	03-05-81	22.96
04-06-64	20.81	11-23-81	24.60
10-07-64	20.94	03-18-82	23.90
01-11-65	20.40	07-21-82	24.57
04-05-65	20.29	11-18-82	24.11
07-12-65	20.18	03-11-83	23.55
10-11-65	20.03	07-28-83	47.18(P)
01-17-66	19.92	11-21-83	23.81
04-04-66	19.83	03-16-84	23.05
10-04-66	19.82	07-21-84	46.59(P)
01-10-67	19.97	11-27-84	23.45
04-04-67	19.92	03-26-85	22.63
07-14-67	20.40	09-15-85	24.72
10-02-67	19.98	11-20-85	23.61
01-09-68	19.95	01-15-86	23.18
04-08-68	20.25(??)	04-08-86	22.73
10-08-68	20.17	10-16-86	23.82
01-14-69	20.49		
04-08-69	20.68		
07-09-69	20.66		
10-08-69	20.65		
01-05-70	20.84		
04-08-70	20.71		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/15E-13bb

Owner: Loma Vista Farms Well Completion Date: 1949

Well Depth: 245 ft. Casing Size: 14 in. Casing Depth 30 ft.

Land Surface Elevation at Well: 4318.6 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 54°F (12°C)

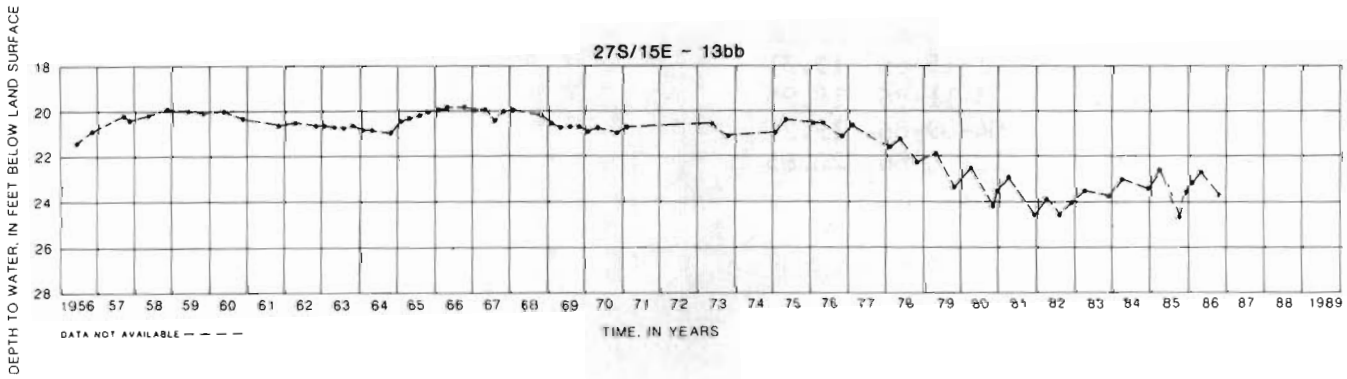
Yield: 2800 gpm Drawdown: 24 ft. Test duration: 3 hrs. Test Date: 1975

Other Well Data: Water Well Reports, Water

Remarks: The well was deepened from 181 to 245 feet on 1-4-75. A change of measuring point after 1972 seems to have resulted in water levels which are a few tenths of a foot deeper than expected based on hydrograph trends at nearby wells.

Generalized Log:

Soil	0 to 2 feet	Pumice and Clay	52 to 73 feet
Hardpan	2 to 3 feet	Sandstone	73 to 86 feet
Sand	3 to 35 feet	Black Sand	86 to 183 feet
Pumice and Sand	35 to 45 feet	Sandstone	183 to 243 feet
Clay	45 to 52 feet	Cinders	243 to 245 feet



Record of Wells Location: 27S/16E-13ab

Dates and Water Levels in Feet Below Land Surface Datum

10-15-58	17.82(??)	04-10-72	16.46
04-26-60	16.26	07-10-72	19.37(R)
10-26-60	16.57	10-11-72	16.94
10-18-61	16.71	04-25-73	16.54
03-21-62	16.78	07-09-73	16.95
07-10-62	17.17	10-01-73	17.18
10-09-62	17.16	10-07-74	16.80
01-09-63	17.01	04-07-75	16.25
04-09-63	16.94	07-08-75	16.74
07-09-63	17.42	09-29-75	16.91
10-08-63	17.52	01-12-76	16.49
01-07-64	17.09	04-13-76	16.34
04-07-64	17.04	07-06-76	16.93
07-09-64	17.42	01-11-77	16.55
10-07-64	17.24	04-14-77	16.93(??)
01-12-65	17.36	07-05-77	17.33
04-06-65	17.37	10-04-77	17.50
07-13-65	17.17	01-19-78	17.21
10-12-65	16.63	04-20-78	16.84
01-18-66	16.31	10-02-78	17.97
04-05-66	16.15	04-02-79	17.44
07-06-66	16.44	07-28-83	20.95(R)
10-05-66	16.48	11-22-83	19.74
01-11-67	16.24	01-10-84	19.08
04-05-67	16.19	03-18-84	19.81
07-12-67	16.60	07-19-84	20.60
10-03-67	16.65	10-15-84	20.67
01-09-68	16.17	11-27-84	19.39
04-09-68	16.30	03-25-85	18.78
07-10-68	16.69	07-29-85	27.88(P)
10-09-68	16.78	09-14-85	20.89
01-15-69	16.64	10-16-85	19.91
04-08-69	16.60	11-19-85	20.06
07-09-69	16.90	11-20-85	20.08
10-09-69	17.01	01-15-86	19.31
01-07-70	16.81	03-11-86	18.95
04-08-70	16.72	04-09-86	19.21
07-01-70	17.02	10-16-86	20.65
10-14-70	17.10		
01-20-71	17.00		
04-12-71	16.85		
07-14-71	16.90		
10-19-71	16.92		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/16E-13ab

Owner: Dick Morehouse Well Completion Date: 1955

Well Depth: 560 ft. Casing Size: 12 in. Casing Depth 6 ft.

Land Surface Elevation at Well: 4312.4 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 64°F (18°C)

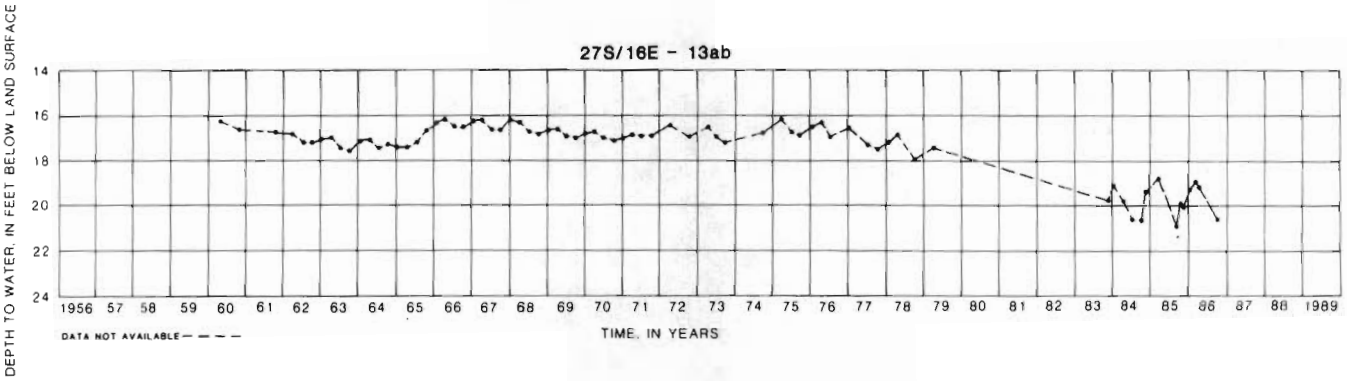
Yield: 1000 gpm Drawdown: 30 ft. Test duration: 6 hrs. Test Date: 1955

Other Well Data: Water Well Report, Water Right File

Remarks: The water level in this well appears to respond less quickly to recharge than do levels in most other Fort Rock Basin wells. The rise in 1965 did not begin until July while others were noted in January. Yet, the topping out of water levels occurred in early 1966 which corresponds closely with that observed in other wells. Some barometric effects are suggested on water levels in the spring of 1984 and 1986.

Generalized Log:

Soil	0 to 5 feet	Rock	290 to 295 feet
Clay	5 to 23 feet	Tuff	295 to 430 feet
Tuff	23 to 230 feet	Pumice	430 to 440 feet
Lava	230 to 235 feet	Tuff	440 to 560 feet
Tuff	235 to 290 feet		



Record of Wells Location: 27S/16E-26cd

Dates and Water Levels in Feet Below Land Surface Datum

01-08-63	19.94	10-04-77	21.18
04-09-63	19.92	01-18-78	22.27(??)
07-10-63	20.13	10-02-78	21.80
08-04-63	20.00(W)	03-05-81	21.15(?)
10-08-63	20.07	07-21-82	23.62
01-08-64	20.03	11-18-82	23.25
04-07-64	20.08	03-10-83	22.62
07-08-64	20.28	07-28-83	25.01
10-07-64	20.19	11-21-83	23.57
01-12-65	19.96	03-18-84	24.13
04-06-65	19.51	03-23-84	24.14
10-12-65	19.24	07-20-84	23.80
01-18-66	19.13	11-27-84	22.63
04-05-66	19.02	03-25-85	22.20
10-05-66	19.26	07-29-85	61.60(P)
01-11-67	19.13	09-14-85	24.54
04-05-67	19.31	11-20-85	23.88
10-03-67	19.47	01-15-85	23.42
01-09-68	19.17	04-08-86	24.60
04-09-68	19.32	05-01-86	24.19
07-10-68	19.89	07-16-86	58.56(P)
01-15-69	19.65		
04-09-69	19.63		
10-09-69	20.06		
01-06-70	19.90		
04-09-70	19.78		
10-14-70	20.14		
01-21-71	19.95		
04-13-71	19.91		
07-14-71	22.57(R?)		
10-18-71	20.16		
04-11-72	19.59		
04-25-73	20.66(??)		
10-01-73	20.19		
07-01-74	21.63		
10-07-74	19.79		
04-07-75	19.33		
09-29-75	19.96		
01-12-76	19.50		
04-13-76	19.44		
10-04-76	20.01		
01-11-77	19.63		

(W) - Water Well Report
(P) - Pumping
(?) - Questionable measurement per field notes
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/16E-26cd

Owner: Mark Bedinger Well Completion Date: 1963+/-

Well Depth: 755 ft. Casing Size: 14 in. Casing Depth 60 ft.

Land Surface Elevation at Well: 4313.4 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 57°F (14°C)

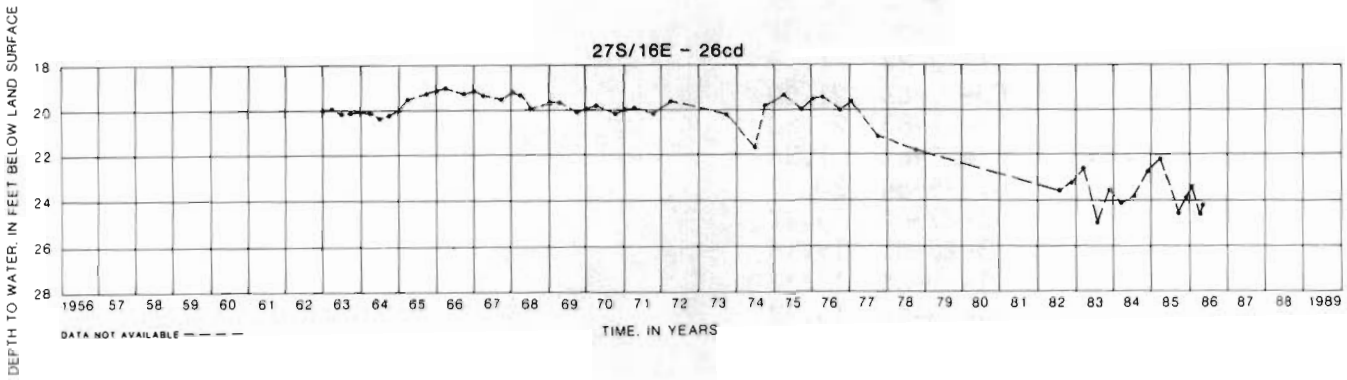
Yield: 2000 gpm Drawdown: 100 ft. Test duration: --- hrs. Test Date: 1963

Other Well Data: Water Well Report, Water Right File

Remarks: The water well report is unclear as to the date the well was completed. Construction began in 1958. Water level response since 1962 may be influenced by diatomite clogging of the bottom of the well. Much was removed from the well in 1984. The unusual drops of water level early in 1984 and 1986 is the opposite of that found in other observation wells and may reflect this clogging.

Generalized Log:

Soil	0 to 2 feet	Blue Silt	242 to 540 feet
Hardpan	2 to 3 feet	Claystone	540 to 580 feet
Diatomite	3 to 90 feet	Pumice	580 to 585 feet
Pumice	90 to 91 feet	Claystone	585 to 616 feet
Diatomite	91 to 240 feet	Basalt	616 to 750 feet
Pumice	240 to 242 feet	Cinders	750 to 755 feet



Record of Wells Location: 27S/16E-32bd

Dates and Water Levels in Feet Below Land Surface Datum

05-25-56	22.60	10-09-69	21.32
10-17-56	22.39	01-06-70	21.63
05-02-57	22.97	04-09-70	21.77
08-20-57	22.72	07-01-70	21.24
10-23-57	23.64	10-14-70	20.47
04-23-58	23.54	01-21-71	20.99
10-15-58	24.29	04-11-72	20.98
05-12-59	25.16	10-11-72	20.99
10-15-59	25.32	04-25-73	21.88
04-26-60	26.48	07-09-73	22.07
10-26-60	26.32	10-01-73	22.20
05-03-61	26.47	07-01-74	21.20
10-19-61	24.15	10-07-74	20.72
03-22-62	24.97	04-07-75	22.00
07-10-62	25.54	07-08-75	22.04
10-09-62	25.38	09-29-75	21.49
01-08-63	25.40	01-12-76	21.54
04-09-63	25.46	04-13-76	22.26
07-10-63	24.37	07-06-76	22.64
10-08-63	21.46	10-04-76	21.73
01-08-64	21.44	01-11-77	21.48
04-07-64	21.91	04-13-77	22.38
07-08-64	21.88	07-05-77	22.88
10-07-64	21.87	10-04-77	22.57
01-12-65	22.29	01-18-78	22.92
04-06-65	21.40	04-20-78	22.64
07-13-65	20.63	10-02-78	18.38
10-12-65	20.38	04-02-79	20.00
01-18-66	20.87	07-30-79	19.82
04-05-66	21.31	07-02-80	20.95
07-06-66	21.59	11-25-80	18.88
10-05-66	21.60	03-03-81	19.91
01-11-67	21.98	11-23-81	20.59
04-05-67	22.20	03-19-82	21.61
07-12-67	21.79	11-18-82	21.53
10-03-67	21.49	03-10-83	21.80
01-09-68	21.88	11-21-83	21.80
04-09-68	22.43	03-18-84	21.34
07-10-68	21.35	07-26-84	20.37
10-09-68	19.85	11-27-84	19.21
01-15-69	20.87	03-26-85	19.16
04-09-69	21.40	11-20-85	18.33
07-10-69	21.57	04-08-86	19.57

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/16E-32bd

Owner: Patty Blevins Well Completion Date: 1956

Well Depth: 1020 ft. Casing Size: 12 in. Casing Depth 32 ft.

Land Surface Elevation at Well: 4335 ft. Determination: Estimate from Topo

Water Use: None Water Temperature: ----

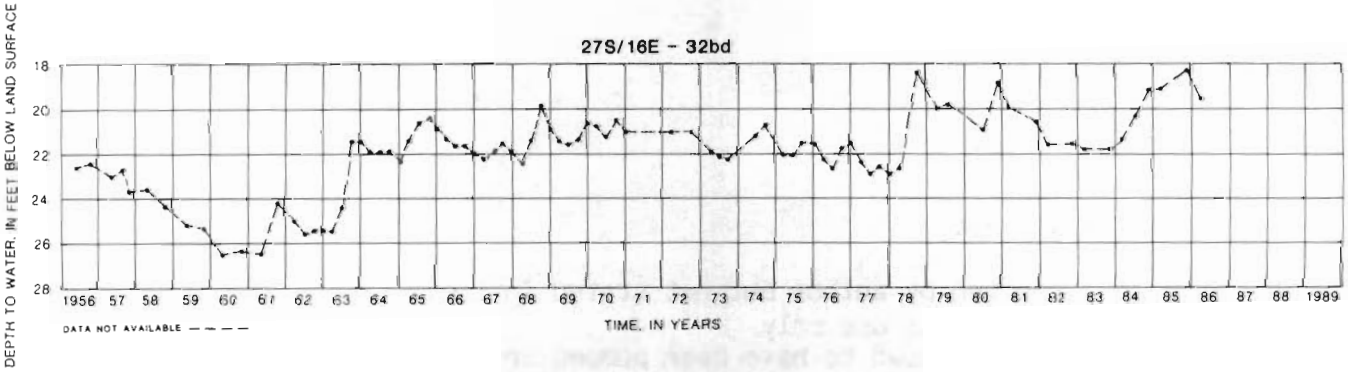
Yield: 60 gpm Drawdown: --- ft. Test duration: 4 hrs. Test Date: 1956

Other Well Data: Water Well Report, Water Right File

Remarks: This well was originally drilled to 848 feet in 1956 and apparently deepened to 1020 feet that year. The yield of the well was viewed as too low for irrigation by the original owner. The water level in the well displays more fluctuation than other observation wells and rests at a level about 20 feet higher. The water level at this well seems to rise due to irrigation of surrounding lands. Although this well is very deep, its water level signature is not that of the main ground water reservoir but is assigned to an upper ground water reservoir.

Generalized Log:

Soil	0 to 22 feet	Rock	215 to 230 feet
Sand	22 to 30 feet	Clay	230 to 710 feet
Rock	30 to 33 feet	Lava	710 to 718 feet
Clay	33 to 180 feet	Clay	718 to 795 feet
Lava	180 to 182 feet	Rock	795 to 848 feet
Clay	182 to 215 feet	No Log below 848 feet	



Record of Wells Location: 27S/16E-32ca(3)

Dates and Water Levels in Feet Below Land Surface Datum

10-15-58	83.31
05-12-59	79.43
10-15-59	95.39
04-26-60	65.25
10-26-60	101.28
05-03-61	69.82
10-19-61	89.10
03-22-62	68.94
07-10-62	93.73
10-09-62	75.00
01-08-63	66.48
04-09-63	62.93
07-10-63	61.86
07-01-74	56.92
04-07-75	57.20
07-08-75	57.38
09-29-75	57.54
01-12-76	57.80
04-13-76	57.99
07-06-76	58.23
10-04-76	58.43
01-11-77	58.58
07-05-77	59.42
10-04-77	61.15
01-18-78	59.59
04-20-78	59.29
10-02-78	61.43
07-02-80	61.89(R)
03-03-81	60.17
11-23-81	61.13
03-19-82	58.45
07-21-82	57.95
11-18-82	57.99
03-10-83	57.35
07-28-83	57.21
11-21-83	57.63
03-18-84	56.30
07-26-84	56.89
11-27-84	56.75
03-26-85	56.86
11-20-85	58.20
04-08-86	56.75

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/16E-32ca(3)

Owner: Jim Lancaster Well Completion Date: 1958

Well Depth: 545 ft. Casing Size: 12 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4415 ft. Determination: Estimate from Topo

Water Use: None Water Temperature: ----

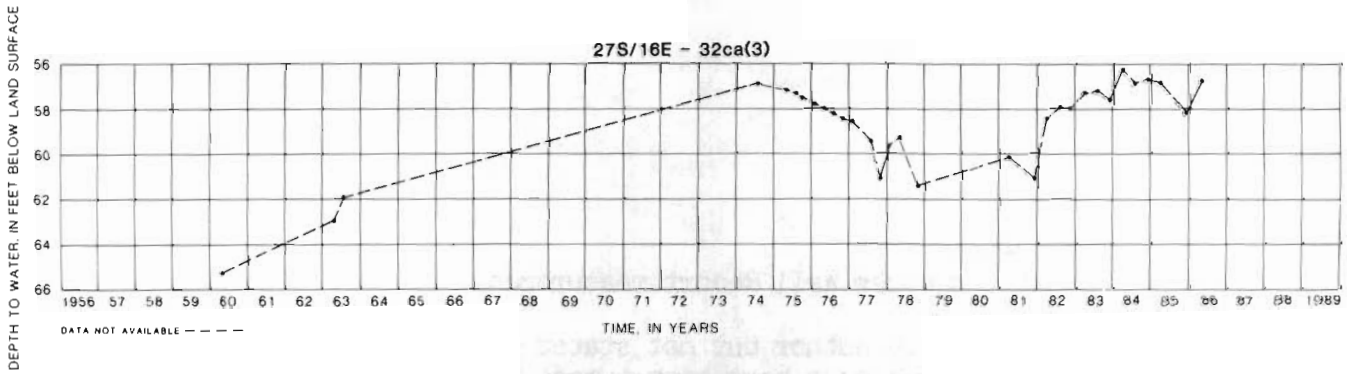
Yield: -- gpm Drawdown: --- ft. Test duration: --- hrs. Test Date: 1956

Other Well Data: Water Right File

Remarks: There is no water well report for this well. However, there is a report for a 530-foot well which is located less than 50 feet east. That well was tested at 180 gpm with 60 feet of drawdown. Apparently, due to poor production, these wells have not been used for irrigation since the early 1960's. Water levels at these wells consistently differ by about 3 feet. Water from this well reflects an upper ground water reservoir and considerable residual drawdown effects.

Generalized Log: The above noted nearby well displays the following materials.

Sand and Boulders	0 to 35 feet	Broken Lava	210 to 450 feet
Lava	35 to 110 feet	Clay	450 to 455 feet
Tuff	110 to 142 feet	Rock	455 to 500 feet
Sand and Gravel	142 to 190 feet	Sand	500 to 530 feet
Tuff	190 to 210 feet		



Record of Wells Location: 27S/17E-14cc

Dates and Water Levels in Feet Below Land Surface Datum

09-09-61	23.00(W?)
10-18-61	20.27
03-21-62	20.26
07-10-62	20.83
10-09-62	20.71
01-07-63	20.55
04-10-63	20.50
07-08-63	20.72
10-07-63	20.84
01-07-64	20.82
04-06-64	20.96
07-07-64	21.24
10-06-64	21.14
01-11-65	20.95
04-05-65	20.54
07-12-65	20.62
10-13-65	20.42
01-17-66	20.21
04-05-66	20.10
07-05-66	20.55
10-04-66	20.40
01-10-67	20.20
04-04-67	20.05
07-11-67	20.57
10-02-67	20.42
01-08-68	20.35
04-08-68	20.42
07-09-68	20.83
10-08-68	20.83
01-14-69	20.66
04-08-69	20.57
07-09-69	20.93
10-08-69	21.04
01-05-70	20.89
04-08-70	20.82
03-19-84	23.01
03-26-85	22.63
11-21-85	23.94
01-14-86	23.31
04-09-86	22.86
07-17-86	25.30
10-15-86	24.45

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/17E-14cc

Owner: Bill Remy Well Completion Date: 1961

Well Depth: 261 ft. Casing Size: 12 in. Casing Depth 35 ft.

Land Surface Elevation at Well: 4316 ft. Determination: Estimate from Topo

Water Use: Irrigation Water Temperature: ----

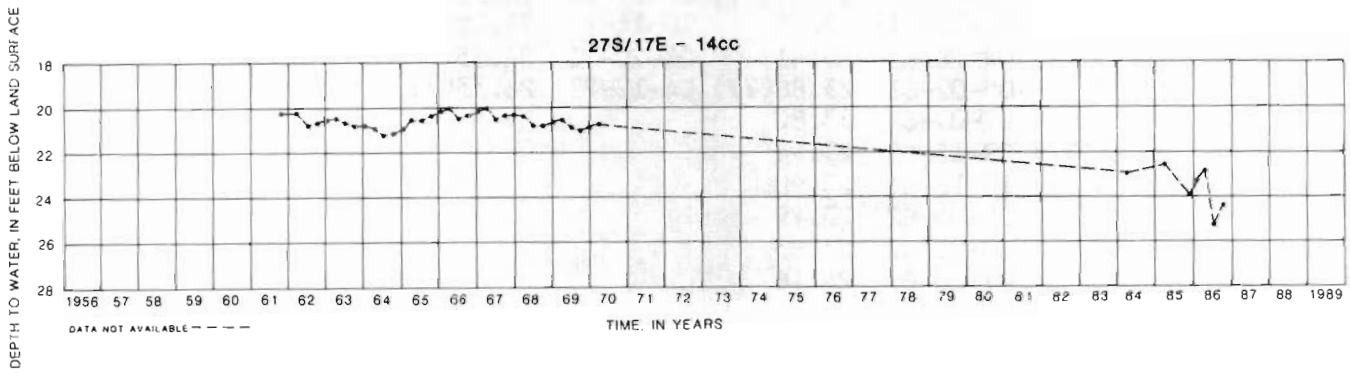
Yield: 1600 gpm Drawdown: 47 ft. Test duration: 5 hrs. Test Date: 1961

Other Well Data: Water Right File, Water Well Report

Remarks: An oil layer of 0.01 foot was determined on the water surface in this well on 11-21-85. For more information on water level trends in the area of this well please consult the Record of Wells for T27S/R17E-22dd and T27S/R17E-27ca.

Generalized Log:

Top Soil	0 to 5 feet	Gray, Hard Basalt	200 to 206 feet
Brown Clay	5 to 35 feet	Hard, Black Sand	206 to 210 feet
Blue Clay	35 to 180 feet	Hard, Gray Basalt	210 to 245 feet
Gray Sandstone	180 to 184 feet	Black, Fractured Basalt	245 to 261 feet
Blue Clay	184 to 200 feet		



Record of Wells Location: 27S/17E-22dd

Dates and Water Levels in Feet Below Land Surface Datum

12-14-38	26.95	07-19-55	25.37	09-26-62	24.11
10-07-40	27.32	09-15-55	25.31	10-09-62	24.09
11-19-40	27.36	09-23-55	25.43(??)	01-07-63	23.96
12-21-40	27.29	10-27-55	25.35	04-10-63	23.90
03-29-41	27.51	04-06-56	24.93	07-08-63	24.13
05-25-41	26.13(??)	05-25-56	24.85	10-07-63	24.13
09-25-41	27.55	08-14-56	24.55(N)	01-07-64	24.05
01-09-42	27.76	08-22-56	24.79	04-06-64	24.70(??)
10-24-42	27.78	10-17-56	24.74	07-07-64	24.52
05-23-43	27.67	12-03-56	24.31	10-26-64	24.35
09-15-43	27.54	04-16-57	24.16	01-11-65	24.18
07-12-46	28.01	05-02-57	24.33(??)	04-05-65	23.77
05-11-47	28.06	05-24-57	24.05	07-12-65	23.83
10-09-47	28.12	08-10-57	24.06	10-11-65	23.64
03-18-48	28.22	08-21-57	24.23(??)	01-17-66	23.40
08-05-48	28.28	10-02-57	24.01	04-05-66	23.29
10-19-48	28.26	10-23-57	24.38(??)	07-05-66	23.52
03-12-49	28.27	04-24-58	24.53(??)	10-04-66	23.54
07-04-49	28.25	08-08-58	23.83	01-10-67	23.43
08-26-49	28.23	09-04-58	23.75	04-04-67	23.23
11-14-49	28.21	09-27-58	23.55(??)	07-11-67	23.46
02-17-50	28.22	10-15-58	23.67	10-02-67	23.44
07-12-50	28.08	12-09-58	23.44	01-08-68	23.68
11-04-50	27.99	04-23-59	23.27	04-08-68	23.61
03-23-51	27.91	05-14-59	23.42	07-09-68	23.22(??)
09-05-51	27.50	07-01-59	22.62(??)	10-08-68	23.97
12-18-51	27.23	08-30-59	23.75	01-14-69	23.87
04-15-52	27.24	10-15-59	23.74	04-08-69	23.79
06-18-52	27.00	01-16-60	23.47	07-09-69	24.03
09-06-52	27.08	04-27-60	23.48	10-08-69	25.26(??)
12-27-52	26.74	06-13-60	23.51	01-05-70	24.30
04-01-53	26.62	10-14-60	23.66	04-08-70	23.95
07-18-53	26.38	10-26-60	23.87(??)	07-01-70	24.38
10-16-53	26.23	01-12-61	23.55	10-14-70	24.25
01-20-54	26.12	04-28-61	23.61	01-20-71	24.15
04-18-54	25.87	05-02-61	23.88(??)	04-12-71	26.33(??)
07-13-54	25.77	07-03-61	23.80		
09-03-54	26.88(??)	09-15-61	23.94		
10-15-54	25.04(??)	10-18-61	23.90		
12-23-54	25.55	01-05-62	23.79		
02-19-55	25.53	03-21-62	23.83		
05-02-55	25.42	07-10-62	24.18		

(N) - Nearby pumping
(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/17E-22dd

Owner: Golden Rule Farms Well Completion Date: Unknown

Well Depth: 54 ft. Casing Size: 8 in. Casing Depth ---- ft.

Land Surface Elevation at Well: 4320+/- ft. Determination: Estimate from Topo

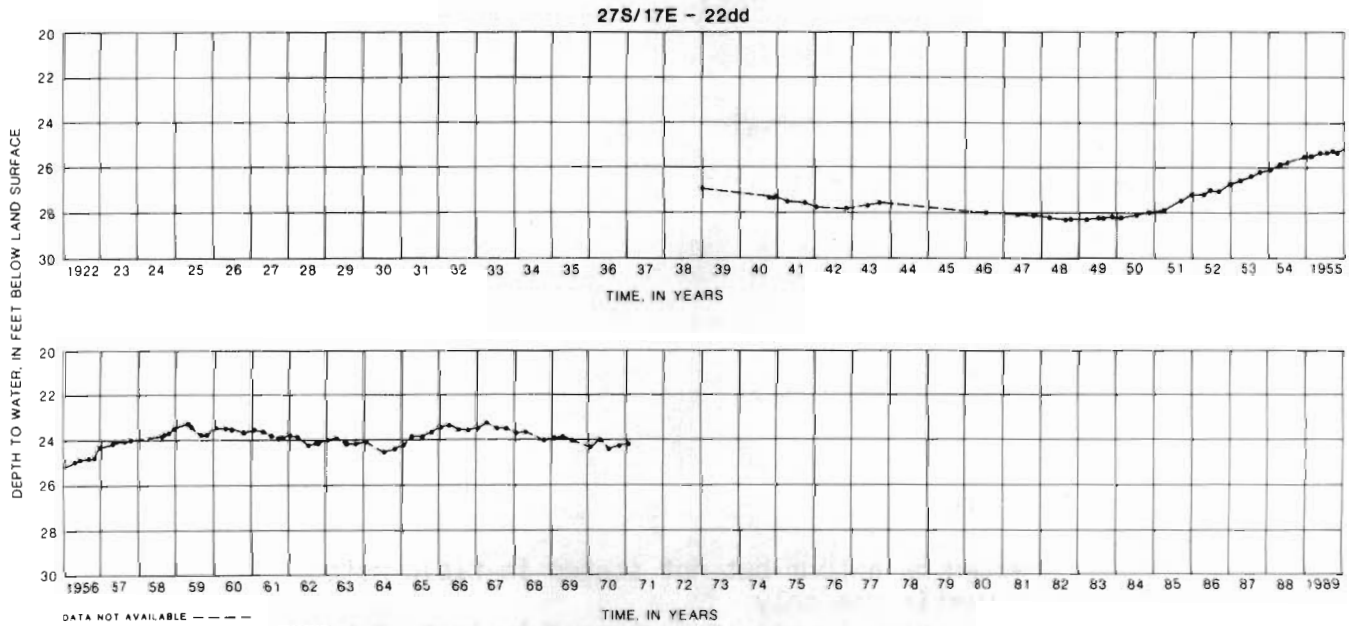
Water Use: None Water Temperature: ----

Yield: --- gpm Drawdown: --- ft. Test duration: --- hrs. Test Date: ----

Other Well Data: Partial Water Chemistry Analysis

Remarks: This well was destroyed about 1976. An obstruction was noted at 26 feet on 10-14-70. Please see the Well Records for T27S/R17E-27db and T27S/R17E-14cc for extensions of water level trends in this area of Christmas Valley.

Generalized Log: Sand is the material of the water-bearing zone. There is a log for a nearby well which is believed to be less than 200 feet from this well. That log shows sandy soil from 0 to 7 feet, white and green diatomaceous earth from 7 to 26 feet and fine, dark sand from 26 to 74 feet.



Record of Wells Location: 27S/17E-27ca

Dates and Water Levels in Feet Below Land Surface Datum

06-18-52	40.98	07-01-70	37.40
05-21-56	38.00	10-14-70	37.37
08-29-56	46.85(P)	01-20-71	37.25
10-17-56	38.23	07-14-71	37.54
08-21-57	39.88(R?)	10-18-71	37.32
10-23-57	37.30	07-10-72	39.12(??)
04-24-58	37.56(??)	10-11-72	39.23(??)
10-15-58	36.92	10-01-73	44.65(R)
05-14-59	36.80	01-12-76	39.58(?)
10-15-59	36.73	10-04-76	37.48
04-27-60	37.59(??)	01-11-77	39.50(??)
10-26-60	36.97	10-05-77	38.01
05-02-61	36.99	01-19-78	37.64
10-18-61	36.84	04-20-78	37.32
03-21-62	36.88	04-02-79	37.79
10-09-62	37.32	03-17-80	38.34
01-07-63	37.18	07-01-80	39.64
04-10-63	37.03	11-25-80	39.50
07-08-63	37.43	03-05-81	38.81
10-07-63	37.51	11-22-81	40.67
01-07-64	37.23	03-17-82	39.80
04-06-64	37.28	11-18-82	39.57(??)
10-06-64	37.46	03-10-83	39.51
01-11-65	37.24	05-19-83	53.19(P)
04-05-65	36.76	07-28-83	56.82(P)
10-11-65	36.70	11-21-83	40.25
01-17-66	36.38	03-18-84	39.10
04-05-66	36.34		
07-05-66	36.77		
10-04-66	36.66		
01-10-67	36.44		
04-04-67	36.28		
07-11-67	36.78		
10-02-67	36.56		
01-08-68	36.63		
04-08-68	36.70		
10-08-68	37.11		
01-14-69	36.95		
04-08-69	36.86		
07-09-69	37.24		
10-08-69	37.32		
01-05-70	37.15		
04-08-70	37.09		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/17E-27ca

Owner: Dave Seibel Well Completion Date: 1952

Well Depth: 220 ft. Casing Size: 16 in. Casing Depth 77 ft.

Land Surface Elevation at Well: 4332.0 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: ----

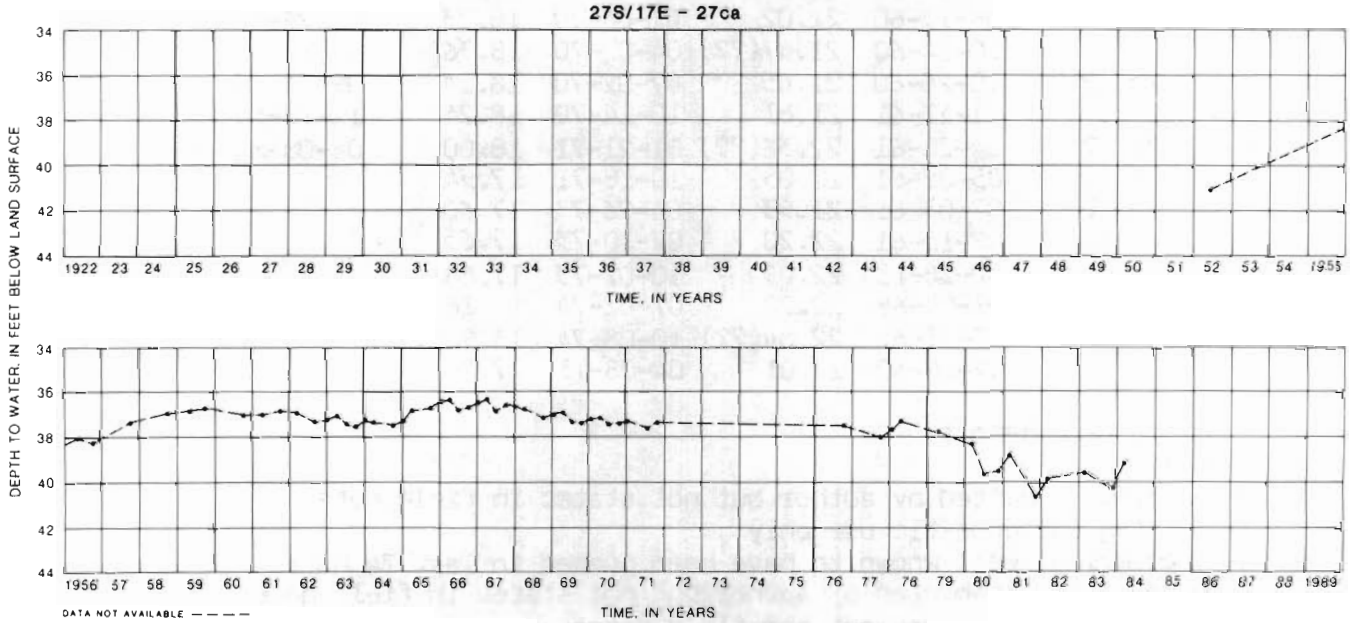
Yield: 4800 gpm Drawdown: 40 ft. Test duration: --- hrs. Test Date: 1952

Other Well Data: Water Chemistry Analysis, Water Right File, Water Well Report

Remarks: Water level accessibility to this well was lost in late 1984. Please see the Well Records for T27S/R17E-14cc and T27S/R17E-22dd for comparable water level trends in this area of Christmas Valley.

Generalized Log:

Soil and Clay	0 to 14 feet	Sand (water-bearing)	139 to 141 feet
Hard Yellow Clay	14 to 28 feet	Hard Lava	141 to 161 feet
Blue Clay	28 to 48 feet	Soft Lava	161 to 171 feet
Hard, Fine Sand (water-bearing)	48 to 60 feet	Hard Lava	171 to 176 feet
Medium Hard Lava	60 to 130 feet	Soft Lava (water-bearing)	176 to 182 feet
Soft Lava (water-bearing)	130 to 139 feet	Hard Lava	182 to 195 feet
		No Data	195 to 220 feet



Record of Wells Location: 27S/18E-6bc(2)

Dates and Water Levels in Feet Below Land Surface Datum

05-23-40	23.43	07-19-55	24.52	09-26-62	22.33	07-09-75	16.79
10-07-40	23.53	09-15-55	24.62	10-09-62	22.29	09-30-75	17.22
11-19-40	23.58	09-23-55	24.66	01-08-63	22.39	01-13-76	17.55
12-21-40	23.59	10-27-55	24.67	04-09-63	22.33	04-14-76	17.66
03-29-41	23.67	04-06-56	24.42	07-08-63	22.26	07-07-76	17.60
05-25-41	23.68	08-22-56	23.80	10-08-63	22.35	10-05-76	17.44
09-25-41	23.67	10-16-56	23.68	01-08-64	22.20	01-12-77	17.60
10-24-42	22.99	12-03-56	23.51	04-07-64	22.12	04-14-77	17.72
05-23-43	22.82	04-16-57	23.29	07-08-64	21.85	07-05-77	17.64
09-15-43	22.57	05-02-57	23.33	10-07-64	21.77	10-05-77	18.03
06-12-45	22.79	05-24-57	23.21	01-12-65	21.71	01-19-78	17.88
10-12-45	22.96	08-10-57	23.12	04-06-65	21.42	04-20-78	17.35
07-12-46	23.32	08-21-57	23.20	07-13-65	21.02	10-02-78	17.39
05-11-47	23.83	10-02-57	23.05	10-12-65	20.75	04-02-79	17.40
10-09-47	23.94	10-23-57	23.87(??)	01-18-66	20.51	07-30-79	17.52
03-18-48	24.11	01-14-58	22.94	04-05-66	20.31	10-01-79	17.68
08-05-48	24.23	04-24-58	23.49(??)	07-06-66	20.19	07-01-80	17.33
10-19-48	24.27	04-25-58	22.82	10-05-66	19.94	10-13-80	17.11
03-11-49	24.45	08-08-58	22.20	01-11-67	19.74	11-25-80	17.26
07-04-49	24.60	09-04-58	22.02	04-05-67	19.56	03-04-81	17.23
08-26-49	24.86(??)	09-27-58	21.89	07-12-67	19.32	11-22-81	18.28
11-14-49	24.68	10-15-58	22.01	10-03-67	19.23	03-17-82	17.82
02-17-50	24.77	12-09-58	22.05	01-09-68	19.00	07-22-82	17.27
07-12-50	24.87	04-23-59	22.19	04-09-68	19.00	11-18-82	16.93
11-04-50	24.98	05-14-59	22.03	07-10-68	18.86	03-10-83	16.91
03-23-51	25.07	07-01-59	21.88	10-09-68	18.88	07-28-83	16.43
09-05-51	25.11	08-30-59	21.68	01-15-69	18.86	11-21-83	16.48
12-18-51	25.16	10-15-59	22.33(??)	04-09-69	18.70	03-17-84	16.40
04-15-52	25.18	01-16-60	21.96	07-10-69	18.53	07-18-84	15.73
06-18-52	25.16	04-27-60	22.01	10-09-69	18.59	11-27-84	16.46
09-06-52	25.12	06-13-60	22.02	01-06-70	18.53	03-26-85	16.57
12-27-52	25.17	10-14-60	21.47(??)	04-09-70	18.36	07-28-85	16.58
04-01-53	25.19	10-26-60	21.65	07-02-70	18.14	09-14-85	16.94
07-18-53	25.09	01-12-61	21.81	10-14-70	18.24	11-19-85	17.21
10-16-53	25.12	04-28-61	22.36(??)	01-21-71	18.00	04-08-86	16.81
01-20-54	25.11	05-02-61	22.05	10-18-71	17.94		
04-18-54	25.00	07-03-61	21.93	04-26-73	17.60		
07-13-54	24.84	09-15-61	22.20	07-10-73	17.65		
09-03-54	24.97	10-18-61	22.09	10-02-73	17.88		
12-23-54	24.73	01-05-62	22.22	07-02-74	17.16		
02-19-55	24.68	03-21-62	22.84(??)	10-08-74	15.94(?)		
05-02-55	24.57	07-09-62	22.01	04-08-75	17.56		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(?) - Questionable measurement per field notes
(??) - Author questions measurement

Record of Wells Location: 27S/18E-6bc(2)

Owner: Terry Nofziger Well Completion Date:

Well Depth: 83/38 ft. Casing Size: 8 in. Casing Depth 10 ft.

Land Surface Elevation at Well: 4315.7 ft. Determination: Leveled

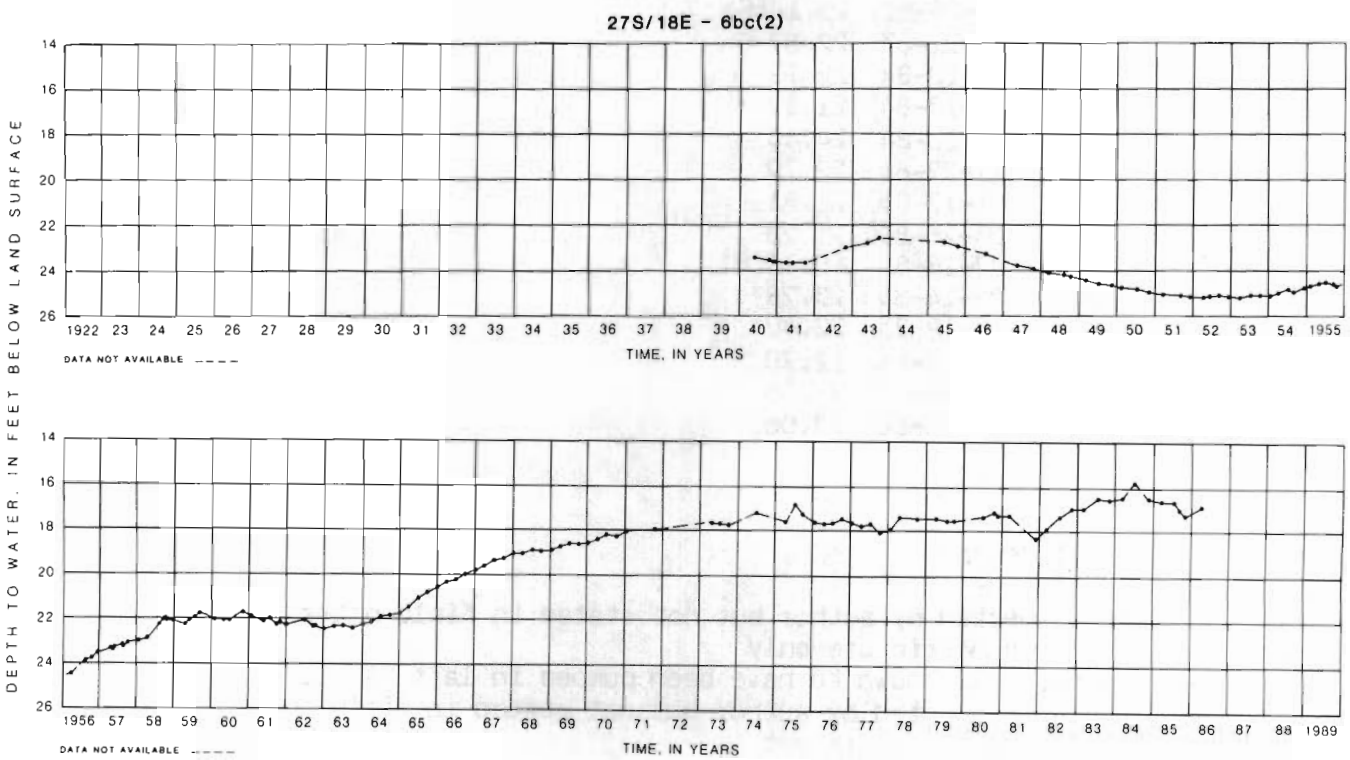
Water Use: None Water Temperature: ----

Yield: --- gpm Drawdown: -- ft. Test duration: --- hrs. Test Date: ----

Other Well Data: Partial Water Chemistry Analysis

Remarks: The well was sounded to a depth of 38 feet on 3-10-83. Hydrograph trends suggest that this well does not derive water from the main ground water reservoir. Nearby pumping is intense yet interference effects are not observed. This well reflects water levels of an upper ground water reservoir which may be very local in extent.

Generalized Log: Sand is reported as the water-bearing zone. No other data available. A well believed to be within 200 feet of this observation well reported diatomaceous earth between 6 and 18 feet and sand at all other intervals to 215 feet. That well is located at T27S/R18E-6bc(1).



Record of Wells

Location: 27S/18E-6db

Dates and Water Levels in Feet Below Land Surface Datum

05-24-56	21.80	10-14-70	19.80
08-29-56	28.38(P)	01-21-71	19.68
10-16-56	21.60	04-13-71	20.66(??)
05-02-57	21.24	10-18-71	19.87
08-21-57	28.44(P)	04-11-72	19.52
10-23-57	20.92	10-12-72	19.79
04-24-58	20.62	04-26-73	19.63
10-15-58	20.43	10-02-73	19.84
05-14-59	20.14	10-08-73	20.03
10-14-59	20.32	04-08-75	19.07
04-27-60	20.00	07-09-75	21.31(R)
10-26-60	20.26	09-30-75	19.97
05-02-61	20.16	01-13-76	19.13
10-18-61	20.24	04-14-76	19.02
03-21-62	20.15	10-05-76	19.49
07-09-62	20.47	01-12-77	18.95
10-09-62	20.50	10-05-77	20.52
01-08-63	20.30	01-19-78	19.67
04-09-63	20.89(??)	04-21-78	18.98
07-08-63	20.50	10-03-78	20.67
10-08-63	20.40	07-01-80	23.82(R)
01-08-64	20.26	11-25-80	22.22
04-07-64	20.35	03-04-81	21.51
07-08-64	20.55	11-22-81	23.46
10-08-64	20.56	03-17-82	22.48
01-12-65	20.23	11-18-82	22.93
04-06-65	19.85	03-10-83	21.91
07-13-65	19.82	07-28-83	25.18(R)
01-18-66	19.60	11-21-83	22.87
04-05-66	19.50	01-10-84	22.17
10-05-66	19.77	03-17-84	21.52
01-11-67	19.53	07-18-84	24.46
04-05-67	19.43	11-27-84	22.29
10-03-67	19.82	01-17-85	21.81
01-09-68	19.50	03-26-85	21.23
04-09-68	19.61	07-28-85	40.63(P)
10-09-68	20.12	09-14-85	23.78
01-15-69	19.59	11-19-85	22.40
04-09-69	19.48	01-14-86	21.70
07-10-69	19.83	04-08-86	21.08
10-09-69	19.86	10-16-86	23.08
01-06-70	19.70		
04-09-70	19.64		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/18E-6db

Owner: Clint Carrico Well Completion Date: 1955

Well Depth: 244 ft. Casing Size: 14 in. Casing Depth 70 ft.

Land Surface Elevation at Well: 4316.3 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 61°F (16°C)

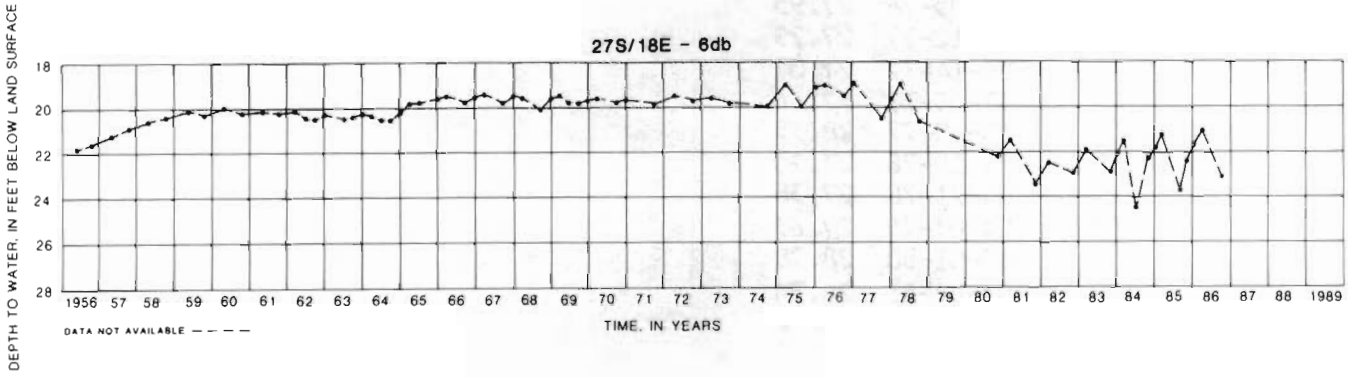
Yield: 910 gpm Drawdown: 15 ft. Test duration: 27 hrs. Test Date: 1984

Other Well Data: Water Well Report, Water Right File, Aquifer Test, Water Chemistry Analysis

Remarks: On 11-19-85 an oil layer of 9.17 feet was measured in the well. This layer at an assumed specific gravity of 0.87 would give a correction of -1.19 feet to the measured oil level. Field notes indicate oil from 1959 to 1967, 1972 to 1976, and 1978 to 1986. It is believed that the current oil layer is the greatest during the life of the well.

Generalized Log:

Soil	0 to 2 feet	Clay	172 to 180 feet
Hardpan	2 to 8 feet	Gravel	180 to 188 feet
Clay	8 to 134 feet	Clay with Gravel	188 to 235 feet
Pumice Gravel	134 to 149 feet	Sand	235 to 237 feet
Clay	149 to 165 feet	Clay	237 to 244 feet
Pumice Gravel	165 to 172 feet		



Record of Wells Location: 27S/18E-21aa

Dates and Water Levels in Feet Below Land Surface Datum

11-06-55	28.53	10-12-65	26.84	03-17-82	29.39
04-06-56	28.19	01-18-66	26.55	07-22-82	30.33
08-22-56	28.05	04-05-66	26.44	11-17-82	30.28
10-16-56	27.82	07-06-66	26.80	03-10-83	29.36
04-16-57	27.61	10-05-66	26.97	05-18-83	29.10
05-02-57	27.64	01-11-67	26.59	07-27-83	30.40
08-10-57	27.60	04-05-67	26.41	09-08-83	31.01
08-21-57	27.96(??)	07-12-67	26.79	11-21-83	30.05
10-23-57	27.56	10-03-67	27.02	01-10-84	29.45
01-14-58	26.78(??)	01-09-68	26.61	03-17-84	29.05
04-24-58	27.63(??)	04-09-68	26.57	05-24-84	29.00
08-08-58	27.12	07-10-68	27.00	07-17-84	30.23
09-04-58	27.16	10-09-68	27.11	09-20-84	31.26
09-27-58	27.15	01-15-69	26.79	10-19-84	30.76
10-15-58	27.15	04-09-69	26.69	11-27-84	30.12
05-14-59	26.90	07-10-69	26.94	01-17-85	29.52
07-01-59	27.78(??)	10-09-69	27.02	03-26-85	29.00
08-30-59	26.96	01-06-70	26.95	07-28-85	30.81
10-15-59	26.79	04-09-70	26.83	08-20-85	31.05
01-16-60	26.64	07-02-70	27.00	09-14-85	31.06
04-27-60	26.61	10-14-70	27.19	10-11-85	30.54
06-13-60	26.66	01-21-71	27.03	10-16-85	30.48
10-26-60	27.03	07-10-73	27.45	11-19-85	30.04
01-12-61	26.74	10-02-73	27.36	12-18-85	29.73
04-28-61	26.62	07-02-74	27.68	01-14-86	29.47
05-02-61	26.85(??)	10-08-74	28.01	03-11-86	29.10
07-03-61	26.85	04-08-75	27.09	04-08-86	28.96
09-15-61	27.18	07-08-75	27.71	05-14-86	28.88
10-18-61	27.28	09-30-75	28.04	07-16-86	30.03
01-05-62	26.99	01-13-76	27.30	10-15-86	30.72
07-09-62	27.23	04-14-76	27.04		
09-26-62	27.41	07-07-76	27.85		
01-08-63	27.09	10-05-76	27.95		
04-09-63	26.94	01-12-77	27.29		
07-08-63	27.21	04-14-77	27.07		
10-08-63	27.40	07-05-77	27.64		
01-08-64	27.16	10-05-77	28.35		
04-07-64	26.88	01-19-78	27.70		
07-08-64	27.11	04-21-78	27.38		
10-07-64	27.33	04-03-79	27.63		
01-12-65	27.01	07-01-80	28.78		
04-06-65	26.70	03-04-81	28.34		
07-13-65	26.89	11-21-81	30.19		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/18E-21aa

Owner: Spirow and Teresa Nicholaw Well Completion Date: 1953

Well Depth: 635 ft. Casing Size: 6 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4321.1 ft. Determination: Leveled

Water Use: None Water Temperature: ----

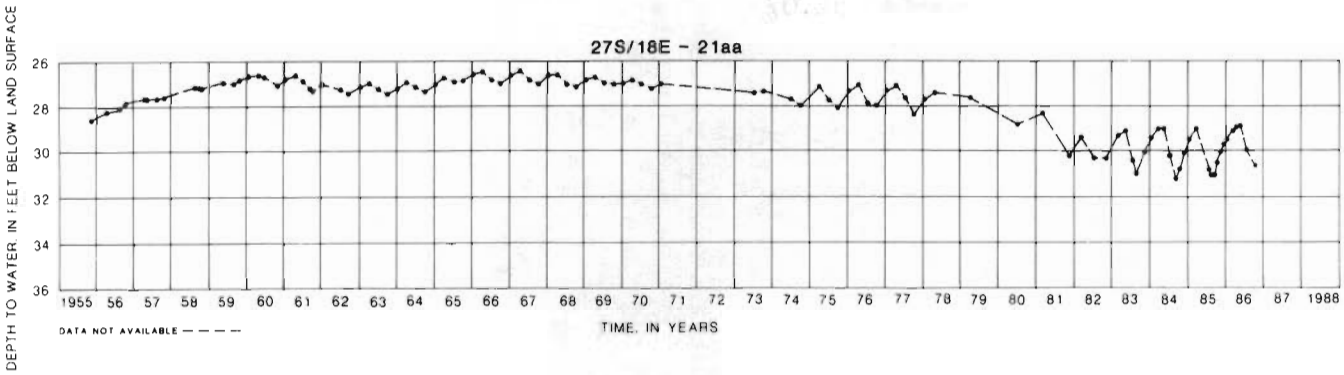
Yield: --- gpm Drawdown: -- ft. Test duration: --- hrs. Test Date: ----

Other Well Data: Continuous Water Level Records

Remarks: The U.S. Geological Survey sounded this well at 366 feet in 1955. It was drilled as an oil test well and no well report is available. The well has always been unused since measurement started in 1955. A continuous water level recorder was set at the well in November, 1985 and appears to display very minor water level sensitivity to barometric changes.

Generalized Log: An irrigation well about 3/4 mile south contains a log of the following materials.

Clay	0 to 55 feet	Lava	220 to 384 feet
Greenstone	55 to 85 feet	Brownstone	384 to 463 feet
Brownstone	85 to 90 feet	Pumice	463 to 479 feet
Sand	90 to 112 feet	Greenstone	479 to 500 feet
Brownstone	112 to 220 feet		



Record of Wells Location: 27S/19E-18cc

Dates and Water Levels in Feet Below Land Surface Datum

08-21-57	49.76	07-02-74	51.07
10-23-57	49.54	04-08-75	49.46
04-24-58	49.71	07-08-75	51.30
10-15-58	49.14	09-30-75	51.14
05-14-59	47.61(??)	01-13-76	50.19
10-15-59	48.44	04-14-76	49.86
04-26-60	48.14	10-05-76	51.33
10-26-60	49.25	01-12-77	50.09
05-02-61	48.87	04-14-77	49.76
10-18-61	49.54	07-05-77	50.82
03-21-62	48.89	10-05-77	51.76
10-09-62	49.11	01-19-78	50.22
01-08-63	48.57	04-21-78	50.43
04-09-63	48.44	03-18-80	49.53
10-08-63	49.17	07-01-80	50.65
01-08-64	48.75	11-25-80	54.55(??)
04-07-64	48.69	03-04-81	49.66
07-08-64	50.03	11-21-81	50.82
01-12-65	48.76	03-17-82	50.49
04-06-65	48.35	03-10-83	50.49
10-12-65	48.35	07-27-83	55.11(?)
01-18-66	47.99	11-21-83	51.52
04-05-66	48.00	03-17-84	50.51
07-06-66	48.48	07-17-84	54.99(P)
01-11-67	48.00	11-27-84	51.55
04-05-67	47.80	03-26-85	50.31
07-12-67	48.25	07-28-85	54.89(P)
01-09-68	48.01	07-29-85	53.20(R)
04-09-68	48.09	09-14-85	52.75
07-10-68	48.68	11-19-85	51.48
01-15-69	48.27	01-14-86	50.77
04-09-69	48.16	04-08-86	50.27
10-09-69	48.39	10-16-86	52.07
01-06-70	49.13		
04-09-70	48.90		
07-02-70	49.02		
10-14-70	49.20		
01-21-71	49.02		
04-13-71	49.18		
10-18-71	49.32		
04-11-72	48.68		
10-12-72	48.47		
10-02-72	50.28		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/19E-18cc

Owner: ZX Ranch Well Completion Date: 1954

Well Depth: 255 ft. Casing Size: 16 in. Casing Depth 20 ft.

Land Surface Elevation at Well: 4340.8 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 68°F (20°C)

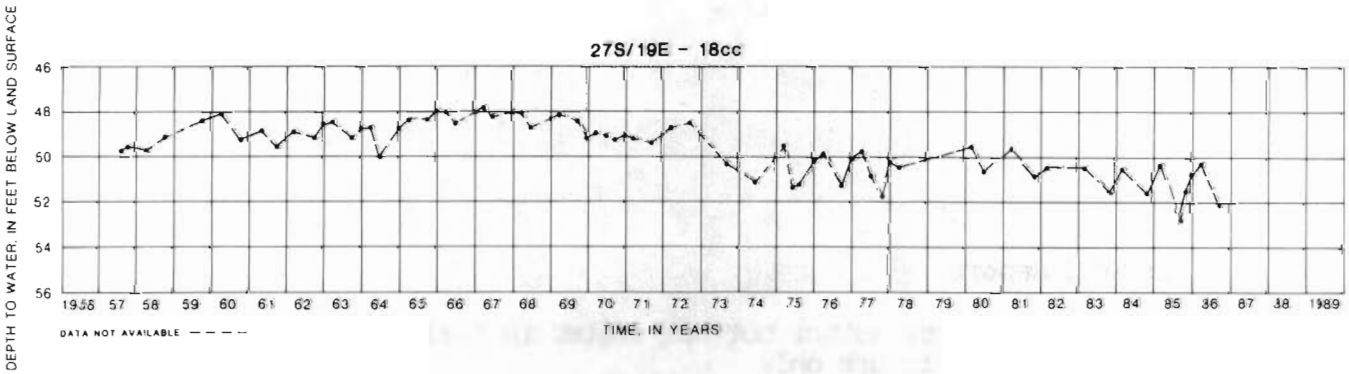
Yield: 900 gpm Drawdown: 2+/- ft. Test duration: --- hrs. Test Date: 1985

Other Well Data: Water Right Files, Water Well Report, Water Chemistry Analysis

Remarks: An oil layer of 4.90 feet was found on the water on 11/19/85. At an assumed specific gravity of 0.87, a water level correction of -0.64 foot would need to be applied to reflect an oil free water level. Measuring point changes prior to 1961 and changes in oil layer thickness since 1961 have probably led to slight water level inconsistencies during the period of record. These errors have probably been only a few tenths of a foot.

Generalized Log:

Soil	0 to 8 feet
Clay	8 to 35 feet
Lava	35 to 255 feet



Record of Wells Location: 27S/20E-9cc(1)

Dates and Water Levels in Feet Below Land Surface Datum

07-20-82	36.30
11-17-82	36.76
03-10-83	36.77
05-18-83	36.98
09-08-83	36.52
11-21-83	36.40
03-14-84	36.64
07-28-85	36.65
10-16-85	36.00
11-19-85	35.55
01-14-86	36.48
04-08-86	36.17
05-01-86	35.93
07-17-86	35.76

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/20E-9cc(1)

Owner: ZX Ranch Well Completion Date:

Well Depth: 95 ft. Casing Size: 6 in. Casing Depth 50 ft.

Land Surface Elevation at Well: 4320.4 ft. Determination: Leveled

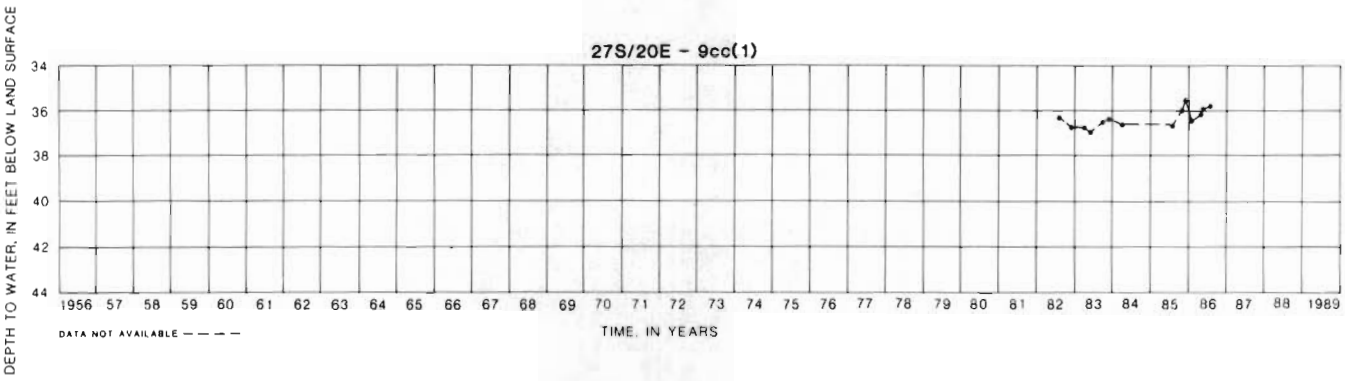
Water Use: None (Stock Formerly) Water Temperature: -----

Yield: --- gpm Drawdown: --- ft. Test duration: --- hrs. Test Date: ----

Other Well Data: Partial Well Report, Partial Water Chemistry Analysis

Remarks: This well is known as the "South Buffalo" well. Water level information at the "North Buffalo" well which is about 150 feet north and is about 210 feet deep indicates an upward vertical gradient in this area. Hardness and chloride increase along this gradient. This well was sounded at 55 feet on 11-21-83.

Generalized Log: This well is reportedly drilled in inter-stratified fine sand, gravel, and clay layers about 6 to 8 inches thick. Gastropod shells are present.



Record of Wells Location: 27S/20E-9cc(2)

Dates and Water Levels in Feet Below Land Surface Datum

10-12-48	32.90
03-05-81	30.40
11-17-82	31.40
03-10-83	31.26
05-18-83	31.36
07-27-83	31.25
09-08-83	31.56
11-21-83	31.60
03-14-84	31.60
05-24-84	36.83(P)
07-17-84	30.90
11-27-84	31.37
03-26-85	31.13
07-28-85	31.42
08-22-85	31.78
10-16-85	31.19
11-19-85	31.41
01-14-86	31.21
05-01-86	30.86
07-17-86	30.98

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/20E-9cc(2)

Owner: ZX Ranch Well Completion Date:

Well Depth: 245 ft. Casing Size: 6 in. Casing Depth 200 ft.

Land Surface Elevation at Well: 4320.6 ft. Determination: Leveled

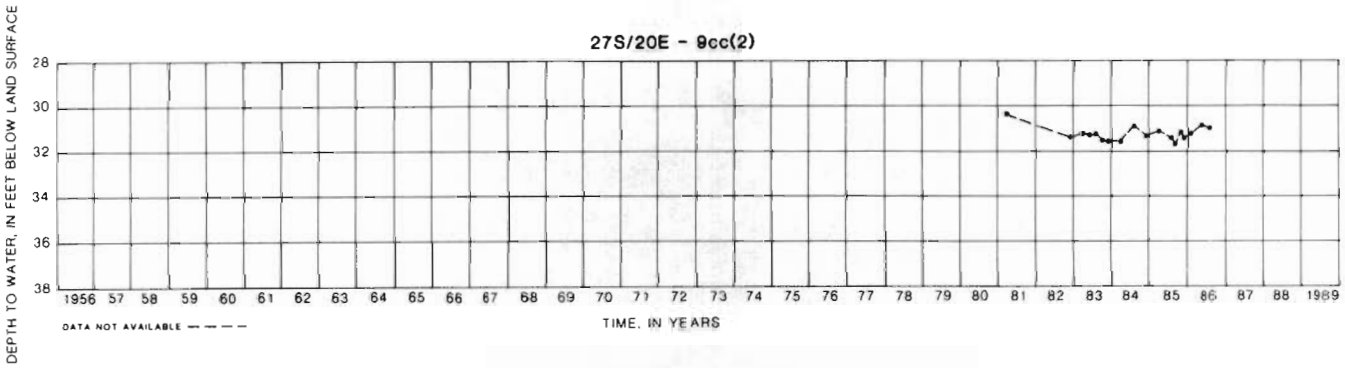
Water Use: Stock Water Temperature: 55°F (13°C)

Yield: 10+/- gpm Drawdown: 6 ft. Test duration: --- hrs. Test Date: 1984

Other Well Data: Water Well Report, Partial Water Chemistry Analysis

Remarks: This well is known as the "North Buffalo" well. Although reported drilled to a total depth of 245 feet, this well was sounded at 210 feet in 1983. Water from the well has a slight rotten egg smell. The water level at the 95-foot deep "South Buffalo" well which is about 150 feet to the south indicates an upward vertical gradient in this area.

Generalized Log: There is no materials log for this well. However, the data for the "South Buffalo" well indicates the presence of interstratified sand and clay to 95 feet.



Record of Wells Location: 27S/22E-21cc

Dates and Water Levels in Feet Below Land Surface Datum

10-09-48	127.95
09-08-83	127.33
03-23-84	127.54
07-26-84	127.02
07-28-85	127.73
09-14-85	127.39
04-08-86	127.25
07-17-86	127.36

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 27S/22E-21cc

Owner: ZX Ranch Well Completion Date: pre-1948

Well Depth: 168 ft. Casing Size: 6 in. Casing Depth 100+/- ft.

Land Surface Elevation at Well: 4418.4 ft. Determination: Leveled

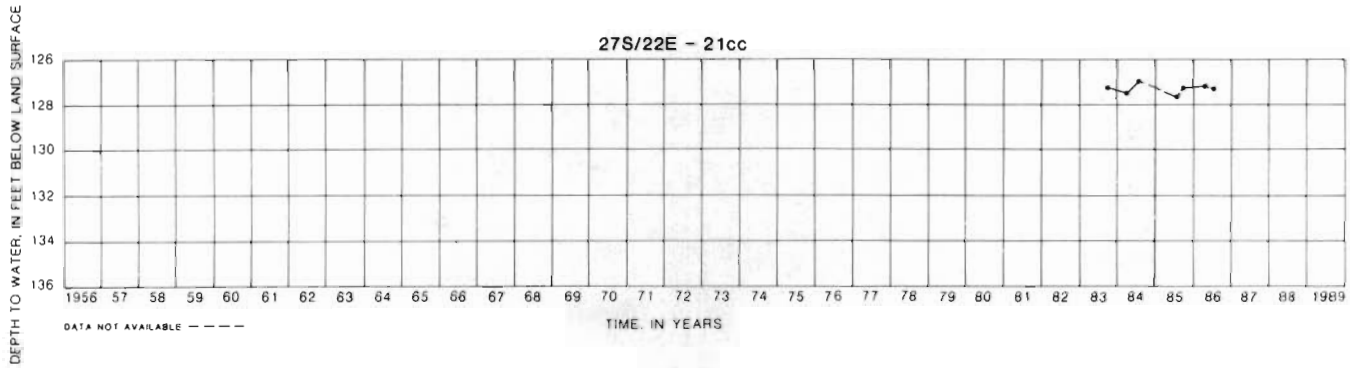
Water Use: Stock Water Temperature: ----

Yield: --- gpm Drawdown: -- ft. Test duration: --- hrs. Test Date: ----

Other Well Data: Water Well Report, Partial Water Chemistry Analysis

Remarks: This well is known as the "East Goodrich" well. The nominal water level change since 1948 suggests that water levels at this well have varied little during the period.

Generalized Log: This well reportedly penetrates and derives water from basalt.



Record of Wells Location: 28S/14S-20ab

Dates and Water Levels in Feet Below Land Surface Datum

03-12-60	44.00(W)	04-26-76	49.36
01-14-65	48.64	08-02-76	46.80
04-08-65	47.84	10-18-76	47.85
07-15-65	44.25	01-24-77	48.39
10-11-65	45.24	04-25-77	55.71
01-17-66	47.30	07-25-77	52.04
04-04-66	48.70	10-17-77	52.66
07-05-66	44.98	01-30-78	51.97
10-04-66	45.59	04-24-78	51.79
01-10-67	48.22	07-24-78	46.50
04-04-67	52.13	07-02-80	48.95
07-11-67	46.65	11-24-80	50.17
10-02-67	46.36	03-03-81	52.45
01-08-68	47.91	11-22-81	50.92
04-08-68	48.80	03-19-82	52.98(R)
07-09-68	45.32	07-21-82	46.43
10-08-68	48.33	11-19-82	48.30
01-14-69	48.75	03-10-83	50.50
04-08-69	47.53	03-22-84	46.60
07-09-69	43.13	07-20-84	44.16
10-08-69	44.90	11-26-84	46.95
01-05-70	45.92	03-25-85	48.74
04-08-70	49.03	07-30-85	46.49
07-13-70	43.88	09-13-85	47.16
10-15-70	45.92	11-21-85	48.47
02-08-71	50.96	01-13-86	49.74
04-26-71	49.07	04-09-86	49.97
07-26-71	44.96	07-16-86	48.08
10-19-71	47.54		
04-11-72	49.10		
11-06-72	46.67		
02-05-73	48.78		
05-07-73	50.96		
07-16-73	47.32		
10-22-73	48.19		
04-22-74	48.65		
07-22-74	43.41		
10-21-74	46.43		
01-27-75	46.98		
04-21-75	51.18		
07-21-75	46.46		
10-13-75	47.14		
01-26-76	48.18		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 28S/14E-20ab

Owner: Lawrence Iverson Well Completion Date: 1960

Well Depth: 155 ft. Casing Size: 14 in. Casing Depth 20 ft.

Land Surface Elevation at Well: 4381.5 ft. Determination: Leveled

Water Use: Stock Water Temperature: 50°F (10°C)

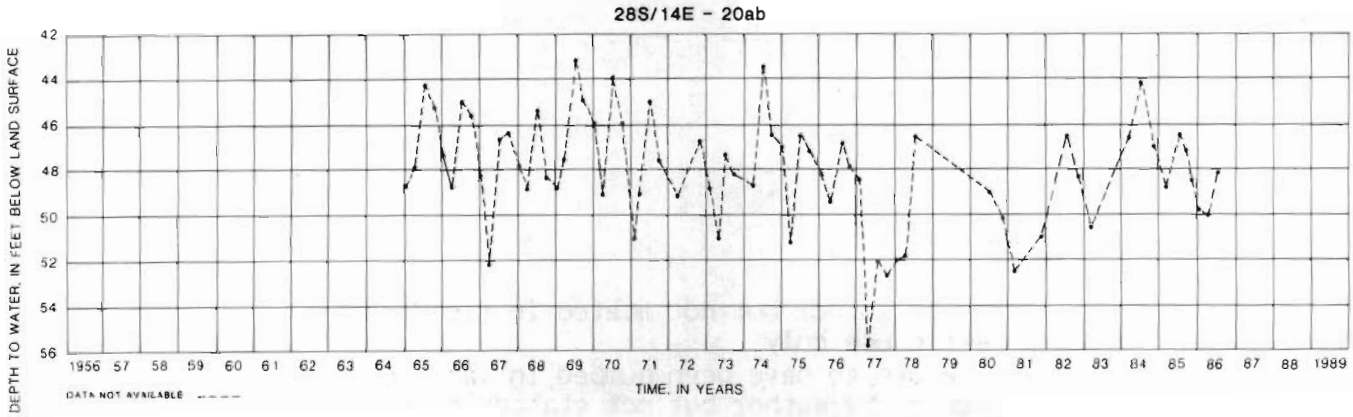
Yield: --- gpm Drawdown: -- ft. Test duration: --- hrs. Test Date: ----

Other Well Data: Water Well Report

Remarks: The water level in this well rests at an elevation about 40 feet higher than that found in the main ground water reservoir. The water level seems to reflect the presence of water in nearby Bridge Creek and the percolation of irrigation water on nearby fields. The water level in this well is considered to reflect an upper ground water reservoir.

Generalized Log:

Soil	0 to 11 feet
Gravel	11 to 55 feet
Diatomite	55 to 75 feet
Clay	75 to 155 feet



Record of Wells Location: 28S/14E-21db

Dates and Water Levels in Feet Below Land Surface Datum

12-14-58	74.50(W)
07-10-63	76.12(R)
10-07-63	76.32(R)
01-07-64	76.79(R?)
04-06-64	76.60
07-07-64	76.62(R)
10-09-64	76.69
01-11-65	76.48
04-08-65	76.02
07-15-65	76.71(R?)
10-11-65	75.50
01-17-66	75.33
04-04-66	76.83(??)
07-05-66	75.35
10-04-66	75.43
01-10-67	75.47
04-04-67	75.27
10-02-67	75.29(R)
01-08-68	75.60
04-08-68	75.72
10-08-68	76.00
01-14-69	76.15
04-08-69	76.12
10-08-69	76.33
01-05-70	76.44
04-08-70	76.22
03-11-83	78.45
11-23-83	78.20
03-22-84	77.95
07-20-84	77.60
03-25-85	77.49
07-30-85	78.40
09-13-85	78.41
01-13-86	77.85
04-09-86	77.20
07-16-86	77.90

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 28S/14E-21db

Owner: U.S. Forest Service Well Completion Date: 12-15-58

Well Depth: 240 ft. Casing Size: 8 in. Casing Depth 240 ft.

Land Surface Elevation at Well: 4376.3 ft. Determination: Leveled

Water Use: Group Domestic Water Temperature: 50°F (10°C)

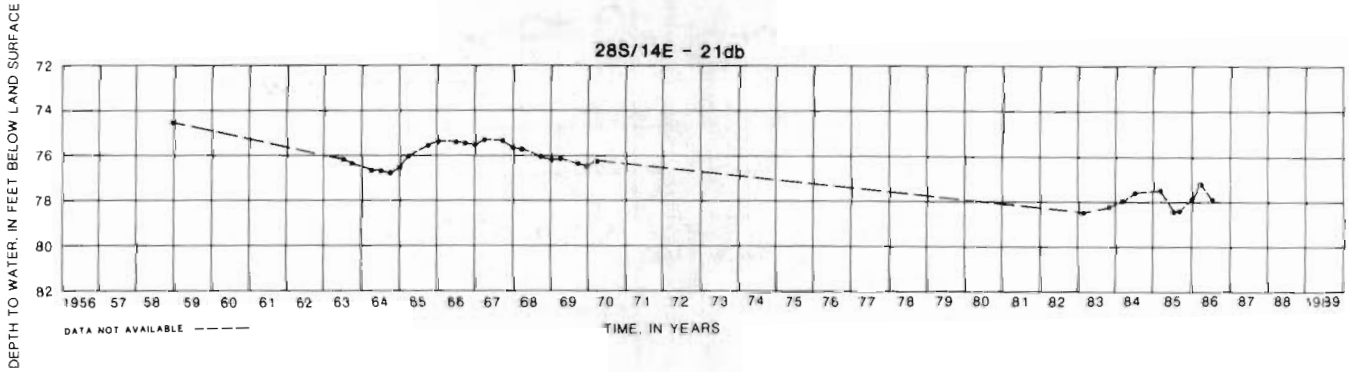
Yield: 154 gpm Drawdown: 10.4 ft. Test duration: 3 hrs. Test Date: 1959

Other Well Data: Water Chemistry Analysis

Remarks: Certain water level measurements were measured after brief pumping and seem to reflect a nearly recovered level. The water well report's water level is reasonable in comparison with water level trends seen at this well and in other basin wells. Measuring point corrections to land surface probably changed since the current measuring point is 4.8 feet below land surface. The water well report's level is believed to be about 1/2 foot too shallow with respect to other measurements.

Generalized Log:

Cemented Gravel	0 to 18 feet	Gravel	145 to 146 feet
Brown Sandstone	18 to 40 feet	Sandstone	146 to 174 feet
Blue Chalk	40 to 73 feet	Sandy Clay	174 to 220 feet
Black Lava	73 to 94 feet	Cinders (water-bearing)	220 to 240 feet
Blue Chalk	94 to 145 feet		

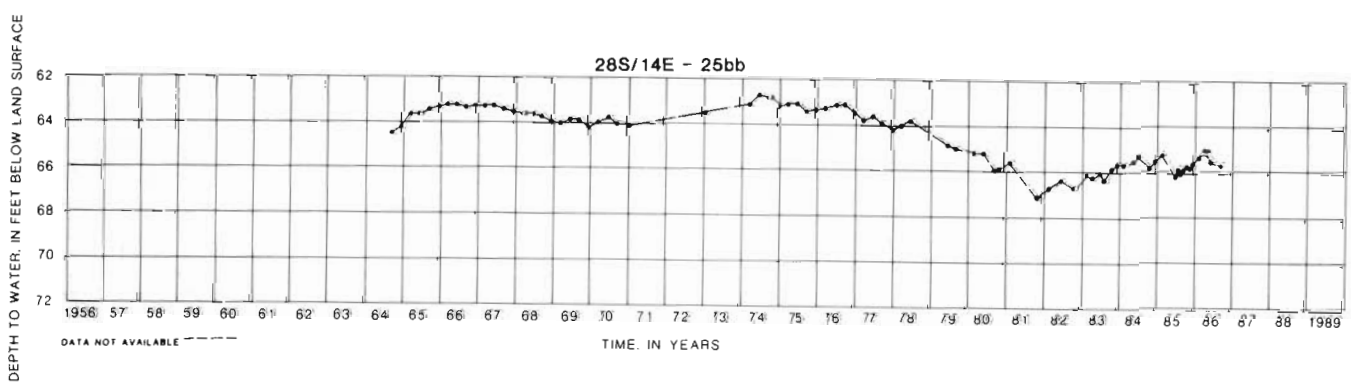


Record of Wells Location: 28S/14E-25bb

Dates and Water Levels in Feet Below Land Surface Datum

10-25-63	72.00(W)	07-09-69	63.70	07-25-77	63.50	03-22-84	65.60
07-18-64	67.00(W)	10-08-69	63.74	10-17-77	63.82	05-24-84	65.47
10-09-64	64.38	01-05-70	64.08	01-30-78	64.07	07-19-84	65.22
01-11-65	64.09	04-08-70	63.87	04-24-78	63.90	11-26-84	65.70
04-05-65	63.52	07-13-70	63.67	07-24-78	63.72	01-17-85	65.40
07-12-65	63.53	10-15-70	63.93	07-30-79	64.75	03-25-85	65.14
10-11-65	63.29	02-08-71	64.00	10-01-79	64.89	07-30-85	66.08
01-17-66	63.19	02-05-73	63.39	03-18-80	65.09	08-23-85	65.75
04-04-66	63.13	10-22-73	65.16(??)	07-02-80	65.12	09-13-85	65.97
07-05-66	63.12	04-22-74	63.01	10-14-80	65.87	10-11-85	65.79
10-01-66	67.00(W)	07-22-74	62.58	11-24-80	65.81	11-21-85	65.65
10-04-66	63.21	10-21-74	62.70	03-03-81	65.48	12-18-85	65.70
01-10-67	63.14	01-27-75	63.09	11-22-81	67.05	01-13-86	65.54
04-04-67	63.14	04-21-75	62.98	03-19-82	66.65	03-11-86	65.25
07-11-67	63.13	07-21-75	62.96	07-21-82	66.33	04-09-86	65.03
10-04-67	63.28	10-13-75	63.29	11-18-82	66.62	05-14-86	65.03
01-08-68	63.36	01-26-76	63.25	03-10-83	66.06	07-16-86	65.47
04-08-68	63.50	04-26-76	63.15	05-18-83	66.20	10-16-86	65.64
07-09-68	63.50	08-02-76	63.00	07-29-83	65.98		
10-08-68	63.60	10-18-76	62.97	09-09-83	66.27		
01-14-69	63.85	01-24-77	63.37	11-23-83	65.80		
04-08-69	63.88	04-25-77	63.66	01-10-84	65.62		

(W) - Water Well Report
(W?) - Author questions Water Well Report measurement
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement



Record of Wells Location: 28S/14E-25bb

Owner: ZX Ranch Well Completion Date: 10-01-66

Well Depth: 560 ft. Casing Size: 16 in. Casing Depth --- ft.

Land Surface Elevation at Well: 4363.4 ft. Determination: Leveled

Water Use: None Water Temperature: 53°F (Reported)

Yield: 1500 gpm Drawdown: 43 ft. Test duration: 8 hrs. Test Date: 1964

Other Well Data: Aquifer Test (this was an observation well), Water Well Reports

Remarks: There are three water well reports on file for this well. They include a new well report (10-25-63) and two deepening reports (07-18-64 and 10-01-66). An additional deepening is suspected between the new well and first deepening reports as a gap of materials logging and casing information exists. This well is located on a ditch bank where the land surface datum has been reckoned to that of the nearby field level. The difference is about 4 feet and may explain the contrast of reported water levels to others.

Generalized Log:

Top Soil	0 to 2 feet	Gray Lava	396 to 398 feet
Sand and Gravel	2 to 30 feet	Gray Claystone	398 to 403 feet
Claystone	30 to 40 feet	Loose Black Lava	403 to 416 feet
Clay and Cemented Gravel	40 to 80 feet	Red Lava	416 to 420 feet
		Black Lava	420 to 433 feet
Black Cinders and Clay	80 to 122 feet	Red Cinders	433 to 435 feet
Claystone	122 to 180 feet	Red Lava	435 to 448 feet
Porous Red Lava	180 to 230 feet	Red Lava and Coarse Sand	448 to 451 feet
Gray Lava	230 to 268 feet		
Porous Red Lava	268 to 270 feet	Red Lava	451 to 469 feet
Lava	270 to 300 feet	Hard, Red Sandy Clay	469 to 473 feet
No Log Available	300 to 352 feet		
Black Lava	352 to 364 feet	Brown Lava	473 to 477 feet
Coarse Black Cinders	364 to 368 feet	Black Lava	477 to 501 feet
Black Lava	368 to 374 feet	Loose Red Lava	501 to 521 feet
Red Lava	374 to 386 feet	Black Lava	521 to 533 feet
Brown Lava	386 to 390 feet	Loose Red Lava	533 to 539 feet
Gray Claystone	390 to 396 feet	Broken Black Lava	539 to 560 feet

Record of Wells Location: 28S/15E-14ad

Dates and Water Levels in Feet Below Land Surface Datum

05-25-56	47.35	04-22-74	47.90
08-29-56	46.90	07-22-74	51.82
10-17-56	46.70	10-21-74	51.37
05-02-57	46.28	01-27-75	48.09
04-26-60	46.04	04-21-75	47.21
10-24-60	47.00	10-13-75	51.21
10-19-61	48.77	01-26-76	48.22
03-21-62	47.12	04-26-76	47.29
10-22-62	51.40	10-18-76	50.80
01-21-63	48.15	01-24-77	49.18
04-29-63	47.30	10-17-77	53.25
07-22-63	56.86	01-30-78	49.96
10-07-63	58.13(R)	04-24-78	48.85
01-07-64	48.11	03-18-80	52.12
04-06-64	47.38	07-02-80	81.67(P)
01-11-65	48.47	10-13-80	66.93(R)
04-05-65	47.03	11-25-80	54.69
10-11-65	51.43	03-03-81	51.75
01-17-66	46.98	11-22-81	56.22
04-04-66	46.37	03-19-82	52.93
07-05-66	52.11	11-18-82	54.69
10-04-66	52.79	03-10-83	51.84
01-10-67	47.21	11-23-83	53.62
04-04-67	46.45	03-22-84	50.64
10-02-67	52.75	07-20-84	56.71
01-08-68	47.85	11-26-84	53.39
04-08-68	46.96	03-25-85	50.48
07-09-68	50.67	07-30-85	60.15
10-08-68	52.54	09-13-85	55.00
01-14-69	48.34	11-21-85	52.36
04-08-69	47.40	04-09-86	50.01
07-09-69	49.67		
10-08-69	48.00		
01-05-70	47.39		
04-08-70	46.99		
07-13-70	50.08		
10-14-70	49.33		
02-08-71	47.65		
04-26-71	47.29		
10-19-71	53.36		
11-06-72	56.54		
02-05-73	48.86		
10-22-73	51.79		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 28S/15E-14ad

Owner: ZX Ranch Well Completion Date: 1955

Well Depth: 520 ft. Casing Size: 16 in. Casing Depth 342 ft.

Land Surface Elevation at Well: 4344.9 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 53°F (11°C)

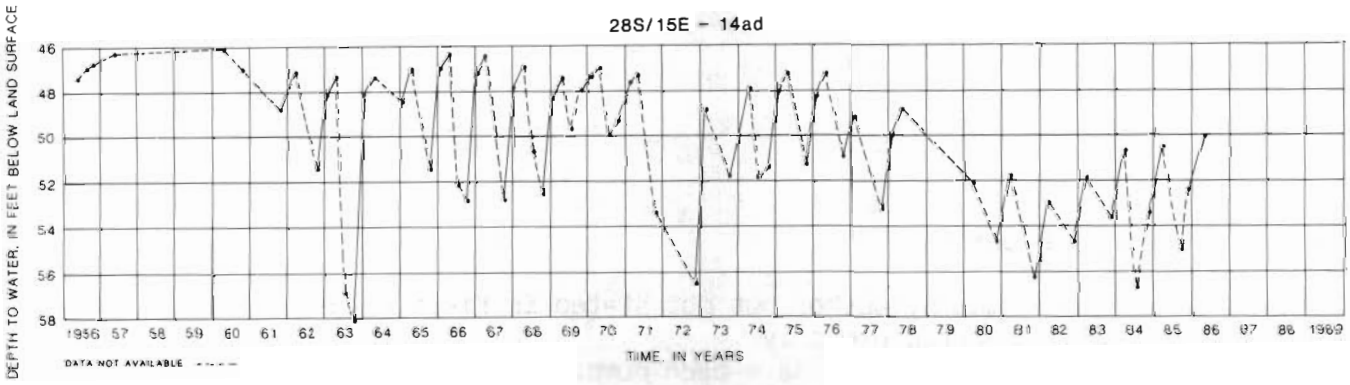
Yield: 1200+/-gpm Drawdown: 30 ft. Test duration: -- hrs. Test Date: 1980

Other Well Data: Water Well Report, Water Right File

Remarks: An oil layer of 4.24 feet was found on the water surface of the well on 11/21/85. At an assumed specific gravity of 0.87, a correction of -0.55 feet on the depth to oil would give an oil-free water level. Oil has been noted on most water level measurement visits to this well. This well experiences more residual drawdown after the irrigation season than most observation wells in the basin. This may be due to local hydrologic conditions and the exceptionally long casing section restricting water level recovery.

Generalized Log:

Soil and Gravel	0 to 7 feet	Broken Lava	452 to 477 feet
Lava	7 to 28 feet	Red Lava	477 to 508 feet
Sand	28 to 245 feet	Cinders	508 to 510 feet
Diatomite	245 to 452 feet	Lava	510 to 520 feet



Record of Wells Location: 29S/16E-16aa

Dates and Water Levels in Feet Below Land Surface Datum

10-13-49	72.41
03-23-84	68.93
11-19-85	69.32
04-09-86	68.37

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 29S/16E-16aa

Owner: George Carlon Well Completion Date: 1949

Well Depth: 680 ft. Casing Size: 6 in. Casing Depth 10 ft.

Land Surface Elevation at Well: 4365.3 ft. Determination: Leveled

Water Use: Irrigation Water Temperature: 57°F (14°C)

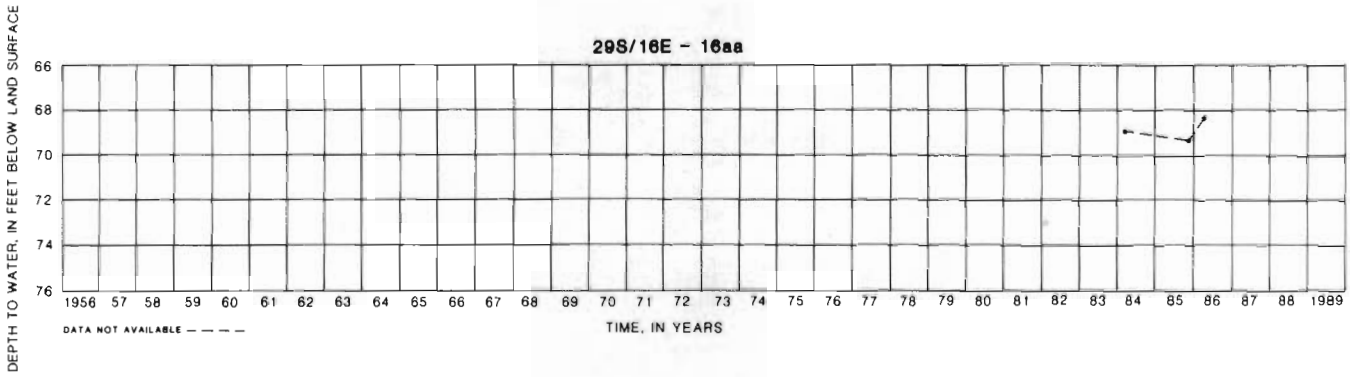
Yield: ---- gpm Drawdown: --- ft. Test duration: -- hrs. Test Date: ----

Other Well Data: Water Well Report, Water Right Files, Water Chemistry Analysis

Remarks:

Generalized Log:

Soil and Sand	0 to 5 feet
Boulders	5 to 10 feet
Lava	10 to 110 feet
Sand	110 to 115 feet
Lava	115 to 680 feet



Record of Wells Location: 29S/16E-17ac

Dates and Water Levels in Feet Below Land Surface Datum

11-25-77	22.80(W)
03-12-83	26.02
11-23-83	26.10
03-22-84	25.44
11-28-84	25.77
03-25-85	25.12
07-30-85	26.46
09-13-85	26.56
11-21-85	25.93
01-15-86	25.58
04-09-86	25.04
10-15-86	26.07

(W) - Water Well Report
(P) - Pumping
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(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 29S/17E-29dd

Owner: George Carlon Well Completion Date: 1940+/-

Well Depth: 106 ft. Casing Size: 6 in. Casing Depth ---- ft.

Land Surface Elevation at Well: 4293.2 ft. Determination: Leveled

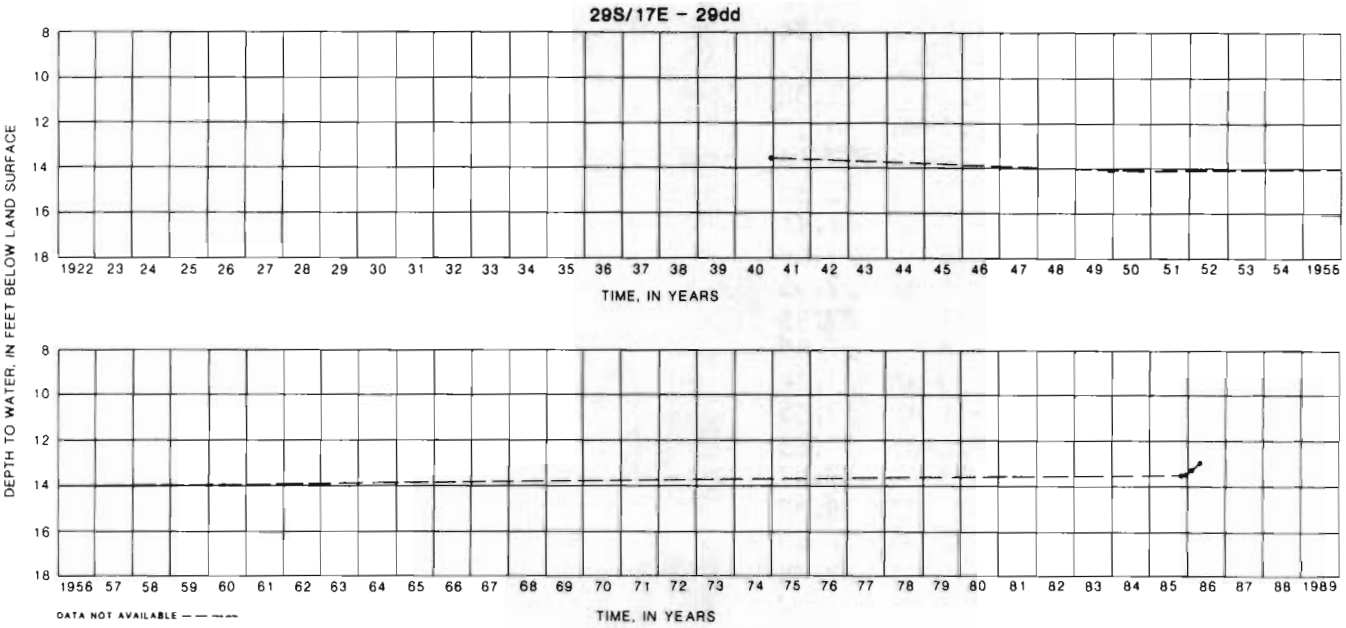
Water Use: Domestic Water Temperature: ----

Yield: 30 gpm Drawdown: --- ft. Test duration: --- hrs. Test Date: ----

Other Well Data:

Remarks: In 1985 this well was sounded to a total depth of 25 feet. U.S. Geological Survey data from 1940 and 1949 indicate little long-term water level fluctuation at this well.

Generalized Log: There is no materials log for this well.



Record of Wells Location: 30S/16E-1bd

Dates and Water Levels in Feet Below Land Surface Datum

10-11-49	38.37	10-21-74	35.86	03-11-86	38.66
10-13-55	37.54	01-27-75	36.94	04-09-86	38.58
04-29-63	36.91	04-21-75	37.16	05-14-86	38.07
07-22-63	35.73	07-21-75	35.73	07-16-86	37.76
10-21-63	35.75	10-13-75	35.99	10-15-86	38.58
04-20-64	36.61	01-26-76	36.74		
07-20-64	35.37	04-26-76	36.51		
10-19-64	35.71	08-02-76	35.71		
01-25-65	37.89	10-18-76	35.89		
04-19-65	38.05	01-24-77	36.22		
07-26-65	35.51	04-25-77	36.23		
10-25-65	35.43	07-25-77	35.84		
01-31-66	35.94	10-17-77	35.97		
04-18-66	36.01	01-30-78	37.63		
07-18-66	35.38	04-24-78	37.69		
10-17-66	35.27	07-24-78	36.29		
01-23-67	36.06	07-30-79	36.80		
04-17-67	37.03	10-01-79	37.36		
07-24-67	35.43	03-18-80	37.82		
10-23-67	35.54	03-03-81	37.80		
01-22-68	36.95	11-22-81	38.41		
04-22-68	37.19	03-16-82	38.40		
07-22-68	35.62	11-18-82	38.33		
10-21-68	35.54	03-09-83	38.35		
04-22-69	36.15	07-29-83	37.14		
07-28-69	35.64	09-07-83	37.00		
10-27-69	35.61	11-23-83	37.32		
01-19-70	35.86	03-22-84	38.12		
04-20-70	37.58	05-24-84	37.08		
07-13-70	35.92	07-19-84	36.50		
10-14-70	35.76	09-18-84	37.11		
02-08-71	36.94	10-18-84	37.08		
07-26-71	35.74	11-26-84	37.55		
10-19-71	35.76	01-17-85	37.95		
04-11-72	36.14	03-25-85	37.85		
07-17-72	35.52	07-30-85	37.56		
11-06-72	35.69	07-31-85	37.65		
02-05-73	36.09	08-20-85	37.63		
05-07-73	36.49	09-13-85	37.97		
07-16-73	35.85	10-18-85	38.38		
10-22-73	36.51	11-19-85	38.83		
04-22-74	36.98	12-18-85	38.68		
07-22-74	35.73	01-13-86	38.82		

(W) - Water Well Report
(P) - Pumping
(P?) - Pumping suspected by author but not stated in field notes
(PD) - Pumping for domestic use only
(R) - Recovering, well known to have been pumped in last 24 hours
(R?) - Recovering, suspected by author but not stated in field notes
(??) - Author questions measurement

Record of Wells Location: 30S/16E-1bd

Owner: Oregon State Game Commission Well Completion Date: 1949

Well Depth: 339 ft. Casing Size: 6 in. Casing Depth 302 ft.

Land Surface Elevation at Well: 4299.9 ft. Determination: Leveled

Water Use: None Water Temperature: 69°F (21°C)

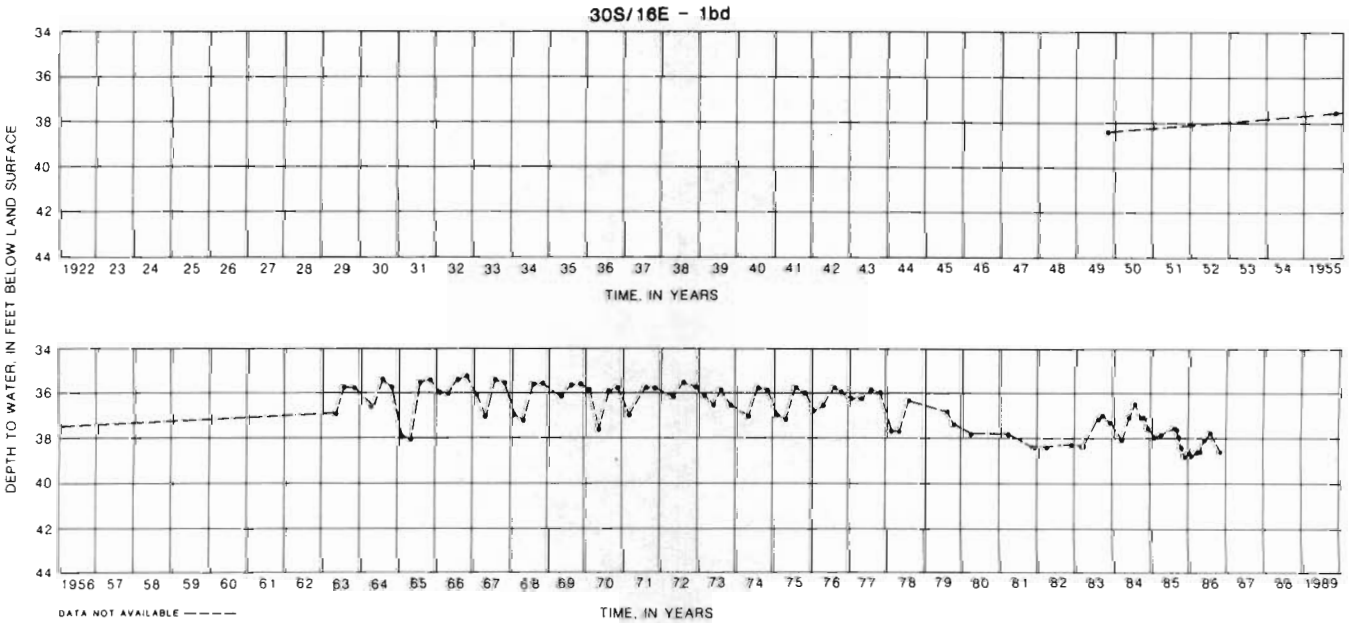
Yield: --- gpm Drawdown: --- ft. Test duration: --- hrs. Test Date: ----

Other Well Data: Water Chemistry Analysis

Remarks: Available data suggests that this well was never in use. The water level responds clearly to changes of stage at nearby Ana Reservoir which draws water from submerged springs. Water levels are highest during the irrigation season when raising of the reservoir level serves to divert water into the Summer Lake Canal. Dozens of flowing wells and springs exist in the Northern Summer Lake Basin near this well.

Generalized Log:

Soil	0 to 5 feet	Red Sand	125 to 200 feet
Boulders	5 to 13 feet	Cinders	200 to 205 feet
Sandstone	13 to 23 feet	Red Sand (water-bearing)	205 to 302 feet
Gravel	23 to 26 feet		
Black Lava	26 to 45 feet	Red Cinders	302 to 305 feet
Sand (water-bearing)	45 to 90 feet	Rock	305 to 335 feet
Black Sand	90 to 125 feet	Red Sand	335 to 339 feet



APPENDIX III

RECORDS OF SUPPLEMENTAL WELLS AND SPRINGS

RECORDS OF SUPPLEMENTAL WELLS AND SPRINGS

Well or spring number: See figure of well-numbering system.
Finish: B, open bottom; L or P, lined or perforated, with interval noted in feet.
Wellhead Altitude: Elevation of land surface at well, in feet above mean sea level.
Recorded Water level: Depth to water below land surface, given in feet and decimal fractions where measured; given in whole feet where reported by well driller or owner; D, dry; F, flowing.
Water level altitude: Elevation of water level in feet above mean sea level.
Type of Pump: C, centrifugal; S, sumbersible; T, turbine; N, none; U, uncertain.

Well performance: Yield in gallons per minute, and drawdown in feet below non-pumping water level as reported by owner, operator, driller, pump company, or state; period indicated under "Remarks."
Water Use: D, domestic; I, irrigation; S, stock; T, test; N, none; U, uncertain.
Remarks: FT, yield from flow test; P or B, pumped or bailed, for the indicated number of hours, when drawdown was measured. Obs, observation well whose water level is measured periodically. All wells drilled; well structures are reported by drillers or state.

				Casing			Water-bearing zone(s)			Water Level				Well Performance			
Well or spring Number	Owner	Year completed	Depth of well	Diameter (in.)	Length (feet)	Finish	Depth/ Thickness (feet)	Character of material	Wellhead Altitude	Recorded	Date Measured	Altitude	Type of pump	Yield	Drawdown	Water Use	Remarks
18S/13E -31a	G. Clawson	1976	925	8	30	L, 0 to 925	820/ 30	Black Sand	3900±20	855	09/15/75	3045±20	U	4	0	D	B,2hrs
20S/15E -14bc	Pine Mountain Cattle Co.	----	907	--	----	-----	----	-----	4780±1	883	00/00/76	3897±1	U	----	--	U	------
20S/16E -30aa	Donna Ramsey	1985	390	8	19	L, 0 to 390	365/ 25	Basalt	4635±5	356	12/12/85	4279±5	U	5	2	D	P,1hr
21S/22E -3bb	Gl Ranch	1959	220	18	20	B	165/ 8	Volcanic Sediments	4157	25.11	05/01/86	4132	T	1100	79	I	P,4hrs,Obs
22S/10E -1da	LaPine H.S.	1983	1458	16 10 8	52 1311 164	P, 1311 to 1443	1318/122	Cinders, Basalt	4230±5	28.03	04/14/86	4202±5	U	950	8	I	P,5hrs,Obs
22S/14E -22ab	U.S. Forest Service	1985	853	8	854	P, 793 to 853	795/135	Lava, sand	5070±5	783	01/15/85	4287±5	U	5	0	D	B,4hrs
22S/21E -16bb	Hampton Butte Grazing Co.	1957	436	8	10	B	----	Sand	4422±5	132.31	05/13/85	4290±5	U	----	--	S	Obs
23S/27E -30ab	Hoyt and Sons Ranch	1952	268	24	268	-----	----	-----	4230±5	70.46	04/29/84	4160±5	T	----	--	I	Obs
24S/11E -35da	Gilchrist Timber Co.	1941	745	8	----	-----	460/ 20	Lava, Sand	4740±5	450	06/25/41	4290±5	T	----	--	U	------
24S/21E -10dc	U.S BLM	1965	435	--	----	-----	----	-----	4572±2	280	12/00/65	4292±2	U	20	0	S	P,4hrs
25S/8E -1bb	U.S. Forest Service	1965	285	12 8	138 285	P, 165 to 175	260/ 25	Gravel	4470±5	257.57	04/16/86	4212±5	U	55	1	N	P,8hrs,Obs

Well or spring Number	Owner	Year completed	Depth of well	Casing: Diameter (in.)	Casing: Length (feet)	Casing: Finish	Water-bearing zone(s): Depth/ Thickness (feet)	Water-bearing zone(s): Character of material	Well-head Altitude	Water Level: Recorded	Water Level: Date Measured	Water Level: Altitude	Type of pump	Well Performance: Yield	Well Performance: Draw-down	Water Use	Remarks
26S/16E -27ac	K. Johnson	1983	1002	14	110	B	170/174 997/ 2	Blk. Sand Lava	4317±2	23	07/08/83	4294±2	T	2000	--	I	P,1hr
26S/20E -6bc	U.S. BLM	1966	160	6	20	B	140/ 8	Black Sand	4290±2	-3.5	09/00/66	4294±2	U	100	--	U	FT
28S/8E -17db	Georgia Pacific	1959	361	--	----	P, 300 to 360	327/ 34	Lava	4665±5	121.44	04/16/86	4544±5	U	225	0	N	P,24hrs,Obs
28S/12E -33ab	U.S. Forest Service	1981	570	8	79	B	----	-----	4892±5	D	04/15/81	<4322±5	U	----	--	U	------
28S/16E -16c	Z. Church	1977	410	14	30	B	----	Pumice	4311±2	17	04/07/77	4294±2	T	2000	46	I	P,4hrs
29S/17E -23bc	E. Shuffield	1950±	150	6	150	-----	----	-----	4295±5	6	00/00/82	4290±5	C	----	--	I	------
29S/21E -24cd	U.S. BLM	1963	177	8	21	B	115/ 50	Lava	4373.6	83.51	07/17/86	4290.09	S	20	--	S	P
29S/23E -3da	U.S. BLM	1945±	177	8	----	-----	----	Sediments	4310±2	18.37	04/15/86	4292±2	U	----	--	N	Obs
30S/18E -5dc	R. Emery	1939±	386	6	----	-----	----	-----	4286±2	F	00/00/83	>4286±2	U	---	--	U	------
30S/20E -26ao	ZX Ranch	1939±	643	10	----	-----	----	-----	4950±20	D	10/00/39	<4307±20	U	---	--	U	------
30S/23E -18dc	State of Oregon	1952	200	8	114	B	195/ 65	Basalt	4272	F	05/22/81	>4272	N	---	--	--	------
31S/7E -1ao	Yamsey Land and Cattle	1962	452	18	372	P, 48 to 372	0/321	Pumice	4545	2.84	04/16/86	4542	T	3400	15	I	P,3hrs,Obs
31S/11E -32bb	Deep Creek Ranch	1950	240	6	----	-----	----	-----	4600	87.2	04/22/70	4513	S	----	--	D	------
31S/15E -32ab	Weyerhauser	1948	1040	8	80	B	766/ 87 1025/ 15	Basalt Basalt	5750±20	741	00/00/48	5009±20	U	----	--	D	------
31S/23E -21cc	U.S. BLM	1966	365	6	64	-----	----	Lava	4480	184.62	04/15/86	4295	S	20	25	S	P,4hrs,Obs
32S/21E -26bb	XL Ranch	----	----	--	----	-----	----	-----	4280±5	0.0	06/09/62	4280±5	U	700	--	I	Spring
33S/18E -13aa	Alan Withers	1960	230	18	102	P, 30 to 102	90/ 81	Sand, Gravel	4390±5	69.38	04/14/86	4321±5	T	1600	34	I	P,8hrs,Obs

APPENDIX IV

PRECIPITATION AT FREMONT

PRECIPITATION AT FREMONT STATION
(43°20'N/121°10'W, prior to 3/25/58 at 43°19'N/121°09'W)
[Inactive since 11/01/85]

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Total Calendar Year	Total Water Year
1986	0.78a	3.55b	1.18b	0.17a	1.09a	1.09a	0.17a	0.01a	0.92a					11.66
1985	0.01	0.47	0.66a	0.34	0.56a	0.60	0.56b	0.18b	1.64b	0.63b	1.25b	0.82b	7.72	9.20
1984	0.11	0.84	1.71	1.08	0.29	0.65	0.13	1.89	0.18	1.14	2.63a	0.41	11.06	14.06
1983	2.16	2.25	4.26	0.72	0.52	0.41	0.23	1.82a	T	0.84	2.34	4.00	19.57	16.73
1982	0.83	4.18c	1.70	0.85	0.35	2.86	0.99	0.15	0.45	0.47	1.47	2.40a	16.70	21.57
1981	1.22	1.19	0.68	0.62	1.31	0.88	0.00	0.41	0.49	0.31	3.51	5.39	16.01	10.28
1980	3.20	0.90	0.59	0.59	0.60	2.33	0.42	0.00	1.07	0.53	0.48	2.47	13.18	13.53
1979	2.16	1.27	1.64	0.63	0.90	T	0.00	2.00	0.07	1.78	1.57	0.48	12.50	9.81
1978	2.28	1.34	0.97	0.90	0.57	0.86	0.10	0.70	0.50	T	0.64	0.50	9.36	14.74
1977	0.23	0.56	0.68	T	2.33	1.49	0.25	0.59	1.07	0.57	2.79	3.16	13.72	7.64
1976	1.03	2.17	0.66	0.22	0.12	0.46	0.12	2.75	0.22	0.37	T	0.07	8.19	11.64
1975	2.38	1.90	2.10	0.96	T	0.66	1.66	0.68	0.08	1.55	0.79	1.55	14.31	12.77
1974	3.02	0.79	1.94	0.37	0.70	1.25	0.84	0.65	0.00	0.36	0.65	1.34	11.91	15.94
1973	1.11	0.81	0.42	0.33	0.41	0.00	0.11	0.10	0.50	1.28	4.38	0.72	10.17	7.20
1972	1.99	1.01	2.25	0.77	0.65	0.21	0.19	0.15	0.19	1.74	0.67	1.00	10.82	11.61
1971	3.27	0.38	1.89	0.34	0.68	1.11	0.47	0.10	0.32	0.37	1.53	2.30	12.76	14.84
1970	3.78	0.54	1.27	0.23	0.37	0.58	T	0.00	0.20	0.77	4.00	1.51c	13.25	10.60
1969	2.55	0.19	0.32	0.29	0.73	3.03	0.06	0.00	0.36	0.88	0.67	2.08	11.16	11.49
1968	1.21	0.93	0.32	0.10	0.94	0.54	0.00	1.7	0.10	0.69	1.93	1.34	9.17	8.19
1967	2.06	0.18	0.85	1.15	0.35	1.49	0.00	T	T	1.59	0.73	0.66	9.06	9.41
1966	2.61	0.34	0.64	0.03	T	0.68	0.53	0.46	0.26	0.30	1.81	1.22	8.88	8.75
1965	2.02	T	T	0.93	0.74	0.76	1.18	2.32	T	0.38	1.52	1.30	11.15	19.92
1964	2.00	0.04	1.08	0.13	0.10	1.35	0.86	0.25	0.09	0.13	1.70	10.14	17.87	8.53
1963	0.83	2.18	0.83	1.02	1.47	0.77	0.79	0.38	0.69	0.63	1.42	0.58	11.59	15.13
1962	0.75	1.04	0.52	0.35	1.18	T	0.43	0.29	0.65	3.59	1.41	1.17	11.38	8.20
1961	0.20	1.24	1.19	0.02	1.99	1.04	0.02	0.10	0.28	0.26	1.21	1.52	9.07	9.77
1960	0.94	1.27	1.33	0.84	0.63	0.05	0.36	0.04	0.98	0.20	3.19	0.30	10.13	7.58
1959	1.21	1.22	0.40	0.41	0.44	0.04	T	1.61	0.35	0.49	0.27	0.38	6.82	7.46
1958	2.80	1.74	0.73	0.48	1.13	1.84	0.16	0.08	0.16	0.00	1.08	0.70	10.90	12.47
1957	1.25	1.07	2.00	0.77	1.33	0.46b	0.12	0.12	1.62b	0.92b	0.82b	1.61b	12.09	15.06
1956	3.86	0.92	0.16	1.35	3.62	0.87	1.73	T	0.55	2.04	0.03	4.25	19.38	21.94
1955	0.35	0.21	0.33	0.77	0.23	0.04	0.04	0.00	0.53	0.33	2.04	6.51	11.38	3.53

T = Trace
Data substituted from another precipitation station when missing at Fremont.
a = Silver Lake Ranger Station (43° 07'N/121° 04'W, Active)
b = The Poplars (43° 16'N/120° 56'W, Active)
c = Summer Lake (42° 57'N/120° 47'W, Active)
d = Lake (T27S/R18E-7, Inactive)
e = Silver Lake (T28S/R14E-22, Inactive)
4684B

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Total Calendar Year	Total Water Year
1954	2.33	0.33	0.73	0.52	0.66	1.06	0.00	0.15	0.42	0.15	0.23	0.65	7.23	10.03
1953	3.16	1.36	0.92	0.40	2.01	0.92	0.00	0.80	0.17	0.35	2.25	1.23	13.57	12.87
1952	1.63	1.89	0.46	0.37	0.92	2.00	0.04	0.00b	0.37	0.04	0.25	2.84	10.81	15.05
1951	1.65b	1.20b	0.42b	0.21	1.21	0.05	0.47	0.20	0.08	1.34	1.23	4.80	12.86	12.55
1950	1.68	0.52	1.33	0.09	0.29	2.87	0.05	T	T	3.52	1.36	2.18	13.89	8.48
1949	0.23	1.41	0.89b	0.10	1.97b	0.05b	0.02	0.00	0.13	0.07	0.88	0.70	6.45	8.18
1948	1.77	1.27	0.78	0.63	1.38	1.67	0.86b	0.15	0.53	0.43	1.63	1.32	12.42	10.81
1947	0.97	0.50	0.63	0.22	1.15	1.09	0.25	0.40	0.27	1.15	0.15	0.47	7.25	7.99
1946	1.72	0.17	0.91	0.08	1.68	0.50	0.42	0.46	0.73	0.74	1.58	0.19	9.18	12.26
1945	0.43	1.10	0.23	0.40	4.04	0.30	0.15	0.29	0.05	0.70	1.98	2.91	12.58	10.30
1944	0.25	0.65	0.15d	0.28	0.48	3.23	2.31	T	0.29	1.02	1.38	0.91d	10.95	10.59
1943	2.70	0.82	0.17	1.00	0.28	0.74	0.42	0.08	T	2.07	0.70	0.16	9.16	12.35
1942	1.37	1.27	0.07	0.45	2.15	0.72	T	T	0.16	T	3.85	2.29	12.33	11.45
1941	1.57	0.94	0.20	0.44	0.48	1.22	1.10	2.03	0.48	1.50	1.82	1.94	13.72	10.84
1940	1.68	2.49	2.01	0.78	0.65	0.56	0.55	T	1.93	0.54	0.41	1.43	13.03	14.04
1939	0.64	0.85	0.50	0.12	0.48	0.05	0.40	T	0.46	0.44	T	2.95	6.89	5.41
1938	1.89	2.51	2.12	0.36	0.06	0.10	0.44	T	0.62	0.57	0.82	0.52	10.01	12.60
1937	0.41	0.56	1.07	1.34	0.09	2.31	0.74	0.00	0.42	0.85	1.46	2.19	11.44	7.25
1936	1.44d	0.70d	0.54d	0.94d	1.22d	1.01d	0.45d	0.77d	0.76d	0.00d	0.03d	0.28d	8.14	10.17
1935	0.62	0.35	0.50	1.41	0.67	0.34	0.34	0.09	0.10	1.08	0.24	1.02	6.76	7.66
1934	1.09	0.44	0.58	0.83	0.41	0.98	0.00	0.50	0.14	1.11	0.86	1.27	8.21	6.71
1933	0.78	0.42	0.88	0.32	0.35	1.26	0.34	0.12	0.39	0.55	0.08	1.11	6.60	6.32
1932	0.94	0.28	0.47	1.83	1.43	0.38	0.03	T	0.00	0.07	0.99	0.40	6.82	8.03
1931	0.16	0.09	0.98	0.26	1.18	1.14	T	T	0.50	0.99	0.43	1.25	6.98	5.16
1930	2.90	0.53	0.65	0.70	0.39	0.17	T	0.58	1.46	0.47	0.27	0.05	8.17	11.05
1929	0.39	0.27	0.34	1.02	0.03	0.90	T	T	0.01	0.56	0.02	3.09	6.63	4.52
1928	1.37	0.57	1.65	0.66	0.21	1.72	0.47	0.10	0.14	0.23	0.49	0.84	8.45	9.14
1927	0.88	2.09	1.71	1.04	0.50	0.61	0.20	0.54	0.83	0.71	0.68	0.86	10.65	14.27
1926	0.53	1.10	0.05	0.78	0.27	0.07	0.38	0.08	0.04	0.77	3.59	1.51	9.17	5.13
1925	0.63	0.91	0.34	1.77	2.58	1.00	0.49	0.13	0.92	0.59	0.64	0.60	10.60	13.69
1924	0.12e	0.45	0.27	0.09	0.08	0.27	0.16	0.38	0.64	1.70	1.70	1.52	7.38	4.94
1923	1.34	0.85	0.11	1.18	1.08	0.92	1.08	0.27	0.55	0.77	0.08	1.63	9.86	11.88
1922	0.51	2.41	0.63	0.42	0.95	1.29	0.07	0.78	0.02	1.23	1.56	1.71	11.58	10.67
1921	1.30	1.77	0.76	0.33	2.12	0.44	0.13	0.00	0.60	0.20	1.55	1.84	11.04	9.82
1920	0.13	0.50	1.18	0.95	T	0.56	0.75	0.41	0.33	0.52	0.96	0.89	7.18	7.80
1919	0.46	1.47	0.18	0.49	T	0.91	0.10	T	0.63	0.35	0.49	2.15	7.23	6.57
1918	0.76	1.04e	0.47	0.09	0.16	0.02	0.31	0.72	1.92	1.28	0.77	0.28	7.82	6.64

T = Trace
Data substituted from another precipitation station when missing at Fremont.
a = Silver Lake Ranger Station (43° 07'N/121° 04'W, Active)
b = The Poplars (43° 16'N/120° 56'W, Active)
c = Summer Lake (42° 57'N/120° 47'W, Active)
d = Lake (T27S/R18E-7, Inactive)
e = Silver Lake (T28S/R14E-22, Inactive)
4684B

APPENDIX V

STREAMFLOW AND RESERVOIR RECORDS

Water Year Discharge at Silver Creek (28S/14E-28),
Change of Storage at Thompson Valley Reservoir (30S/14E-17),
and Discharge from Ana River (30S/17E-6).

Year	Silver Cr (AF)	T.V. Res (AF)	Ana River (AF)
1985	26,490	-960	63,660
1984	50,300	-1,990	63,070
1983	51,090	1,940	63,960
1982	46,910	9,900	63,020
1981	10,550	-1,670	62,050
1980	18,600	1,790	62,790
1979	17,590	-6,660	64,670
1978	27,330	6,960	65,040
1977	12,060	-9,520	62,160
1976	17,330	-1,390	61,980
1975	31,740	-500	63,390
1974	52,630	6,950	63,680
1973	16,310	-4,850	62,320
1972	41,400	-2,410	68,740
1971	44,890	3,210	69,730
1970	24,000	740	66,970
1969	22,860	3,430	67,070
1968	14,830	-6,530	66,730
1967	31,230	1,710	67,600
1966	18,130	-4,010	70,640
1965	41,360	-	72,920
1964	11,340	-	67,770
1963	26,320	-	68,090
1962	13,040	-	66,410
1961	11,270	-	64,880
1960	10,730	-	67,550
1959	12,670	-	68,030
1958	51,810	-	69,220
1957	30,290	-	64,350
1956	62,750	-	65,660
1955	12,510	-	63,060
1954	44,160	-	63,570
1953	33,210	-	62,990
1952	39,530	-	-
1951	39,480	-	-
1950	14,090	-	-
1949	13,590	-	-
1948	11,260	-	-
1947	8,610	-	-
1946	15,640	-	-
1945	9,020	-	-
1944	8,580	-	-

Year	Silver Cr (AF)	T.V. Res (AF)	Ana River (AF)
1943	37,160M	-	-
1942	23,400E	-	-
1941	11,120	-	-
1940	12,410	-	-
1939	9,270	-	-
1938	23,360	5,580	73,000E
1937	9,400	-	70,000E
1936	10,320	-	67,000E
1935	10,170	-	64,000E
1934	2,647	-	66,000E
1933	8,960	-	67,000E
1932	11,300	-	66,000E
1931	1,700	-	64,000E
1930	5,500	-	70,000E
1929	9,300E	-	73,000E
1928	19,900E	-4,310	77,000E
1927	22,770	-	66,000E
1926	4,350	-	79,000E
1925	15,100	-	91,000E
1924	2,110	-	90,000E
1923	12,990	-	79,000E
1922	13,900	-	-
1921	34,200	-	92,000E
1920	7,340	0	83,000E
1919	17,800	0	87,000E
1918	9,540	0	90,000E
1917	22,400	0	96,000E
1916	35,700	0	-
1915	11,600	0	96,000E
1914	37,700	0	97,000E
1913	31,800	0	-
1912	32,000	0	102,000E
1911	44,800	0	-
1910	51,700	0	102,000E
1909	-	0	103,000E
1908	-	0	-
1907	-	0	-
1906	40,100	0	102,000E

E=Estimated from a single or a few gaging measurements
M=Some Record Missing
-=No Record

Note: Thompson Valley Reservoir was created by completion of a dam in 1922. Flow of the Ana River was reduced temporarily by submergence of Ana River Springs in 1922-23 and continuously by submergence from a permanent dam since 1926.

APPENDIX VI

WATER LEVEL CHANGES AT SELECTED WELLS

Calender Year Water Level Changes (Ft) at Selected Wells

Year	25S/14E 15bc	25S/19E 31bc	26S/18E 26ab	27S/15E 4ac	27S/16E 13ab	27S/17E 27dd	27S/18E 21aa	28S/14E 25bb
1985	0.0	-0.3	+0.1	0.0	-0.2	E -0.2	0.0	-0.2
1984	+0.4	0.0	+0.1	+0.3	0.0	E +0.4	0.0	+0.2
1983	+0.4	+0.2	E +0.5	+0.4	-	+0.5	+0.1	+0.7
1982	+0.2	+0.2	E +0.2	+0.3	-	+0.7	E 0.0	E +0.4
1981	-0.9	-0.8	E -1.0	-1.1	-	-1.1	E -1.0	-1.2
1980	E -0.6	E -0.4	E -1.0	E -0.6	-	-0.8	E -0.4	E -0.4
1979	E -0.5	E -0.4	E 0.0	E -0.5	-	-0.4	E -0.4	E -0.8
1978	E -0.5	E -0.3	E +0.1	E -0.5	E -0.4	-0.2	E -0.1	E -0.4
1977	-0.5	-0.2	-0.1	-0.6	E -0.7	-	-0.4	-0.6
1976	0.0	0.0	0.0	-0.5	0.0	-	-0.0	-0.1
1975	E 0.0	0.0	E -0.1	+0.1	E -0.1	-	E -0.1	-0.2
1974	E +0.5	E -0.3	E -0.3	+0.6	E +0.1	-	E -0.0	E +0.2
1973	+0.1	E +0.2	E -0.2	-0.2	E 0.0	-	E -0.1	E +0.1
1972	+0.2	E 0.0	+0.2	+0.3	E +0.1	-	E +0.1	E +0.3
1971	+0.4	E +0.1	-0.1	+0.3	+0.4	E +0.1	E 0.0	E +0.3
1970	-0.3	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	0.0
1969	-0.3	-0.2	0.0	-0.2	-0.2	-0.2	-0.1	-0.2
1968	-0.5	-0.2	-0.1	-0.4	-0.4	-0.4	-0.2	-0.4
1967	-0.2	-0.1	-0.2	-0.1	0.0	-0.2	0.0	-0.2
1966	0.0	-0.3	+0.1	+0.1	+0.1	0.0	0.0	0.0
1965	+0.9	+0.9	+0.5	+0.8	+1.1	+0.9	+0.5	+1.1
1964	-0.1	-0.1	+0.1	-0.1	-0.3	0.0	+0.1	
1963	0.0			0.0	-0.1	-0.1	-0.1	
1962	-0.3			-0.1	-0.3	-0.3	-0.1	
1961	E -0.3			-0.3	E -0.2	+0.1	-0.1	
1960	E 0.0			-0.2		+0.1	-0.2	
1959	E -0.3			-0.1		-0.1	+0.2	
1958	E +0.3			+0.5		+0.5	+0.6	
1957	E +0.8			+0.5			+0.2	
1956	E +0.6			+1.1			+0.7	
1955	E +0.5			+0.2				
1954	+0.9			+0.7				
1953	+0.6			+1.8				
1952	+1.2			+0.6				
1951	+0.5			+0.8				
1950	+0.3			+0.3				
1949	0.0			0.0				
1948	0.0			-				
1947	0.0			-				
1946	-0.1			-				
1945	E -0.1			E 0.0				
1944	E -0.2			E 0.0				

Year	25S/14E 15bc	25S/19E 31bc	26S/18E 26ab	27S/15E 4ac	27S/16E 13ab	27S/17E 27dd	27S/18E 21aa	28S/14E 25bb
1943	E 0.0			E -0.1				
1942	-0.2			0.0				
1941	-0.3			-0.3				
1940	-0.2			-0.2				
1939	-0.3			-0.3				
1938	E -0.2			-				
1937				-				
1936				E -0.2				

E=Estimated
M=Some Record Missing

APPENDIX VII

GROUND WATER RIGHTS

GROUND WATER RIGHTS - FORT ROCK BASIN, JULY 1986

(Symbols: C, combined diversion or acreage under this permit; D, domestic; F, fish culture; FR, fish and recreation; G, group domestic; L, lake maintenance; Q, quasi-municipal; S, supplemental irrigation; T, transfer number. Use is primary irrigated acres unless otherwise noted.)

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Morehouse Ranch	00 00 22	GR1500		GR1450	26 15 17dd	3.23	190.0	
Parks, Merritt Y. & R. Helen	05 00 28	GR347		GR333	27 15 4ac	3.45	168.0	
Eskelin, Edwin A.	01 05 50	U-345	U-317	31236	27 15 2cd	1.05	84.0	
Pitcher, Leonard	01 20 50	U-347	U-322	22859	27 15 3ad	0.99	78.0	
Miles, Jess	07 19 50	U-354	U-341	46197	27 15 13bb	0.96	77.0	
Pitcher, Owen	03 29 51	U-426	U-394	27305	27 15 2ac	1.00	80.0	
Bowen, Darrel E.	10 11 51	U-439	U-410	41932	27 15 24cc	0.30	30.2	
Branch, Floyd & Venita	03 03 52	U-467	U-448	36073	26 14 3	0.95	75.9	
Wahl, Viola and H.L.	03 04 52	U-469	U-487	51862	27 17 27ca	1.93	154.4	
Golden Rule Farms	03 04 52	U-469	U-487		27 17 27ca	0.73	58.8	T-5239
Buick, K.O., Anna L., Malcolm K.	05 01 52	U-494	U-445	46781	27 15 11db	0.72	57.2	
Schaub, Richard	07 01 52	U-508	U-512	44006	26 15 32bc	0.45	35.5	
Wahl, Viola & H.L.	07 01 52	U-509	U-513	28682	26 15 29bc	0.50	40.0	
Miles, Charles C.	07 03 52	U-510	U-461	27427	27 15 2bc	0.64	51.0	
Baert, Bud	08 18 52	U-517	U-472	27978	26 14 12ab	0.74	58.8	T-3510
Albertson, Albert E.	01 11 54	U-656	U-597	27013	28 16 19ba	1.61	128.8	
Hovius, Ruth E.	07 28 54	U-735	U-648	37388	27 16 34ca	0.40	41.4	
Albertson, A.E.	08 23 54	U-742	U-664	27018	27 16 13	2.65	211.6	
Turner, Ed & Verna	08 23 54	U-743	U-665	28570	26 15 5ba	1.83	146.9	
Irwin, Echo & Glenn	08 23 54	U-743	U-665	28571	26 15 6ab	1.89	151.0	
Koehler, Herman Paul	11 29 54	U-765	U-706	31068	27 15 25bc	1.29	103.1	
Albertson, Albert E.	12 07 54	G-50	G-410	26991	28 15 13cd	1.96	156.9	
Albertson, Albert E.	12 07 54	G-51	G-411	46198	28 15 14ad	1.59	127.2	
Alder Creek Ranch	12 07 54	G-51	G-411	50504	28 15 14ad	0.85	68.0	T-3963
Parks, Merritt	12 29 54	U-773	U-690	33067	26 15	2.01	160.8	
Poplars Ranch	12 29 54	U-773	U-690	33067	26 15 34cc	2.01	160.8	T-5293
Miles, Charles C.	01 17 55	U-780	U-695	27430	27 15 2bc	0.38	30.0	
Pitcher, Leonard	02 01 55	U-784	U-710	27536	27 15 3ba	0.98	78.6	
Morehouse, Sam K.	03 15 55	G-61	G-155	27315	26 18 30ad	0.31	25.0	
Long, R.A.	03 15 55	U-797	U-713	27537	25 14 29da	1.20	152.9	
Robinson, Clifford L. & Irvin C.	03 13 56	G-267	G-172	27101	27 16 32aa	2.50	215.8	
Miles, Charles	04 10 56	G-292	G-385	31369	27 15 2	0.32	17.0	
Miles, Charles	04 10 56	G-292	G-385	31369	27 15 2	-	8.9	S
Kittredge, Jack L.	05 10 56	G-360	G-245	33178	26 14 24cd	0.55	43.9	T-3640
Wahl, Hugh	09 07 56	G-465	G-370	27318	26 15 20dc	2.46	196.8	
Wahl, Hugh	09 07 56	G-466	G-371	30882	27 18 6	3.93	314.6	
West Sacramento Enterprises, Inc.	08 14 57	G-727	G-696	34171	27 19 29bd	0.85	68.2	
Alder Creek Ranch	08 14 57	G-728	G-697	50917	27 19	5.52	441.2	
Hughes, Eugene	10 01 57	G-777	G-676	34170	27 19 32	2.94	235.0	
West Sacramento Enterprises, Inc.	10 01 57	G-776	G-662	34169	27 19 32ba	0.85	68.0	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Morehouse, Robert	03 04 58	G-881	G-826	33068	27 18 6bd	0.44	34.9	
Schaub, Richard	10 27 58	G-1292	G-1136	27329	26 15 32cb	0.35	28.0	
Heilmeyer-Owsley, Thelma C.	11 06 58	G-1022	G-1072	35750	27 15 14ab	0.66	53.1	
Gillette, Jack L. & E. Kathrine	12 08 58	G-1326	G-1224	35867	27 18 18cc	1.53	122.1	
Miles, Charles C.	02 06 59	G-1366	G-1241	31370	27 15 2ba	0.57	60.0	
Bowen, Darrel G.	04 08 59	G-1434	G-1301	30575	27 15 24ba	2.00	160.0	
Guinee, Tim P.	09 21 60	G-1843	G-1686	30784	29 16 16aa	0.36	28.8	
Alder Creek Ranch	08 03 61	G-2085	G-1915	50760	27 19 19ac	2.49	199.3	T-2990
Christmas Valley Improvement District	09 07 61	G-2114	G-1950	33280	27 17 10dd	0.91	72.2	
Christmas Valley Improvement District	09 07 61	G-2114	G-1950	33280	27 17 10dd	0.10	-	D
Christmas Valley Improvement District	09 07 61	G-2114	G-1950	33280	27 17 10dd	0.50	-	L
Alder Creek Ranch	11 24 61	G-2166	G-1997	50918	27 19 18cc	1.44	139.6	T-2989
M. Penn Phillips Company	12 15 61	G-2190	G-2017	31072	27 17 22bb	0.42	39.0	
Ward, Maurice L.	02 28 62	G-2243	G-2065	35644	26 15 28aa	0.96	76.5	
Golden Rule Farms	04 11 62	G-2292	G-2165		27 18	0.28	22.1	T-5240
Century Ranch	04 11 62	G-2292	G-2165	51864	27 15	1.06	85.2	
Kittredge, Jack L.	12 13 62	G-2504	G-2314	35751	26 15 21da	1.63	130.0	T-5411
Christmas Valley Mutual Water Imp. Dist.	06 13 63	G-2633	G-2440	36770	27 17 17ab	0.25	-	G
Beck, John W.	08 06 63	G-2676	G-2488	35641	27 16 26cd	2.93	234.4	
Christmas Valley Mutual Water Imp. Dist.	08 12 63	G-2679	G-2582	36771	27 17 14ab	0.25	-	Q
Damewood, Lyle & Helen	10 11 63	G-2718	G-2521	35972	26 19 5bc	1.11	89.0	
Bank of Central OR	05 05 64	G-2849	G-2652	35642	26 14 12ba	0.45	36.3	T-4553, T-4599
Tuttle, Robert R.	11 16 65	G-3291	G-3070		26 15	0.96	76.96	T-5238
Tuttle, Robert R. & Geraldine	11 16 65	G-3291	G-3070	51865	26 15	0.73	57.74	T-5238
Tuttle, Robert R. & Geraldine	11 16 65	G-3291	G-3070	51865	26 15	0.30	24.3	T-5238, S
Hamett, Bob & Alice	11 07 66	G-3719	G-3516	52872	25 19 31	0.94	75.0	
Boatwright, G.R.	12 07 66	G-3748	G-3540	41322	26 14 28ba	0.33	35.4	
L.H. Ranch, Incorporated	07 30 68	G-4525	G-4263	38097	29 16 16aa	0.12	9.5	
Miles, Charles C. & Alice	09 10 68	G-4591	G-4301	41323	27 15 2ab	0.75	60.0	
Pettus, John A.	10 02 69	G-5009	G-5267	53352	27 17 33	1.00	-	FR
Bettencourt, Andrew	03 13 70	G-5129	G-4866	41330	26 14 13dd	1.96	156.4	
Wittick, George E. & Beverly	03 19 70	G-5463	G-5374	47062	27 15 2ab	0.25	20.0	
Martin, Jessie	04 23 70	G-5166	G-4898	41331	27 17 9ad	0.23	18.5	
Frazee, Felix A.	04 27 70	G-5173	G-4904	43774	25 17 2aa	0.36	29.1	
Miles, Harold A. & Lois L.	04 01 71	G-5475	G-4979	41096	27 15 2dd	1.56	124.5	
Mattis, W.Y.	05 10 71	G-5506	G-5402	48888	26 14 31ba	1.00	80.0	T-5364
Kittredge, Jack L. or Doris	07 19 71	G-5572	G-5007	44493	26 15 6	2.00	160.0	
Hollingsworth, Wayne W.	11 29 71	G-5677	G-5497	52629	28 16 12ac	0.96	77.0	
Branch, Floyd A. & Venita	12 14 71	G-5685	G-5499	48031	26 14 3	1.00	80.0	
Wolfsturm, Emil & Renate	01 12 72	G-5702	G-5511	46880	28 16 10dc	0.24	19.0	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Blevins, Mearl	01 12 72	G-5703	G-5512	46881	27 16 34ca	1.07	85.8	
Wagner, R.B. or E.M.	02 08 72	G-5721	G-5522	51465	26 15 4ac	0.91	72.7	
Bowers, Roy A. & Sons, Inc.	02 29 72	G-5736	G-5532	47717	26 14	5.19	432.18	
Cliff, Cameron	03 28 72	G-5762	G-5544	46780	28 14 15aa	4.93	394.2	
Alder Creek Ranch	09 27 72	G-5911	G-5623	50750	27 19	4.45	355.6	
Iverson, Lawrence & Marjorie	03 26 73	G-6047	G-5739	50386	28 15 19aa	1.891	151.5	T-4868
Iverson, Lawrence & Marjorie	03 26 73	G-6047	G-5739		28 15 19ac	0.109	8.7	T-4868
View Point Ranches	04 09 73	G-6063	G-5755	48889	28 16 19ba	1.70	136.2	
Alder Creek Ranch	04 09 73	G-6062	G-5754	50751	27 19 29bd	0.69	55.0	
Alder Creek Ranch	04 09 73	G-6064	G-5756	50752	27 19 20bc	2.19	175.5	
Eversmann, Wm. H.	06 11 73	G-6167	G-5850	54688	25 14 15cb	0.81	77.3	
Tucker, Ernest P. & Jessie O.	07 10 73	G-6221	G-5875	52364	28 16 2dd	0.73	58.5	
Chausse, N.J.	07 12 73	G-6227	G-5878		25 15 27	0.48	38.0	
Powell, Kenneth E.	08 02 73	G-6253	G-5895	48606	27 16 21aa	0.22	18.0	
Bowen, Darrel G.	09 19 73	G-6303	G-5925	47614	27 15 24cb	1.90	154.4	
Campbell, Jack E.	11 30 73	G-6075	G-5762	46977	25 14 16cb	1.98	158.0	
Miles, Harold A. & Lois	02 14 74	G-6433	G-5999	47919	27 15 2cd	1.09	87.1	
Alder Creek Ranch	03 05 74	G-6451	G-6051	50753	27 19	8.98	718.1	
Damewood, Lyle & Helen	05 16 74	G-6535	G-6143	47615	26 19 5bb	1.24	99.2	
Iverson, Lawrence	07 02 74	G-6586	G-6174	50387	28 15 19aa	0.37	29.4	T-4869
Iverson, Lawrence	07 02 74	G-6586	G-6174		28 15 19ac	0.37	29.4	T-4869
Alder Creek Ranch	09 23 74	G-6669	G-6670	50754	27 19	9.00	720.6	
Gillette, Jack L.	11 19 74	G-6731	G-6261	46679	27 18 7ca	1.95	156.0	
Lanier, Gerald & Elva	11 25 74	G-6735	G-6003	47616	27 16 5bb	1.56	124.4	
Lanier, Gerald & Elva	11 25 74	G-6738	G-6006	47617	27 16 6ab	1.56	124.4	
Dowers Farms	11 25 74	G-6934	G-6452	47722	26 15 13db	1.55	123.6	
Dowers Farms	11 25 74	G-6935	G-6453	47723	26 15 14bd	1.54	122.8	
Dowers Farms, Inc.	12 09 74	G-6756	G-6007	48731	27 16 7bc	1.05	84.0	
Banfield Veterinary Hospital, Inc.	01 09 75	G-6782	G-6295	46979	25 14 20dd	1.93	154.0	
Golden Rule Farms, Inc.	02 20 75	G-6820	G-6320	48607	27 17 22cd	1.98	158.2	
Dinsdale, James	03 28 75	G-6870	G-6406		26 15 29	3.50	280.0	
Dowers Farms, Inc.	05 05 75	G-6736	G-6004	47718	26 15 13bb	0.99	79.5	
Dowers Farms, Inc.	05 05 75	G-6737	G-6005	47719	26 15 13cc	1.57	125.6	
Dowers Farms, Inc.	05 05 75	G-6932	G-6450	47720	26 15 11cc	1.54	122.8	
Dowers Farms, Inc.	05 05 75	G-6933	G-6451	47721	26 15 14ad	1.54	122.8	
Ward, Maurice L.	07 01 75	G-7034	G-6522	47819	26 15 28aa	0.47	37.2	
Roth, David & Gayle	07 08 75	G-7043	G-6530		25 17 1cc	2.00	160.0	
Brown, Wade, et al	07 31 75	G-7059	G-6678		25 17 1	1.98	158.0	
View Point Ranches	08 18 75	G-7080	G-6552	48890	28 15 13db	1.56	125.0	
First National Bank of Oregon	08 20 75	G-7085	G-6554	47820	26 15 33dd	1.50	119.68	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Mattis, Michael W.	09 10 75	G-7107	G-6571	47621	26 14 31bd	0.94	75.0	T-5363
Jensen, Henry	09 25 75	G-6469	G-6064	48732	27 17 2ad	0.47	37.4	
Oster, Harlan F. & Eloise	09 25 75	G-7121	G-6693	50506	27 19 5dc	0.54	43.0	T-4818
Oster, Harlan F. & Eloise	09 25 75	G-7121	G-6693	52786	27 19 5da	1.41	112.8	T-4818
Tompkins, Charles & Ilene	10 06 75	G-7127	G-6696	47618	25 14 34bc	2.00	160.0	
Hall, Melvin & Ramona	10 08 75	G-7132	G-6583	47725	27 17 1ab	1.55	154.5	
H.U.I. Ranch, Inc.	12 04 75	G-7174	G-7841		25 17 2dd	1.74	139.2	
Damewood, Lyle	12 22 75	G-7190	G-6621	47619	26 19 5ad	2.44	195.0	
Basey, Clinton & Mary Anne	01 06 76	G-7207	G-6704	47620	28 14 23bb	1.62	129.9	
Reed, Robert Carl	01 08 76	G-7214	G-6637	54689	25 14 15cd	0.004	4.4	T-5576
Reed, Robert Carl	02 27 76	G-7214	G-6637	53002	25 14 15cd	0.043	-	T-5576, C
Warmington, George	02 09 76	G-7254	G-6654	54425	25 15 34bd	2.00	160.0	
Burke, Glenn C.	02 26 76	G-7272	G-6682	49855	25 15 27db	1.10	87.9	
Reed, Robert Carl	01 08 76	G-7214	G-6637	54689	25 14 15cc	0.066	75.0	
Reed, Robert Carl	02 27 76	G-7214	G-6637	53002	25 14 15cc	0.737	-	C
Carlon Cattle Company	04 12 76	G-7331	G-6891	52063	28 15 24bc	1.92	153.8	
Black, Haskel & Shirley	04 12 76	G-7332	G-6770	51594	27 17 21aa	1.48	118.4	
View Point Ranches	04 13 76	G-7335	G-6772	48891	28 15 13bb	1.57	125.3	
Campbell, Jack E.	05 06 76	G-7358	G-6812	46980	25 14 16cb	0.96	76.6	
Tuttle, Robert R.	05 17 76	G-7370	G-6868		26 15 32ad	4.27	301.3	
Morrison, Fritz L. & Marilyn R.	05 17 76	G-7372	G-6820	47726	26 15 4	2.00	170.8	
Banfield Veterinary Hospital, Inc.	06 04 76	G-7398	G-7129	48609	25 14 29aa	1.94	155.3	
Widenoja, Richard N, Niilo J & Mary Jane	06 04 76	G-7399	G-7130	48610	26 15 5ba	0.60	48.0	
Golden Rule Farms, Inc.	06 14 76	G-7406	G-6910	49057	27 17 22dd	1.60	128.1	
Johnson, K. Dale	06 24 76	G-7416	G-6920		26 16 27aa	1.56	130.0	
Brown, Wade	08 09 76	G-7471	G-6955		25 18	15.24	1220.76	
Rumsey, Thelma C.	08 09 76	G-7473	G-6957	48608	27 15 14bd	1.64	78.0	
Rumsey, Thelma C.	08 09 76	G-7473	G-6957	48608	27 15 14bd	-	53.1	S,C
Widenoja, Richard N.	09 01 76	G-7500	G-6980		26 15 6aa	2.00	160.0	
Widenoja, Nillo J. & Mary Jane	09 02 76	G-7503	G-6983	54426	26 17 27dc	1.97	157.0	
Black, Haskel & Shirley	10 11 76	G-7539	G-7010	51591	27 17 21bd	1.44	115.4	
Black, Haskel & Shirley	10 11 76	G-7540	G-7011	51592	27 17 21ca	2.15	172.1	
Black, Haskel & Shirley	10 11 76	G-7541	G-7012	51593	27 17 21ab	0.16	12.7	
Wagner, Ray B. Wagner Farms	11 01 76	G-7567	G-7134	48611	25 13 27ca	1.67	133.2	
Fine, Harold L. & Roy L. Forman	11 09 76	G-7575	G-7048		26 16 18	3.60	292.0	
Heavilin, O.R.	12 14 76	G-7605	G-7054	52619	27 15 3	2.96	236.4	
Edwards, Billy J.	01 28 77	G-7668	G-7105		25 15 27	1.88	150.6	
Emery Livestock Company	02 04 77	G-7693	G-7242	52563	28 15 30bb	5.09	499.0	
Blevins, Mearl W. & Patty L.	02 09 77	G-7712	G-7364	54690	27 16 34ca&cd	1.95	156.3	
Church, Zane D.	02 11 77	G-7720	G-7170		28 16 16	7.0	560.0	
Wolfsturm, Emil & Renate	02 14 77	G-7729	G-7174	52873	28 16 10da	0.49	39.0	
Gillette, Jack L.	02 15 77	G-7737	G-7191		27 18 18	2.50	124.5	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location			Diversion Q (cfs)	Irrigated Acres	Remarks
Gillette, Jack L.	02 15 77	G-7737	G-7191		27	18	18		75.5	S, C
Miles, Harold A.	02 22 77	G-7791	G-7269	52643	27	15	1	2.67	268.3	
Bettencourt, Andrew	02 28 77	G-7863	G-7382		26	14	11	2.97	237.9	
Kittredge, Jack & Doris	04 25 77	G-8060	G-7646		26	14	24ac	5.10	408.7	
Gallogly, Donald R. & Alice G.	04 26 77	G-8070	G-7470		26	16		9.75	780.0	
Kruse, Kenneth V. & Kathrine G.	04 29 77	G-7651	G-7361		26	14		10.12	809.1	
Dinsdale, James	04 29 77	G-8079	G-7474	52783	25	18	4db	1.87	149.6	
Tiahrt, Theodore R.	05 04 77	G-8093	G-7480		26	15	22	4.80	520.0	
Tiahrt, Theodore R.	05 04 77	G-8094	G-7481		26	15	22	4.40	520.0	
Tompkins, Charles	05 06 77	G-8099	G-7484	52623	25	14	34ac	2.00	160.0	
Smith, William L. & Floy O.	05 18 77	G-8139	G-7510	52624	26	14	28ca	0.58	46.0	
Salisbury, Virginia, Ivan & Wade Brown	05 31 77	G-8180	G-7336		25	17	1aa	6.00	480.0	
Tuttle, Robert R.	06 07 77	G-8195	G-7848		26	15	31ac	5.13	410.0	
Crofoot, Percy	07 06 77	G-8253	G-7644	52648	27	13	26bc	1.50	160.0	
Dowers Farms, Inc.	07 29 77	G-8308	G-7556	48733	25	17	1bd	1.57	125.6	
Beal, Harlie E.	07 29 77	G-8309	G-7557	48734	27	16	7cb	0.76	83.4	
Dowers Farms, Inc.	07 29 77	G-8310	G-7558	48735	26	15	14dd	1.55	123.8	
Dowers Farms, Inc.	07 29 77	G-8311	G-7559	48736	26	15	11db	1.55	123.8	
Dowers Farms, Inc.	07 29 77	G-8312	G-7560	48737	26	15	14cc	1.55	123.8	
Ward, Maurice L. & Hazel I.	08 24 77	G-8398	G-7840		26	15	28aa	0.50	40.0	
Bowen, Darrel G.	09 13 77	G-8445	G-7842	52621	27	15	25ac	1.67	133.9	
McDowell, Charles M. & Fernette M.	09 14 77	G-8446	G-7843		29	16	17db	1.75	140.2	
McCain, James P.	11 10 77	G-8527	G-7886		26	16	8cc	2.00	160.0	
Wright, James L.	11 21 77	G-8540	G-7887		26	17	24ca	1.25	100.0	
Troudy, Chester & Helen	11 30 77	G-8550	G-7767	48612	25	14	21aa	1.57	125.6	
Piepgrass, Ralph H.	11 30 77	G-8551	G-7768	52644	25	14	21bb	1.53	122.0	
Eskew, J. & P.	12 06 77	G-8566	G-7921		24	18	33ca	2.00	160.0	
Crowson, Gilbert T.	12 21 77	G-8583	G-7994	53449	25	18	3bd	1.60	127.8	
Carlon, Evan	01 06 78	G-8231	G-7846		28	15	24ac	1.57	125.6	
Carlon Cattle Company	01 06 78	G-8232	G-7847		28	15	24	5.50	439.34	
Forman, Roy L.	01 12 78	G-8601	G-8060		26	16	19	3.70	296.4	
Bennet, John G.	01 13 78	G-8197	G-7849	53145	27	18	20dd&cd	3.41	273.0	
Morehouse, Richard	01 19 78	G-8609	G-7996		26	15	15	4.00	320.0	
Warmington, George H.	03 01 78	G-8672	G-8097	54427	25	15	27 & 34	1.365	109.1	
Crowson, Gilbert	03 10 78	G-8684	G-8061	53450	25	18	3cc	1.60	128.1	
Alder Creek Ranch	04 04 78	G-8714	G-8120	50755	27	19	29bd	0.44	35.4	
Alder Creek Ranch	04 04 78	G-8715	G-8121	50756	27	19	34cb	2.37	189.2	
Alder Creek Ranch	04 04 78	G-8716	G-8122	50757	27	19	19dc	0.86	69.1	
Alder Creek Ranch	04 04 78	G-8717	G-8123	50758	28	15	14dd	1.68	134.4	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Church, Zane D.	04 12 78	G-8731	G-8100		28 16 21bd	3.50	280.0	
D.V.A.	04 19 78	G-8747	G-8195	54691	27 17 13dc	1.82	145.7	
Golden Rule Farms, Inc.	04 19 78	G-8748	G-8196	52631	27 17 11bd	1.67	133.6	
Flowerree Farms	04 19 78	G-8749	G-8197	53853	26 18 35dc	1.66	132.7	
Nordyke, Robert G.	04 19 78	G-8750	G-8198	54054	27 17 24ac	1.72	137.5	
Golden Rule Farms, Inc.	04 19 78	G-8744	G-8246	52632	27 17 14dd	0.85	67.8	
Golden Rule Farms, Inc.	04 19 78	G-8745	G-8247		27 17 8ac	2.00	160.0	
D.V.A.	04 19 78	G-8746	G-8248	54692	27 17 13cc	1.83	146.4	
Oxenford, Joe	04 27 78	G-8771	G-8199	52784	27 15 32ca	3.27	261.7	
Porterfield, Cody J.	05 02 78	G-8783	G-8134		26 15 24	3.98	318.0	
Ritter, Clyde	05 03 78	G-8790	G-8075	51903	26 16 29cc	1.56	125.0	
Ritter, Clyde	05 03 78	G-8791	G-8076	51904	26 16 32bb	1.57	125.6	
Ritter, Clyde	05 03 78	G-8792	G-8077	51905	26 16 32ab	1.57	125.4	
Dowers Farms, Inc.	05 03 78	G-8786	G-8068	48738	27 15 12bd	1.46	116.6	
Dowers Farms, Inc.	05 03 78	G-8787	G-8069	48739	27 15 12ad	1.58	126.2	
Dowers Farms, Inc.	05 03 78	G-8788	G-8070	48740	26 16 33bb	1.57	125.6	
Dowers Farms, Inc.	05 03 78	G-8789	G-8071	48741	26 16 33cb	1.57	125.6	
Dowers Farms, Inc.	05 03 78	G-8793	G-8072	48742	27 15 12dd	1.58	126.0	
Dowers Farms, Inc.	05 03 78	G-8794	G-8073	48743	27 15 12cd	1.43	114.0	
Dowers Farms, Inc.	05 03 78	G-8795	G-8074	48980	27 15 13ac	1.52	121.5	
Blevins, Mearl W. & Patty L.	05 19 78	G-8813	G-8201	52641	27 16 34ac	2.67	213.3	
Stewart, Arthur	06 07 78	G-8838	G-8271		26 19	3.16	253.0	
Tuttle, Robert R.	06 13 78	G-8850	G-8251	53854	26 15 17da	3.15	251.8	
Effingham, John H.	08 10 78	G-8924	G-8330	53347	27 17 29ac&dc	3.45	275.8	
Morehouse, Kenyon K.	08 29 78	G-8205	G-8245	53453	26 18 30ac	0.50	40.0	
Hall, Melvin D. & Romona R.	11 24 78	G-9024	G-8375	54694	27 17 1cc	1.57	125.6	
Church, Buckley D.	11 30 78	G-9030	G-8407		28 16 9	4.00	320.0	
Lanier, Gerald L. & Elva M.	12 05 78	G-9038	G-8455	52638	27 16 5db	1.63	130.0	
Fine, Harold L.	12 06 78	G-9043	G-8408		26 16 18cb	2.50	200.0	
Church, Zane D.	12 27 78	G-9065	G-8432		28 16 15	2.45	196.0	
Cherry, Leonard M.	12 29 78	G-9069	G-8431	52616	26 18 12dc	0.98	78.3	
Tiahrt, Ted R. (Double Tree Ranch)	02 08 79	G-9126	G-8551		26 15	14.50	640.0	
Tiahrt, Ted R. (Double Tree Ranch)	02 08 79	G-9126	G-8551		26 15	-	520.0	S, C
Roberts, Alfred L. & Alta B.	04 05 79	G-9192	G-8572		25 15 33	1.74	139.5	
Emery, Kenneth & Dorothy	04 23 79	G-9209	G-8600		28 15 30ad	4.25	339.8	
Overholser, H. Dale	04 30 79	G-9220	G-8574		26 16 25aa	3.42	273.5	
Wagner, Ray B. (Wagner Farms)	05 03 79	G-9225	G-8601	52874	25 13 27db	1.63	130.1	
Emery Livestock	05 03 79	G-9226	G-8649		28 15	4.19	335.0	
Lynch, Fred R. and Mary Ann	06 01 79	G-9262	G-8575		26 14 22db	1.96	157.0	

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Branch, Floyd & Venita	06 15 79	G-9279	G-8678	52622	26 14 3	1.68	134.7	
Mattis, Michael W.	06 20 79	G-9288	G-8709	52618	26 14 31bd	0.26	20.7	
Caldwell, Bill	08 06 79	G-9345	G-8737		28 14 22cb	0.03	2.4	
Poplars Ranch	08 21 79	G-9373	G-8650		26 15 28	1.69	135.0	
Lanier, Brent	08 22 79	G-9375	G-8738	51273	25 19 30da	0.92	73.7	
Hall, Melvin D. & Ramona	08 27 79	G-9380	G-8739		27 17	5.40	432.0	
Crofoot, Percy	09 07 79	G-9395	G-8652	52647	27 13 26bc	1.08	86.3	
Lanier, Brent	09 14 79	G-9403	G-8777	51274	25 19 20dc	1.00	80.0	
Brown, Wade	09 27 79	G-9419	G-8778	53053	25 18 17bd	1.67	133.8	
Brown, Wade	09 27 79	G-9420	G-8779		25 18 21ac	3.48	278.4	
Brown, Wade	09 27 79	G-9421	G-8780		26 18 5ad	2.99	239.0	
Stockhoff, Robert L.	10 31 79	G-9453	G-8874	53148	24 18 35cb	0.84	67.3	
Surcamp, LeRoy	02 13 80	G-9547	G-8841	52617	25 14 15bc	2.00	160.0	
Lanier, Gerald L.	02 15 80	G-9548	G-8981	53054	27 16 5ac	1.59	127.0	
Bell A Land and Cattle Company	02 21 80	G-9556	G-8915		28 14 23aa	2.00	160.0	
Neuschwander, Ira	02 27 80	G-9576	G-8849	52633	27 17 16bc	0.18	14.0	
Damewood, Lyle and/or Helen	03 07 80	G- 9596	G-9325		25 18 34bb	1.75	140.0	
Boyles, Donald R. & Marlene	04 04 80	G-9622	G-8820	54695	26 18 14cb	0.67	267.2	
Boyles, Donald R. & Marlene	03 17 80	G-9622	G-8820	54695	26 18 23bc	2.67	-	C
Boyles, Donald R. & Marlene	03 17 80	G-9627	G-8821	53147	27 17 12cc	1.63	130.2	
Blevins, Mearl W. & Patty L.	03 17 80	G-9618	G-8982	52875	27 16 27bc	1.74	139.0	
Ward, Maurice L. & Hazel I.	03 25 80	G-9632	G-8983	52620	25 15 32dc	2.00	160.0	
Mulkey, Gylan	03 31 80	G-9641	G-8984	52876	27 17 3db	1.66	132.5	
Fine, Harold L.	04 17 80	G-9687	G-9017		26 16 7	3.60	288.0	
Ginter, Lloyd	04 28 80	G-9707	G-10046		26 16 34db	2.00	160.0	
Grassman, Larry	06 03 80	G-9756	G-9015		26 18 29cb	2.00	160.0	
Morse, Marvin C.	06 03 80	G-9758	G-9018	53855	26 18 31aa	1.58	126.5	
Alder Creek Ranch	06 03 80	G-9763	G-8988	50759	27 19	1.42	114.0	
Peters, Daniel F.	06 11 80	G-9777	G-9019		26 19 32dc	1.65	132.0	
Floweree Farms, Inc.	06 11 80	G-9778	G-9022		27 18 12ad	1.65	132.0	
Floweree Farms, Inc.	06 11 80	G-9779	G-9023		27 18 1dd	1.65	132.0	
Floweree Farms, Inc.	06 11 80	G-9780	G-9024		26 18 36dd	1.67	132.0	
Banfield Veterinary Hospital, Inc.	06 13 80	G-9787	G-9062	52630	25 14 29aa	0.04	3.0	
Crouch, Fred G.	06 16 80	G-9792	G-8876	53454	26 18 8cb	1.31	104.5	
Hanson, Gerald	06 17 80	G-9796	G-9021	53538	26 16 30db	1.6	128.2	
Widenoja, Niilo J. & Mary Jane	06 18 80	G- 9800	G-9544	54428	26 17 27dc	0.40	32.0	
Warmington, George & Barbara	06 24 80	G-9806	G-8916		25 19 32da	4.00	320.0	
Hanna, Robert K.	07 01 80	G-9816	G-9027		26 14 12ba	0.57	48.0	
Golden Rule Farms, Inc.	07 02 80	G-9818	G-9063	53349	26 17 33bd	1.66	132.5	
Golden Rule Farms, Inc.	07 02 80	G-9819	G-9064		26 18 22	2.67	320.0	

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Golden Rule Farms, Inc.	07 02 80	G-9820	G-9065		26	18	14aa	2.00	160.0	
Golden Rule Farms, Inc.	07 02 80	G-9821	G-9066		27	17	7	2.67	320.0	
Golden Rule Farms, Inc.	07 02 80	G-9822	G-9067	53350	26	17	32bd	1.58	126.7	
Golden Rule Farms, Inc.	07 02 80	G-9823	G-9068	53540	27	17	8dd	1.60	127.7	
Houston, Vernon D.	07 09 80	G-9827	G-8884	53149	25	18	4ba&ca	3.28	262.9	
Nagely, Marvin G.	07 10 80	G-9831	G-8888	51770	27	18	21dc	3.36	268.4	
Poplars Ranch	07 15 80	G-9834	G-9069		26	15	33	0.80	64.1	
Nofziger, Charles D.	07 15 80	G-9836	G-9118		27	17	8ba	1.68	278.0	
Nofziger, Charles D.	07 15 80	G-9836	G-9118		27	17	8ca	1.69	-	C
Nofziger, Charles D.	07 15 80	G-9836	G-9118		27	17	8cb	0.09	-	C
Nofziger, Terry L.	07 15 80	G-9835	G-9347		27	18	6	3.36	268.3	
Wagner, Ray & Edna	08 04 80	G-9867	G-9071		25	13	27	9.15	427.5	
Wagner, Ray & Edna	08 04 80	G-9867	G-9071		25	13	27	-	137.5	S, C
Grassman, Larry	08 07 80	G-9757	G-9016		26	18	30dd	2.00	160.0	
Stutzman, Mervin	08 13 80	G-9886	G-9141		26	16	14	4.00	320.0	
Floweree Farms, Inc.	08 14 80	G-9889	G-9072		27	18	1	2.00	160.0	
Banfield Veterinary Hospital, Inc.	08 22 80	G-9901	G-9509	52634	25	13	26dc	0.22	-	F, C
Floweree Farms, Inc.	08 27 80	G-9909	G-9026		26	18	35ac	2.00	160.0	
Hanna, Robert K.	09 09 80	G-9816	G-9027		26	14	12ba	0.03	-	C
Enlow, Melvin D.	09 09 80	G-9926	G-9074	53232	27	19	4bd	1.61	128.4	
Enlow, Melvin D.	09 17 80	G-9941	G-9075	53233	27	19	4aa	2.00	159.8	
Enlow, Melvin D.	09 17 80	G-9942	G-9076	53234	27	19	4cd	1.70	136.0	
Blackman, Claude Alan	10 01 80	G-9966	G-9121	52877	26	19	19cd	1.39	110.8	
Robey Ranches	10 14 80	G-9978	G-9077		27	16	11cc	2.00	160.0	
Banfield Veterinary Hospital, Inc.	11 17 80	G-9787	G-9062	52630	25	14	29aa	0.04	3.0	
D.V.A.	12 02 80	G-10036	G-9078	54693	27	17	19aa	1.69	135.2	
Mensch, Richard	12 15 80	G-10051	G-9122	53351	26	19	5cd	1.63	130.0	
Grassman, Earl L.	12 16 80	G-10056	G-9167	54631	26	17	25bd	2.45	270.8	
Grassman, Earl L.	12 16 80	G-10056	G-9167	54631	26	17	25ca	0.87	-	C
Grassman, Earl L.	12 16 80	G-10056	G-9167	54631	26	17	25cd	0.05	-	C
Strubhar, Timothy J.	12 17 80	G-10058	G-9123		26	18	23cb	2.00	160.0	
Roth, David & Galyn	12 18 80	G-10068	G-9261		25	17		10.07	853.0	
Nofziger, Terry L.	12 22 80	G-10071	G-9124		26	18		8.00	640.0	
Tuttle, Robert E.	12 23 80	G-10072	G-9137	52637	25	14	16dd	0.72	57.75	
Enlow, Melvin D.	09 09 80	G-9926	G-9074	53232	27	19	4bd	1.61	128.4	
Enlow, Melvin D.	09 17 80	G-9941	G-9075	53233	27	19	4aa	2.00	159.8	
Enlow, Melvin D.	09 17 80	G-9942	G-9076	53234	27	19	4cd	1.70	136.0	
Johnson, Ronald D. & Suzanne E.	12 29 80	G-10075	G-9168		27	18	21bc	0.48	38.0	
Morse, Marvin C.	12 31 80	G-9755	G-9148	53856	26	18	31ba	1.44	115.5	
The Poplars Ranch	01 09 81	G-10095	G-9146		26	15	34	2.76	220.0	
Schrock, Leslie L.	01 09 81	G-10091	G-9326		27	18	5	4.00	320.0	

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~~Phipps, Gregory Todd~~	~~01 12 81~~	~~G-10094~~	~~G-9170~~		~~26~~	~~18~~	~~11ba~~	~~2.00~~	~~160.0~~	
Nofziger, Charles D.	01 13 81	G-10096	G-9125	53457	26	16	3cb	1.24	231.0	
Nofziger, Charles D.	01 13 81	G-10096	G-9125	53457	26	16	4da	1.65	-	C
Nofziger, Verl E.	01 13 81	G-10097	G-9126	53458	26	16	23bc	1.61	264.0	
Nofziger, Verl E.	01 13 81	G-10097	G-9126	53458	26	16	23cc	1.69	-	C
Nofziger, Verl E.	01 13 81	G-10098	G-9127	53459	26	16	26ab	1.65	264.0	
Nofziger, Verl E.	01 13 81	G-10098	G-9127	53459	26	16	26dc	1.65	-	C
Turner, L.E.	01 13 81	G-10101	G-9144	53055	27	19	9ac	1.64	131.4	
Robey, Jr., Jim	01 13 81	G-10099	G-9171	53056	27	16	10cd	1.69	135.0	
Hanson, Gerald Roy	01 16 81	G-10104	G-9145	53539	26	16	29ba	1.52	121.6	
Eskew, John M.	01 19 81	G-10108	G-9173		24	18	33	1.83	146.5	
Pick, Dave	01 22 81	G-10115	G-9230	52642	25	14	28ab	1.68	134.0	
Huebner, Marion O.	01 23 81	G-10119	G-9564		27	17	17ca	3.73	298.62	
O'Leary, Jeremiah	01 26 81	G-10123	G-9201		28	15	27cc	2.0	160.0	
Schmidt, William W. and/or Laurena	01 26 81	G-10125	G-9202		27	18		4.0	320.0	
Fox, Walter D.	01 29 81	G-10129	G-9174	52365	27	17	16cb	0.75	59.7	
Effingham, John H.	01 30 81	G-10132	G-9203	53348	27	17	29da	0.19	15.4	
Flowerree Farms, Inc.	02 03 81	G-10137	G-9175		27	18	1	3.30	264.0	
Crowson, Gilbert	02 06 81	G-10148	G-9262	53451	25	18	3ad	1.57	125.6	
Hicks, Lawrence W.	02 12 81	G-10155	G-9232	53150	26	16	11cc	1.13	90.0	
Jelden, Monty	02 13 81	G-10158	G-9592	53860	26	15	9dc	0.83	79.0	
St. Clair, Frank E. & Kathleen	02 17 81	G-10162	G-9176	53151	26	16	10ca&cd	3.22	258.0	
Crofoot, James	02 18 81	G-10166	G-9204	54248	27	13	23db	0.99	79.5	
Kergil, William V.	02 18 81	G-10168	G-9205		25	18	14cc	1.00	80.0	
Schrock, Earl	02 18 81	G-10167	G-9275		26	17	36bc	1.91	153.0	
Crouch, Fred G.	02 22 81	G-10173	G-9233	53455	26	18	8cb	2.00	194.4	
Crowson, Gilbert	02 24 81	G-10178	G-9312	53452	25	18	3ad	1.61	129.1	
Birch Circle Farms	02 25 81	G-10042	G-9229		26	17	25dd	2.00	160.0	
Roth, David & Galyn	03 03 81	G-10068	G-9261		25	17		0.58	-	C
Greene, Kenneth J. & Patricia C.	03 09 81	G-10200	G-9313		28	16	3	6.00	480.0	
Grassman, Larry	03 12 81	G-10211	G-9314	52625	27	17	12bc	1.58	126.0	
Cornell, Frank, Kathleen and Patrick	03 16 81	G-10214	G-9276		26	16	26	4.00	320.0	
Oster, Harlan Frank	03 19 81	G-10219	G-9408	53460	27	19	5da	1.57	125.8	
Tucker, Ernest P.	03 27 81	G-10231	G-9264	52628	27	16	13cb	0.33	26.2	
Alberts, Cecil R.	04 01 81	G-10247	G-9279	54697	25	19	29ad	1.57	125.6	
960 Ranch, Inc.	04 03 81	G-10250	G-9292	53152	24	18	34ac	1.59	127.3	
960 Ranch, Inc.	04 03 81	G-10252	G-9293	53153	24	18	34dc	1.60	128.0	
960 Ranch, Inc.	04 03 81	G-10253	G-9294	53057	24	18	33bd	2.23	272.0	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Schmidt, William W. and/or Laurena Z.	04 15 81	G-10271	G-9462		27 18 20ca	2.00	120.0	
Schmidt, William W. and/or Laurena Z.	04 15 81	G-10271	G-9462		27 18 20ca	-	40.0	S, C
Warmington, George	04 27 81	G-10167	G-9275		26 17 36ba	0.09	7.0	
Flaming, John and Norma	04 28 81	G-10291	G-9348	52626	25 15 19	3.35	267.6	
Flaming, John and Norma	04 28 81	G-10292	G-9349	52635	25 14 23dd	1.71	137.0	
Flaming, John and Norma	04 28 81	G-10293	G-9350	52366	25 14 35cc	1.60	127.6	
Flaming, John and Norma	04 28 81	G-10294	G-9351	52367	25 14 35bc	1.60	127.6	
Flaming, John and Norma	04 28 81	G-10295	G-9352		26 15 27	4.00	320.0	
Howard, James R.	05 05 81	G-10304	G-9353	52878	27 16 18ba	2.01	160.5	
Lee Chism Reforestation Co., Inc.	05 12 81	G-10313	G-9329		27 18 8cd	0.50	40.0	
Flores, Jim	05 18 81	G-10323	G-9354		27 17 14dc	0.13	10.0	
Huss, Charles A. & Judith S.	05 18 81	G-10327	G-9355	53857	25 19 20bb	1.62	129.4	
Stutzman, Mervin	05 18 81	G-10328	G-9356		26 16 10dd	2.00	160.0	
Gillette, Jack L.	05 26 81	G- 9385	G-9311		27 17	2.28	188.8	
Fus, Lynn	05 26 81	G-10339	G-9357		26 17 35db	0.25	20.0	
Kane, Marion F. & Margaret Jean	05 26 81	G-10342	G-9358	52645	27 17 20cb	1.00	80.0	
Stockhoff, Robert L.	06 09 81	G-10366	G-9974		24 18 35bb	4.00	320.0	
Mattingly, Lawrence H. & Della M.	06 12 81	G-10373	G-9465	54250	25 19 20cb	1.63	130.7	
Loma Vista Farms, Inc.	06 16 81	G-10377	G-9466	53858	26 15 10cc	0.95	75.8	
Iverson, Lawrence & Marjorie	06 17 81	G-10384	G-9463		28 15 20bc	1.84	70.0	
Iverson, Lawrence & Marjorie	06 17 81	G-10384	G-9463		28 15 20bc	-	40.7	S, C
Loma Vista Farms, Inc.	06 22 81	G-10395	G-9469	53859	27 16 6cb	1.03	82.1	
Loma Vista Farms, Inc.	06 22 81	G-10397	G-9471		26 15 13cc	2.00	160.0	
Fine, Harold L. (Buz)	06 25 81	G-10404	G-9474		26 16 7ad	1.88	150.0	
McDonald, James M.	06 26 81	G-10407	G-9598	52627	25 18 17bd	0.68	54.3	
Iverson, Lawrence & Marjorie	06 29 81	G-10411	G-9599		28 15 18da	1.80	108.0	
Iverson, Lawrence & Marjorie	06 29 81	G-10411	G-9599		28 15 18da	-	36.0	S, C
Olson, Willie A. & Linda S.	07 06 81	G-10425	G-9421		26 18 12ba	1.00	80.0	
Oster, Harlan F.	07 10 81	G-10442	G-9612	52879	27 19 7bb	0.48	38.2	
Dunlap, Eulon	07 30 81	G-10471	G-9422		26 18 8dd	1.00	80.0	
Yuckniuk, John	08 07 81	G-10504	G-9433		27 18 2ad	0.50	40.0	
Flowerree Farms, Inc.	08 24 81	G-10528	G-9691		27 18 12ad	0.35	28.0	
Grassman, Larry	12 21 81	G-10212	G-9568	52636	27 17 12ad	1.62	129.4	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Clinkenbeard, Robert & Arline	04 05 82	G-10680	G-9651	52640	27 16 18ab	1.52	121.6	
L.H. Ranch, Inc.	04 21 82	G-10689	G-9786		29 16 16aa	0.31	24.7	
Johnson, K. Dale	05 24 82	G-10727	G-9797		26 16 27aa	1.31	104.6	
Dinsdale, Sam	06 15 82	G-10127	G-9803		26 15 19ac	4.74	379.58	
Flowerree Farms, Inc.	12 08 82	G-10852	G-10006		26 16 31	3.30	264.0	
Perkins, Gary L.	01 21 83	G-10870	G-10026	54251	26 19 6db	2.90	349.5	
Schrock, Earl Jr, & Laurie	01 31 83	G-10874	G-10055		25 18 5aa	2.00	160.0	
Kane, Marion F. & Margaret J.	02 10 83	G-10878	G-10016	52646	27 17 20cb	0.25	20.0	
Cliff, Cameron	02 28 83	G-10662	G-10039		28 14	40.55	143.3	
Cliff, Cameron	02 28 83	G-10662	G-10039		28 14	-	4168.6	S, C
Vloedman, Herbert R.	03 22 83	G-10900	G-10043		28 16 10	1.47	117.5	
Wolfstrum, Renate	03 22 83	G-10901	G-10044	52785	28 16 11ac	1.00	80.0	
The Poplars Ranch	04 06 83	G-10917	G-10111		27 15 4ac	1.06	85.4	
The Poplars Ranch	04 06 83	G-10918	G-10278		26 15 34cc	0.31	25.0	
Nofziger, Verl E.	04 08 83	G-10923	G-10035	53058	27 17 4ca	1.63	130.5	
Pick, Dave	04 14 83	G-10925	G-10122		25 14 27aa	1.65	132.0	
Tuttle, Robert R.	04 15 83	G-10927	G-10176		26 15 32cc	2.07	175.5	
Tuttle, Robert R.	04 15 83	G-10927	G-10176		26 15 32cc		6.5	S, C
Golden Rule Farms, Inc.	04 18 83	G-10930	G-10097		26 17 35	1.80	144.0	
Golden Rule Farms, Inc.	04 18 83	G-10929	G-10224		27 17 27	2.62	209.2	
Cromwell, Ken A.	04 20 83	G-10932	G-10123		26 18 1dd	1.50	280.0	
O'Leary, John Kevin	04 25 83	G-10937	G-10061		26 18 8	2.00	160.0	
Brown, Wade	04 27 83	G-10940	G-10099		26 16 6db	5.10	408.0	
Goldberg, David M.	06 07 83	G-10985	G-10156	53154	25 18 35da	0.95	76.1	
Bowen, Darrell G.	06 15 83	G-10998	G-10174		27 15 24cc	0.20	16.3	
Carrico, Clinton	06 20 83	G-11004	G-10159		27 18 5bc	2.70	216.0	
Bowen, Darrell G.	06 20 83	G-11003	G-10179		27 15 25ac	0.50	40.0	
Doty, Ralph J.	07 11 83	G-11026	G-10192		27 17 30dc	0.19	15.0	
Flowerree Farms, Inc.	07 19 83	G-11029	G-10160		26 18 36cc	0.50	40.0	
Flowerree Farms, Inc.	07 20 83	G-11030	G-10161		27 19 6dc	2.00	160.0	
Kane, Marian F. & Margaret Jean	08 11 83	G-11051	G-10210		27 17 20cb	0.25	20.0	
Flowerree Farms, Inc.	08 24 83	G-11061	G-10163		26 19 30ca	0.50	40.0	
Flowerree Farms, Inc.	08 24 83	G-11062	G-10164		27 19 5ca	1.00	80.0	
Porter, Gene	09 01 83	G-11071	G-10219		27 15 2ad	1.01	81.0	
Mattis, Michael W.	09 02 83	G-11072	G-10227		26 14 31bd	0.78	62.7	

Name	Priority Date	Appl. Number	Permit Number	Cert. Number	Well Location	Diversion Q (cfs)	Irrigated Acres	Remarks
Powell, Kenneth E.	09 15 83	G-11084	G-10235	53059	27 16 21aa	0.25	19.7	
Halford, David F. & Rosella F.	09 22 83	G-11091	G-10238		27 17 11dc	0.25	20.0	
Grassman, Lawrence John	10 04 83	G-10996	G-10172		26 18 29cb	1.50	120.0	
960 Ranch, Inc.	10 06 83	G-10956	G-10146		24 18 34	3.30	264.0	
Church, Zane	10 12 83	G-11144	G-10307		28 16 16aa	1.00	80.0	
Sams, Robert H. & Marion M.	10 12 83	G-11147	G-10266		26 19 32cc	0.13	10.0	
Wade, B. Joe	10 12 83	G-11152	G-10268		27 18 12	1.00	80.0	
North Lake School District 14	10 13 83	G-11158	G-10327		25 14 32dd	0.06	5.0	
North Lake School District 14	10 13 83	G-11159	G-10328		28 14 22db	0.05	4.0	
Murphy, Donald W. & Doris R.	10 13 83	G-11166	G-10274		27 17 26cc	1.75	140.0	
Dinsdale, James B.	10 14 83	G-11167	G-10329	54698	25 18 8ad	1.73	138.6	
Swain, Everett L. & Winona G.	10 14 83	G-11181	G-10332	54253	27 15 12cc	0.016	1.3	
Golden Rule Farms	10 14 83	G-11175	G-10277		27 16	8.45	676.0	
Iverson, Lawrence & Marjorie	10 21 83	G-11196	G-10330		28 15 19	0.05	4.0	
Scott, George	10 24 83	G-11197	G-10331	54252	27 15 11da	0.03	3.1	
Seibel, David A.	12 07 83	G-11210	G-10297	53235	27 17 27bd	0.17	13.6	
Halford, David F. & Rosella F.	12 21 83	G-11211	G-10298		25 18 15da	1.00	80.0	
Marti, Frederick & William Pittock	01 11 84	G-11214	G-10318		26 18 16bc	4.00	320.0	
Stockhoff, Robert L.	02 15 84	G-11234	G-10326		24 18 35cb	0.98	78.0	

APPENDIX VIII

NORTHERN SUMMER LAKE BASIN

NORTHERN SUMMER LAKE BASIN

The northern portion of the Summer Lake Basin (29S/16, 17 and 18E and 30S/16, 17 and 18E) is of great interest in the discussion of ground water in the Fort Rock Basin. The area is noteworthy for its large springs and strongly flowing wells. The flow constancy and quality of these supplies are high and represent an important resource for irrigation, wildlife habitat and other uses in the area (fig. 15). A lack of watershed area and precipitation (about 150 square miles with 10 inches of precipitation annually) necessitate that the principal source of the water is outside the watershed. The potentiometric surface map indicates that ground water should flow from the Fort Rock Basin (Plate 3).

Ground water in the northern Summer Lake Basin occurs largely under confined conditions. This water is found in lava-rock aquifers which are overlain by up to several hundred feet of thinly bedded lacustine deposits (Brown, 1957). The maximum thickness of these deposits may be more than 1,000 feet at some places. Well logs show a general thickening to the south and with distance from the bedrock slopes of the basin.

Prior to the construction of local wells, water from these aquifers discharged largely through seeps and springs with access through the overlying confining layers. Probably some slow upward leakage also permitted discharge through evapotranspiration. Now, dozens of wells tap these aquifers and discharge water at rates up to 2000 gpm. Many of these are flowing. Total discharges are estimated in excess of 90,000 AF/yr.

Ana Springs (or Ana River Springs) are the major discharge of water from this aquifer and feed the Ana River. These springs have been continuously submerged by Ana Reservoir (30S/17E-6) since 1926 (Appendix V). Initial submergence produced an average hydraulic back pressure on the springs of about 30 feet and reduced spring flow by about 20,000 AF/yr. As now operated, the pool over the springs is maintained at an altitude of about 4221 feet from May to September and at about 4214 feet from October to April. Nearby wells and springs respond to these changes in reservoir level. Well 30S/16E-1bd is clearly within the cone of depression of Ana Springs. A reservoir fluctuation of about 7 feet results in a water level fluctuation in the well of about 1 foot, being deeper in the winter and shallower in the summer (fig. 16). A high reservoir level serves to reduce Ana Springs discharge and to increase aquifer pressure, flowing well discharge and nearby spring discharge (30S/17E-5).

The modification of flow from Ana Springs since 1926 has had an unclear affect on the potentiometric surface (Plate 3). The hydraulic characteristics of the aquifer as investigated by Brown (1957) suggests very transmissive conditions. That information, the measured response of Ana Reservoir on Well 30S/16E-1bd and the presence of significant nearby springs suggest that aquifer water

levels there probably changed little in response to Ana Springs submergence. Discharge at other springs probably increased quickly and total antecedent discharges were re-established. In any case, some amount of water level rise must have occurred in the aquifer near Ana Springs.

Both the discharge of Ana Springs and the level at Well 30S/16E-1bd are clearly related to the pool elevation of Ana Reservoir. Discharge from the reservoir is the sole source at the Ana River gage except during rare precipitation conditions in which the reservoir receives direct runoff. On a short term basis, the discharge of Ana Springs can now be manipulated with resultant effect on discharge changes at other points and water level (storage) changes in the underlying aquifer. Long term, the total discharges must reflect average recharge. The slow but steady reduction of Ana River discharge in recent years (fig. 17) coupled with recent water level declines in the local aquifer (fig. 16) suggest that discharges surpass recharge. Water right permitting (fig. 15), well drilling activity and some field observations support the view that well discharges are increasing in the northern Summer Lake Basin. On the supply side, it is possible that recharge is already modestly reduced by pumpage in the Fort Rock Basin. Ultimately, the effect of that pumpage would require decades to be significant to existing users.

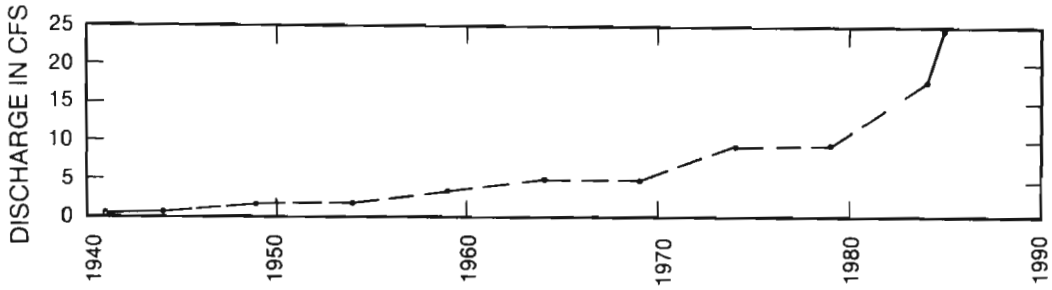


Figure 15: Northern Summer Lake Basin Water Rights on Ground Water.

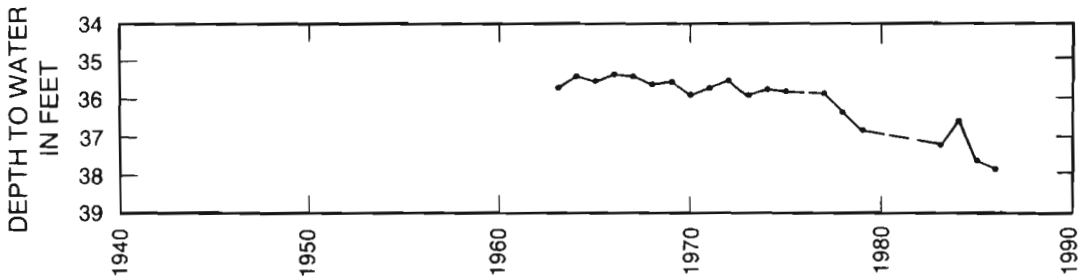


Figure 16: July Water Levels at Well T30S/R16E-1cb.

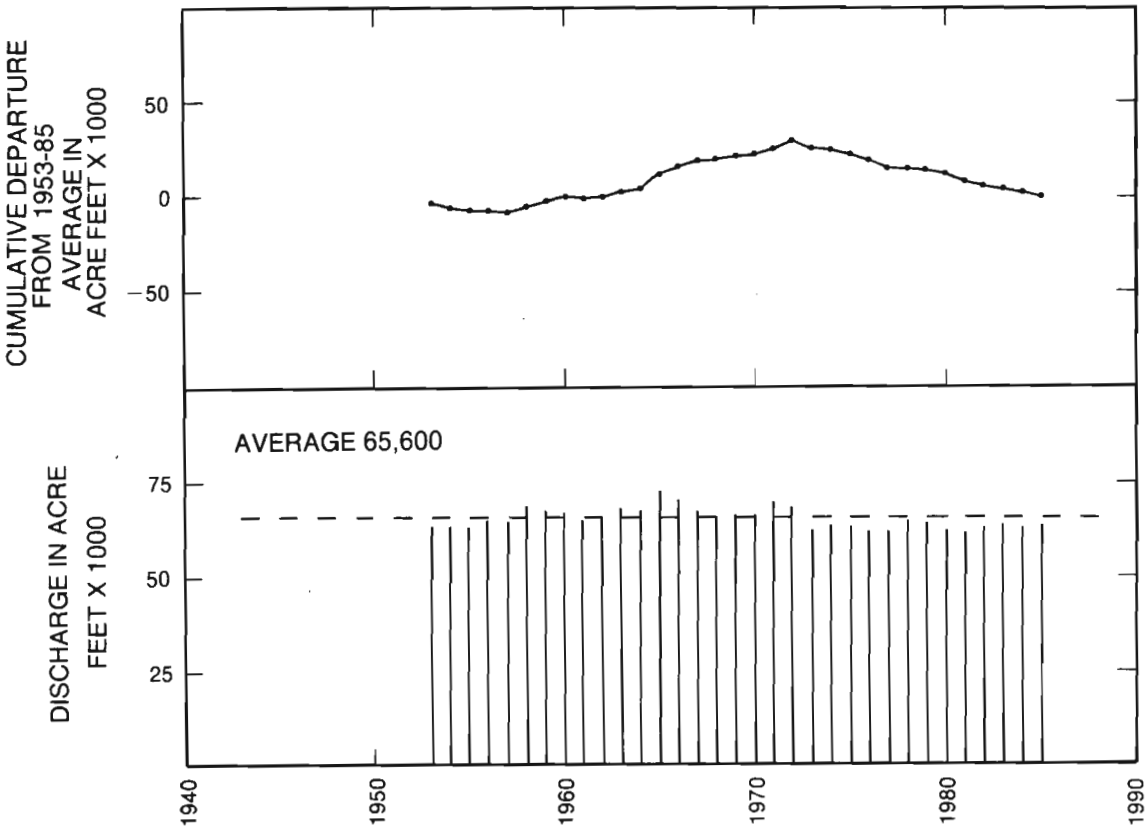


Figure 17: Discharge and Departure from Average Discharge for Water Years in Acre-Feet: 1953-85 (Ana River, Oregon).

APPENDIX IX

PROCLAMATION FOR THE INITIATION OF PROCEEDING FOR THE DETERMINATION OF A CRITICAL GROUND WATER AREA

BEFORE THE WATER RESOURCES DIRECTOR OF OREGON

LAKE, KLAMATH AND DESCHUTES COUNTIES

IN THE MATTER OF INITIATION OF A CRITICAL GROUND WATER AREA DETERMINATION IN THE FORT ROCK BASIN	))))	PROCLAMATION

The intiation of a critical ground water area proceeding is hereby proclaimed pursuant to OAR 690-10-050 in the Fort Rock Basin. The proposed exterior boundaries of this area, which include parts of Lake, Klamath and Deschutes Counties, are described as follows:

> Beginning at the southwest corner of Section 35, Township 22 South, Range 13 East, WM; thence northeasterly to the southeast corner of Section 25, Township 22 South, Range 15 East, WM; thence southeasterly to the southwest corner of Section 35, Township 23 South, Range 19 East, WM; thence southeasterly to the southeast corner of Section 9, Township 28 South, Range 21 East, WM; thence southwesterly to the southwest corner of Section 6, Township 29 South, Range 20 East, WM; thence northwesterly to the southwest corner of Section 16, Township 28 South, Range 18 East, WM; thence southwesterly to the southwest corner of Section 14, Township 29 South, Range 16 East, WM; thence southwesterly to the southeast corner of Section 21, Township 31 South, Range 15 East, WM; thence northwesterly to the southeast corner of Section 36, Township 30 South, Range 12 East, WM; thence northwesterly to the southwest corner of Section 34, Township 26 South, Range 10 East, WM; thence northeasterly to the point of beginning.

This initiation of proceedings for the determination of a critical ground water area is brought under ORS 537.730(a) and ORS 537.730(d). ORS 537.730(a) allows for such action when

> "Ground water levels in the area in question are declining or have declined excessively".

ORS 537.730(d) allows for such action when

> "The available ground water supply in the area in question is being or is about to be overdrawn".

Preliminary investigation has disclosed that water level declines are occurring at rates which reflect a close match between recharge and pumping demand. Such conditions would provide water level equilibrium in the future at somewhat lower water levels. Further appropriation threatens to overdraw the reservoir and may result in water level declines which will not equilibrate in the future.

The ground water reservoir covered by this proclamation is herein termed the "Main Ground Water Reservoir". This reservoir includes all water contained in the basalt, as well as the interbedded and overlying pyroclastic and sedimentary aquifers. Further, the potentiometric level of water in these aquifers is approximately 4300 feet above mean sea level or lower.

Prior to completion of the proceeding for determination of a critical ground water area, no application for a permit to appropriate water from the Main Ground Water Reservoir will be approved or denied.

Dated at Salem, Oregon this 26th day of March, 1984. This proclamation is effective immediately.

WILLIAM H. YOUNG
Director

BASE FROM USGS STATE BASE MAP, 1979

PLATE 1

MAP SHOWING THE FORT ROCK BASIN, AREA OF GROUND WATER CONTROL, AND GAGING STATION LOCATIONS

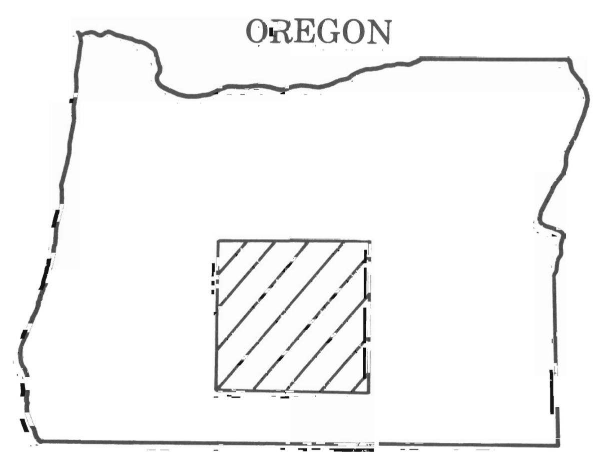
LEGEND

BASIN BOUNDARY. Solid line shows approximate location of the Fort Rock Basin topographic boundary.

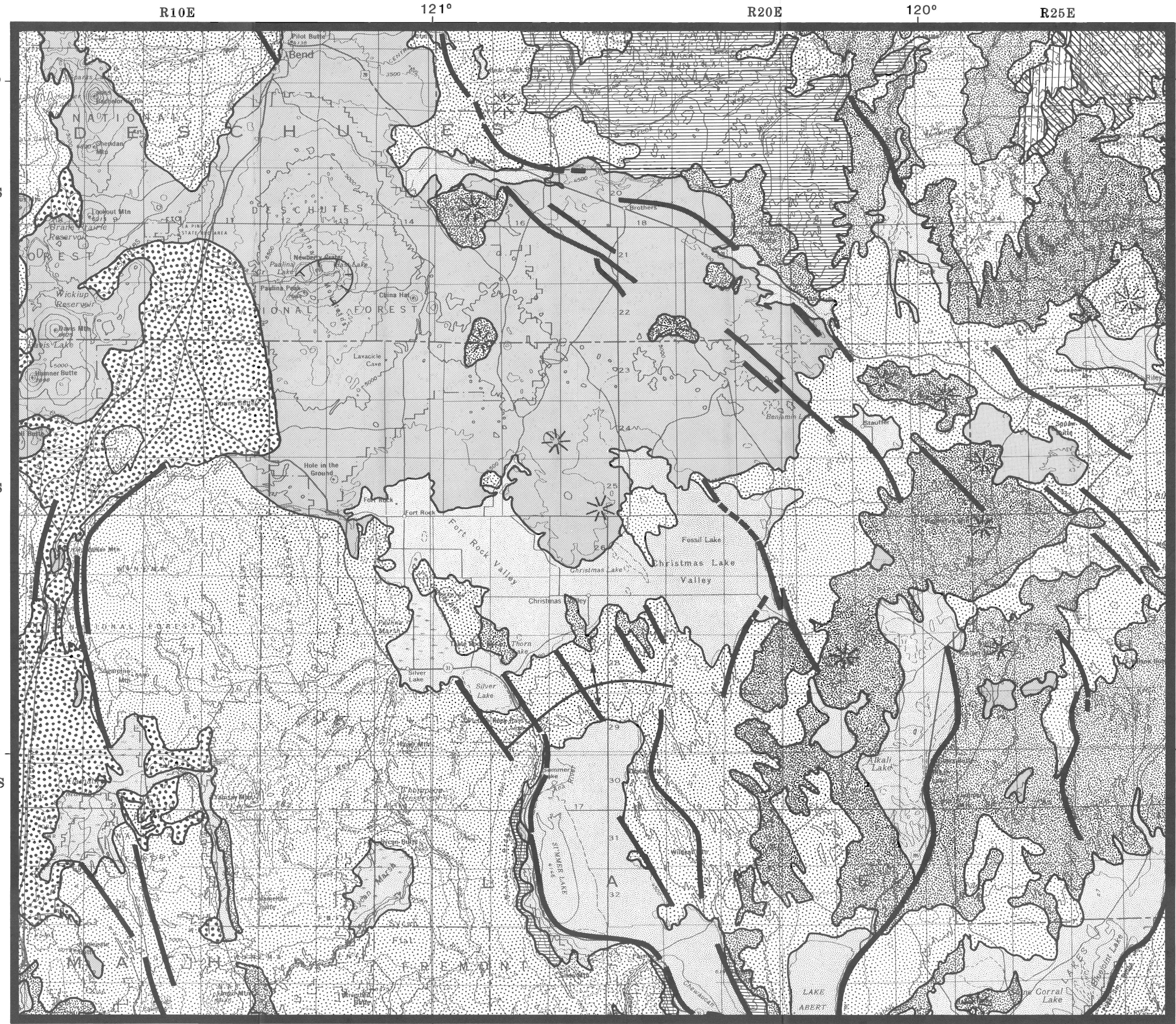
GROUND WATER CONTROL AREA BOUNDARY. Dashed line shows boundary of area controlled by the Proclamation of the Water Resources Director of March 26, 1984.

● PRECIPITATION GAGING STATION. Circle shows location of precipitation gaging station with station name.

▲ SURFACE WATER GAGING STATION. Triangle shows location of surface water gaging station with station name.



AREA OF THIS PLATE



SCALE 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

N

BASE FROM USGS STATE BASE MAP, 1979

PLATE 2

GEOLOGIC MAP OF THE FORT ROCK BASIN REGION OF SOUTH-CENTRAL OREGON

LEGEND

QUATERNARY alluvium, lake sediments, fluvioglacial deposits and pumice.

QUATERNARY pumice and ash.

LATE CENOZOIC basalt and andesite.

YOUNGER CENOZOIC (Miocene and Pliocene) continental sedimentary rocks, ash-flow tuffs, some interbedded rhyolite flows.

YOUNGER CENOZOIC (Miocene and Pliocene) basalt and andesite flows and minor continental sedimentary rocks.

OLDER CENOZOIC (Eocene, Oligocene and early Miocene) volcanic and continental sedimentary rocks.

MESOZOIC sedimentary and volcanic rocks.

PALEOZOIC sedimentary rocks.

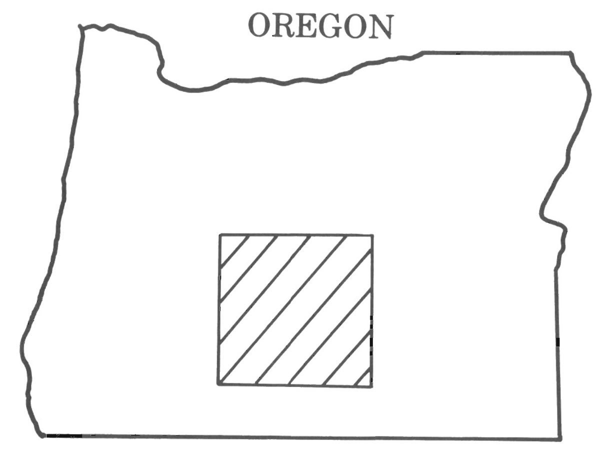
Major volcanic vents and domes of Cenozoic age.

Fault, dotted where concealed.

Large volcanic crater.

Anticline, arrows show dip from axis.

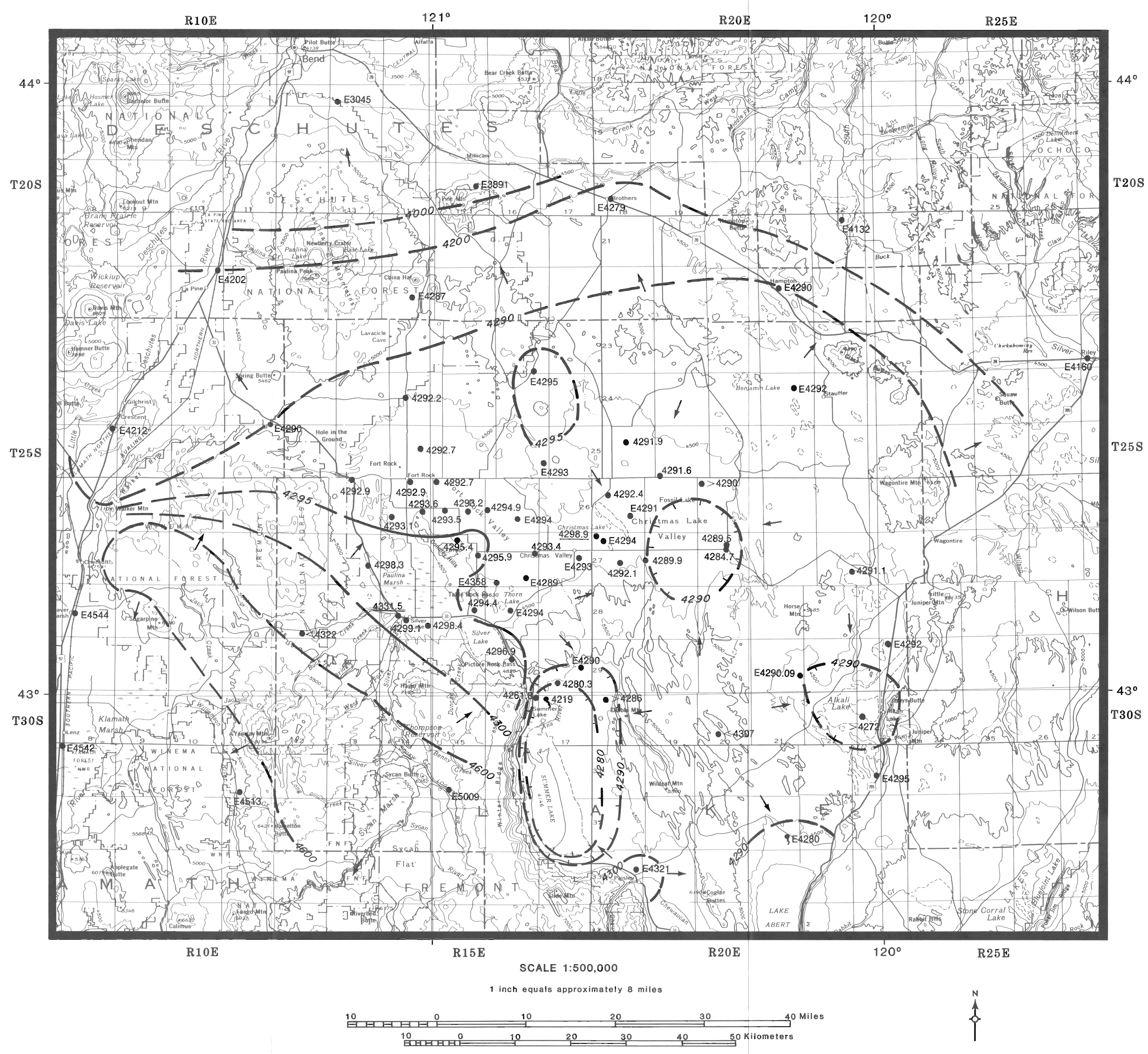
(Geology after Weissenborn, 1969)



AREA OF THIS PLATE

PLATE 3

POTENTIOMETRIC SURFACE MAP OF THE FORT ROCK BASIN REGION OF SOUTH-CENTRAL OREGON APRIL/MAY 1986



BASE FROM USGS STATE BASE MAP, 1979

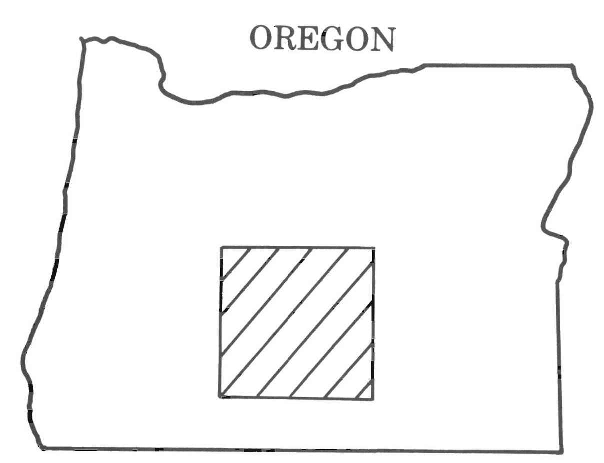
LEGEND

-4200- POTENTIOMETRIC CONTOUR. Solid line shows approximate altitude of the ground water level. Dashed line shows inferred altitude. Depression shown by hachures inside closed contours. Contour interval is variable and listed in feet. Datum is mean sea level.

● 4293.1 WELL. Number is altitude of the ground water level in feet. Altitude preceded by (E) indicates an estimate usually within 2 feet based on a combination of uncertainties in wellhead elevation and water level. Altitude preceded by (<) indicates an estimate less than the listed value while (>) indicates greater than the listed value. An underlined altitude shows a ground water level which is not part of the main ground water reservoir of the Fort Rock Basin or the regional water table outside the basin.

4219 SPRING. Number is altitude of spring water at point of issuance or spring pond.

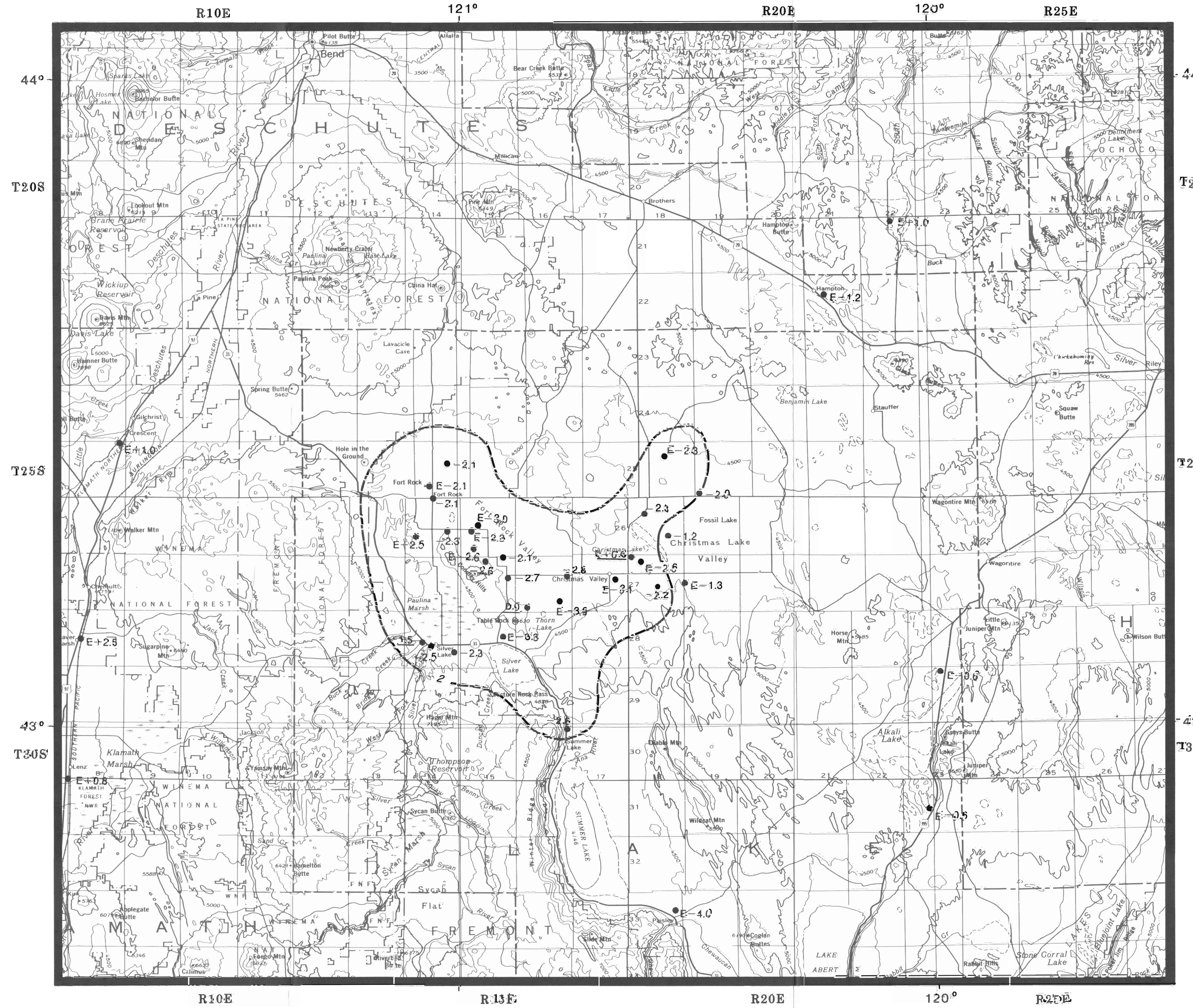
→ GROUND WATER FLOW DIRECTION. Arrow shows inferred flow direction based on potentiometric levels and topography.



AREA OF THIS PLATE

PLATE 4

POTENTIOMETRIC CHANGE MAP OF THE FORT ROCK BASIN REGION OF SOUTH-CENTRAL OREGON, JANUARY 1976 TO JANUARY 1986



SCALE 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

10 0 10 20 30 40 50 Kilometers

N

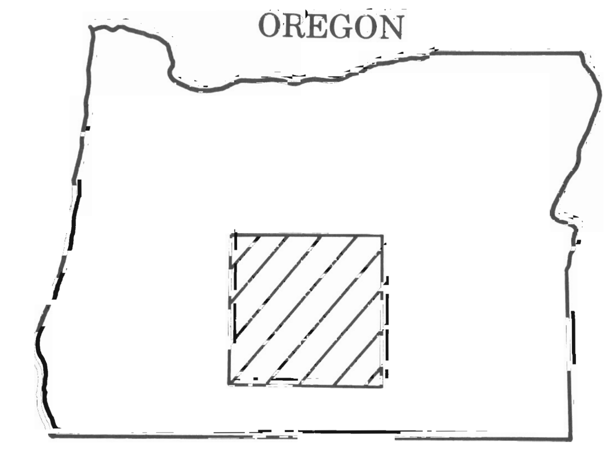
BASE FROM USGS STATE BASE MAP, 1979

LEGEND

-- 2 -- POTENTIOMETRIC CHANGE CONTOUR. Solid line shows approximate change of the ground water level in feet. Dashed line shows inferred change.

-2.1 WELL. Number is change of the ground water level in feet. Change preceded by (E) indicates an estimate usually within 0.2 foot. An underlined change shows a ground water level change which is not part of the main ground water reservoir of the Fort Rock Basin or the regional water table outside the basin.

OREGON



AREA OF THIS PLATE