Ground-Water Resources of the San Luis Valley Colorado

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1379

Prepared in cooperation with the Colorado Water Conservation Board and the United States Bureau of Reclamation

Ground-Water Resources of the San Luis Valley Colorado

By WILLIAM J. POWELL

With a section on

An Inflow-Outflow Study of the Area

By PHILIP B. MUTZ

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1379

Prepared in cooperation with the Colorado Water Conservation Board and the United States Bureau of Reclamation

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1958

UNITED STATES DEPARTMENT OF THE INTERIOR

FRED A. SEATON, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.

CONTENTS

ILLUSTRATIONS

[All plates in pocket except as indicated]

TABLES

GROUND-WATER RESOURCES OF THE SAN LUIS VALLEY, COLORADO

By WILLIAM J. POWELL

ABSTRACT

An area of 1,500 square miles in the San Luis Valley, Colo., comprising parts of Saguache, Rio Grande, Alamosa, and Conejos Counties, is underlain by a thick sequence of Tertiary and Quaternary water-bearing sedimentary rocks that have long been used as a source of supply of ground water for domestic, stock, irrigation, and other uses. The investigation upon which this report is based was concerned primarily with the determination of the probable quantity and quality of ground water that would be intercepted by the proposed closed basin drain and the determination of ground-water conditions in the area irrigated by diversions from the Rio Grande, where large quantities of ground water are being withdrawn for irrigation.

The area, characterized by low topographic relief, includes large areas of relatively flat land. The southern part is drained by the Rio Grande, and the northern part, in a so-called closed basin, has no drainage outlet. Because of the high mountain ranges that border the valley, the area has an arid climate.

Data in the report indicate that the shallow ground water that would be intercepted by the proposed closed basin drain would be adequate in quantity but not of a quality that would meet requirements unless it could be diluted with a much larger amount of water of better quality.

The storage of ground water in the shallow aquifer in the area of inflow-outflow study probably can be correlated with the operation of the proposed Wagon Wheel Gap Reservoir, provided a network of selected observation wells is maintained in the area and the position of the ground water divide is carefully recorded. The amount of ground water leaving the area by way of the artesian aquifers probably cannot be determined but can be assumed to remain relatively constant. The data presented should enable the determination of whether the system of subirrigation should be restricted to certain areas and whether certain areas can be irrigated best by subirrigation or by pumping ground water.

The pumping of shallow ground water during years of very low runoff may lower the water table to the extent that subirrigation may be difficult or impossible in certain areas. On the other hand, the pumping of ground water is the only means of salvaging crops during those years.

The shallow aquifer in the area of inflow-outflow study is recharged almost entirely by the application of surface water for irrigation. It is capable of supplying all the water needed for irrigation in the area for a period of only a few years if no surface water is available for recharge. Although the shallow unconfined aquifer is overdeveloped locally, there are

large areas in which additional supplies can be made available with the result that the present loss of water by evapotranspiration in the sump area of the closed basin will be reduced.

The use of deep artesian wells appears to have relatively little effect upon the supply of water in the shallow confined and unconfined aquifers, for the confining layers of clay seem to be thicker and more extensive with depth. The recharge to the deeper aquifers probably is restricted largely to areas beyond the present limits of development of shallow ground water for irrigation.

Water in the shallow artesian aquifers moves from the sides of the closed basin toward the sump area, where much of it moves upward through leaky and lenticular confining layers into the unconfined aquifer and is eventually lost by evapotranspiration; the remainder moves southward and discharges into the Rio Grande.

Water in the artesian aquifers is not fully developed, and relatively large additional supplies of water can be withdrawn. Owing to the danger of mutual interference of wells, however, adequate regard should be given to their proper spacing. The artesian water generally is of satisfactory quality for irrigation although locally it may be unsuitable.

The shallow unconfined water generally is of suitable quality for irrigation except in the sump area of the closed basin, where the percent sodium generally is too great. The belief that the shallow ground water is contaminated by the upward movement of artesian water into the shallow aquifer is false in that the artesian water is of better quality than the unconfined water. The shallow ground water appears to obtain most of its mineral constituents by solution during its lateral movement from the sides of the valley toward the sump area of the closed basin and by evapotranspiration.

INTRODUCTION

LOCATION AND EXTENT OF THE AREA

The part of the San Luis Valley, Colo., that is considered in this report includes about 12¼ townships in Saguache County, 9½ townships in Rio Grande County, 17¾ townships in Alamosa County, and 2½ townships in Conejos County—a total of approximately 42 townships, or about 1,500 square miles. Most of the area is in a so-called closed basin, in the northern part of the San Luis Valley; but a small part is in the valley of the Rio Grande. Its location is shown in figure 1.

PURPOSE OF THE INVESTIGATION

The results of two separate but closely related investigations of adjoining parts of the area are combined in this report. As these investigations were undertaken for different purposes, they will be considered separately.

The first investigation, begun in 1946, was concerned only with the sump area of the closed basin—the area east of State High-

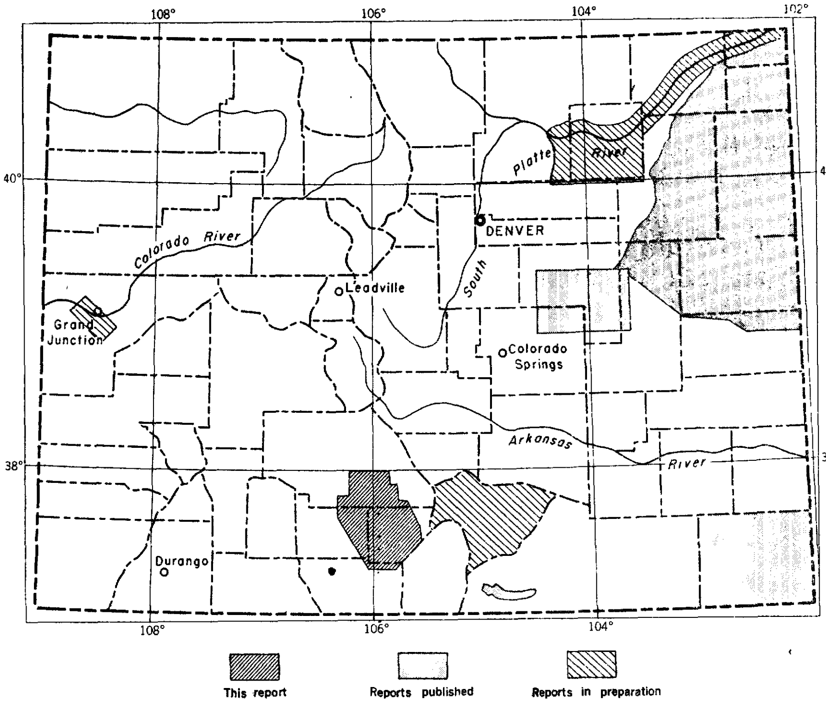


FIGURE 1.—Index map of Colorado, showing area described in this report and areas on which ground-water reports are published or are in preparation.

way 17 and north of U. S. Highway 160. (See pl. 1.) Its purpose was to determine the quantity and quality of ground water that would be intercepted by the proposed closed basin drain, which had been under consideration for some time by the State of Colorado and United States Bureau of Reclamation. The feasibility of the proposed drain depended upon the possibility of intercepting sufficient ground and surface water of a quality that would meet the requirements of the Rio Grande compact. The plan involved conduction of the water thus drained, if satisfactory as to quantity and quality, to the Rio Grande at a point below Alamosa and the diversion of a like quantity of water from the Rio Grande near Del Norte to augment the supply of irrigation water in the western part of the closed basin. The recoverable ground water was found to be adequate in quantity but unsatisfactory in quality, unless it could be diluted with a much larger amount of surface water. Studies of the surface-water supply available to the drain were made during the period of investigation (1946–52) by the Bureau of Reclamation. The weather was so dry during this period, however, that the needed quantity of surface runoff was not available. The ground-water studies, however, disclosed the availability of ground water of better quality in areas both east and west from the proposed drain site.

After the completion of the major field work in the sump area in 1947, the investigation was extended to include a detailed study of the ground-water conditions in the area irrigated by diversions from the Rio Grande where, since the beginning of the drought of the thirties, heavy withdrawals for irrigation were being made also by pumping from shallow wells and from a few deep artesian wells.

In addition to the completion of the study of the feasibility of the proposed closed basin drain, the major purpose of the enlarged investigation was to provide sufficient basic geologic and hydrologic data to assist the Colorado Water Conservation Board and the Bureau of Reclamation in determining (1) whether the use of underground storage could be correlated with the operation of the proposed Wagon Wheel Gap Reservoir in such a way as to insure the most efficient use of water and to minimize irrigation shortages (that is, whether the established subirrigation system should be restricted to certain indicated parts of the area, whether other parts could be irrigated best by surface flooding with water from the Rio Grande, and whether other parts could be irrigated best by pumping from shallow or deep wells, with substantial reliance placed upon the use of ground-water storage during periods when the proposed Wagon Wheel Gap Reservoir would not supply the full requirements); (2) the effect of pumping shallow ground water from the same ground-water reservoir that has been maintained for subirrigation; (3) the effect of the use of deep artesian water wells on the supply of shallow confined and unconfined ground water; and (4) the suitability of deep artesian water for irrigation.

THE CLOSED BASIN COMMITTEE, AND DIRECTION OF THE INVESTIGATION

Soon after the creation of the Colorado Water Conservation Board in 1937, the late Clifford H. Stone, first director of the board, appointed a Closed Basin Committee to direct and guide hydrologic studies in the closed basin of the San Luis Valley. The first members of this committee were E. B. Debler, representing the U. S. Bureau of Reclamation; C. V. Theis, representing the U. S. Geological Survey; and R. J. Tipton, representing the Colorado Water Conservation Board. At meetings on September 7, 1940, and June 24, 1941, the committee planned investigations of several alternative lines for the proposed closed basin drain. The investigations were carried on subsequently by the Bureau of Reclamation.

After the beginning of the Colorado cooperative ground-water program by the Colorado Water Conservation Board and the Geological Survey in July 1945, Judge Stone reactivated the Closed Basin Committee, with membership as follows: D. M. Forester, project engineer, San Luis Valley project, representing the Bureau of Reclamation; S. W. Lohman, district geologist, representing the Geological Survey; and R. J. Tipton, chairman, representing the Colorado Water Conservation Board. The first meeting of the new committee, held at Monte Vista, October 8–10, 1945, was attended also by C. V. Theis, the former Geological Survey member, and other personnel of the Geological Survey, Bureau of Reclamation, and Rio Grande Compact Commission. At this and later meetings, the committee formulated the plans for the ensuing cooperative ground-water investigations in the San Luis Valley, gave general direction to the program, and periodically advised the three cooperating agencies of the progress of the work.

After his transfer to another State in 1947, Mr. Forester was replaced on the committee by W. H. Sweet, as project engineer of the San Luis Valley project, to represent the Bureau of Reclamation. In 1952, Mr. Lohman was replaced on the committee by T. G. McLaughlin, district geologist, to represent the Geological Survey. Mr. Lohman, however, continued to serve in an advisory capacity.

The ground-water phase of the investigation was financed in part by the Colorado Water Conservation Board and the Geological Survey but in large part by the Bureau of Reclamation. In addition to supplying both funds and personnel for the ground-water studies, the Bureau of Reclamation carried out other related investigational work in the area, including land-use studies, measurement of flows in all irrigation canals and drainage ditches, and measurement of precipitation at selected points.

The investigation was under the general supervision of the Closed Basin Committee. The ground-water phase, with which this report is concerned, was under the immediate supervision of S. W. Lohman until 1952, and thereafter it was under the immediate supervision of T. G. McLaughlin. The Geological Survey's participation was carried on under the general administration of the late O. E. Meinzer through 1946 and, thereafter, of A. N. Sayre, successive chiefs of the Ground Water Branch, U. S. Geological Survey.

PREVIOUS INVESTIGATIONS

According to an old report (Carpenter, 1891), artesian water was discovered accidentally in the San Luis Valley in the fall of 1887, while an ordinary sand point was being driven. This discovery brought about such prompt and widespread development that by 1891 there were an estimated 2,000 flowing wells in the valley. The accelerated use of artesian water led to the classic study of the geology and artesian water supply by Siebenthal (1910). At the time his field work was completed in 1904, there were 3,234 flowing wells in the valley.

During the 25-year period following Siebenthal's detailed report, no extensive investigations were made; however a few brief studies during this period touched on the artesian water and related problems. In 1916 W. N. White (1916) of the Geological Survey estimated that there were 5,000 artesian wells in the valley. During the period 1927–30, Tipton and Hart (1931) conducted consumptive-use studies, by means of evaporation tanks, and made drainage studies.

Studies in the San Luis Valley were made in connection with the work of the Rio Grande Joint Investigation of the National Resources Committee. They resulted in a report by Bryan (1938) on the geology and general ground-water conditions in the valley of the Rio Grande, including the San Luis Valley, and a report on ground water in the San Luis Valley by Robinson and Waite (1938), in which the authors estimated that more than 6,000 flowing wells had been drilled in the valley by the end of 1936.

In a special report on the San Luis Valley project, Tipton (1939) gave preliminary estimates on the construction, cost, yield, operation, and benefits of an earlier proposed closed basin drain. A U. S. Department of Agriculture report (Bayard and Ahrens, 1943) recommended financing, under the Water Facilities Act, the construction of shallow irrigation wells along the west side of the San Luis Valley as a means of relieving the water shortage.

HISTORY AND METHODS OF INVESTIGATION

FIELD WORK

1946.—Thirty-three test wells and 6 observation wells were drilled along the line of the proposed closed basin drain. For observing water levels during pumping tests, 167 jetted and bored observation wells and 156 temporary jetted wells were constructed (pl. 2). Twenty-seven of the 33 test wells, each related to 6 observation wells, were test-pumped. Gaging stations were established on creeks and drains tributary to the sump area, and level lines were run to the observation wells. Water levels were measured in the observation wells. Samples of water were collected from lakes, streams, shallow wells, and deep artesian wells. Cross sections, based on logs of the test wells, were prepared.

1947.—Forty-seven jetted or bored observation wells were constructed. Water levels in observation wells were measured, gaging stations were maintained, and additional samples of water were collected in the sump area. Water-table contour maps for the sump area were prepared, and the results of the pumping tests were computed. The yield of the proposed drain was estimated. Based on the analyses of many samples of water, the average quality of ground water that may be intercepted by the proposed drain was estimated.

Except for continued observation of water levels and streamflow, the studies of the proposed closed basin drain were practically completed by the end of the 1947 season.

An inventory of nonirrigation wells north of Monte Vista was begun as the first part of the expanded investigation of the irrigated area of the valley.

1948.—Additional water samples were collected, artesian wells in the northern part of the area were inventoried, and an inventory of irrigation wells was begun. The discharge rates of nearly all flowing artesian wells that were visited were measured or estimated. Pumping tests of 6 irrigation wells were conducted, using 6 temporary jetted observation wells for each test; 139 other observation wells were sunk. Automatic recorders were installed on 6 unused irrigation wells, and lines of levels were run to wells in which water levels had been measured. The following instruments were installed and maintained: 10 nonrecording rain gages, 21 gaging stations on canals entering the irrigated area, and 43 gaging stations on ditches draining the area.

1949.—Eight temporary test wells and 11 test holes, aggregating 1,228 feet, were drilled; pumping tests were conducted on the 8 test wells, using 6 jetted observation wells for each test. Fifty-one other jetted observation wells were put down. The collection of water samples continued. More wells were inventoried, additional observation wells were established, and additional lines of levels were run to wells and test holes. Observation wells that were equipped with recorders were serviced, and other observation wells were maintained. Maintenance of gaging stations and rain gages continued. Aerial photographs of the sump area were made periodically as a means of estimating the extent of sheetflooding by streams.

1950.—The inventory of wells in the area south of the Rio Grande was completed. Flow and head tests were made on 8 flowing wells, and head tests were made on 4 other flowing wells. Additional water samples were collected and additional levels were run. The observation wells and the rain and stream gages were maintained.

The major part of the field work was completed by the end of the season in 1950, except for 2 years of additional records.

1951–53.—The field work was completed, including measurement of the discharge of wells, determination of the cost of pumping and the efficiency of wells, continued measurement of water levels in the observation wells, continued maintenance of the gaging stations and rain gages, and the running of levels to the remaining wells.

PREPARATION OF REPORT

The base maps for plates 1, 8, 9, and 10 were prepared by the Bureau of Reclamation. The "Introduction" and the section on the quantity and quality of ground water available to the proposed closed basin drain were prepared by S. W. Lohman; the remainder of the text was prepared by the author, with a great amount of assistance by T. G. McLaughlin. The section on the inflow-outflow study, prepared by Philip B. Mutz of the Bureau of Reclamation, is a supplement to this report.

The report contains analyses of 1,079 samples of water made in laboratories of the Geological Survey in Albuquerque and Salt Lake City, mainly by V. E. Arnold, W. M. Webster, E. L. Singleton, and E. F. Williams, but in part by H. R. Simms, C. S. Howard, J. B. Kindler, W. M. Noble, R. T. Kiser, and E. V. Jaramillo. Analyses of 48 samples of water collected prior to this investigation were made by the Bureau of Reclamation.

Included also are tabulated records of 2,162 wells, sample logs of 250 test holes, and drillers' logs of 41 wells and oil-test holes.

ACKNOWLEDGMENTS

The writer is indebted to many Federal employees for their participation in various phases of the investigation and to the many well owners and drillers, city and county officials, and others in the area who supplied information about wells or rendered other courtesies. The writer was assisted in the field work primarily by W. Kenneth Bach of the Geological Survey and Philip B. Mutz, Ward Mathias, Harry R. Simcox, Lester Williams, and Carl Slingerland of the Bureau of Reclamation.

C. V. Theis, former Geological Survey member of the Closed

A. PUTTING DOWN OBSERVATION WELL BY MEANS OF COMPRESSED AIR.

B. PULLING WELL PIPE AFTER COMPLETION OF TEST.

JETTING OBSERVATION WELLS.

Basin Committee, made available his unpublished report concerning the method used in this investigation for determining the quantity of ground water that may be intercepted by the proposed closed basin drain, and he gave helpful advice during the October 1945 meeting of the committee. R. J. Tipton of the Colorado Water Conservation Board, as chairman of the Closed Basin Committee and as an engineer with long experience with water problems in the San Luis Valley, offered valuable advice on many phases of the investigation.

The following drillers supplied logs of wells: Harold P. Doty, B. Smith, Howard and Ora Platz, R. Biggs, J. Sanford, H. A. Dewey, V. Wheeler, and Edward Warner.

The following ranch owners consented to the use of their wells and premises for the pumping or flow tests: John Gariatakis, R. F. McNitt, Roy Lofton, the late Jim Fogal, Grant E. Oxley, Jim Crow, Limon and Howard Linger, Mrs. A. Murray, J. Ross, John Berry, Van I. Warden, Gervet Gesink, William J. and Leslie P. Getz, and Frank Sheldon. Stanley and John Stribling, Victor Crow, and William Hagan assisted materially in locating many wells on their large tracts of land.

Ray W. Villyard and Web Allison of the Rural Electrification Administration and the Public Service Co. of Colorado provided data on power consumption by well-pumping plants. K. Montgomery and Ronald Iske of Monte Vista and P. H. Henry and C. R. Bollier of Alamosa, city officials, supplied records of public water supplies. Joseph R. Clair, Denver Sample Log Co., furnished the log and samples of drill cuttings from an oil test near Center. K. Bryning, engineer for the Rio Grande Canal, assisted in locating wells.

Ivan C. Crawford, director, and R. J. Tipton, engineer, Colorado Water Conservation Board, read the manuscript of this report.

WELL-NUMBERING SYSTEM

Well numbers appearing in this report are based on the U. S. Bureau of Land Management system of land subdivision. The number shows the location of the well by township, range, section, and position within the section. A graphical illustration of this method of well numbering is shown in figure 2. The first numeral indicates the township, the second indicates the range, and the third indicates the section in which the well is situated. The lowercase letters following the section number locate the well within the section. The first letter denotes the quarter section, and the second letter denotes the quarter-quarter section. The

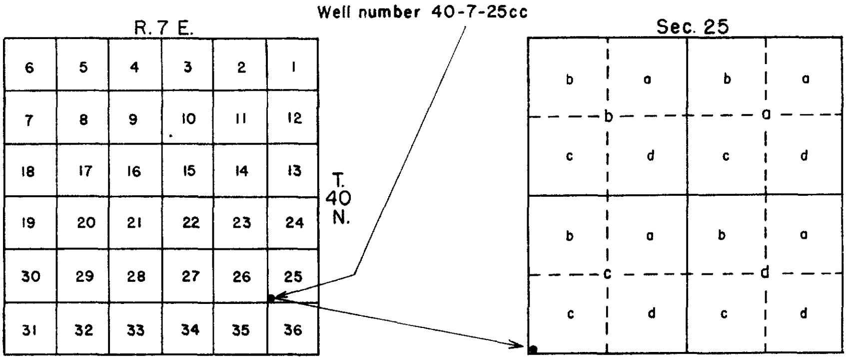


FIGURE 2.—Well-numbering system.

letters are assigned in a counterclockwise direction, beginning with (a) in the northeast quarter of the section or of the quarter-quarter section. If more than one well is in a quarter-quarter section, consecutive numbers beginning with 1 are added to the well numbers. For example, the well number 36–8–1aa2 indicates a location in the northeast quarter of the northeast quarter of sec. 1, T. 36 N., R. 8 E., and shows that this is the second well inventoried in the quarter-quarter section.

The locations of test holes and test wells are shown on plate 16. Numbers assigned to test holes and test wells are consecutive and are in order by townships from south to north and by ranges from west to east. Within a township, the wells are numbered in the order of the sections.

GEOGRAPHY

TOPOGRAPHY AND DRAINAGE

The San Luis Valley lies in a broad structural depression between high mountain ranges that converge to the north. The valley, about 115 miles long, extends from Poncha Pass at the north to a point about 15 miles south of the New Mexico State line. Its maximum width is about 50 miles, at the latitude of Del Norte. The San Luis Hills, a series of low basalt-capped hills and mesas that rise 500 to 1,000 feet above the valley floor, lie in the southern part of the valley in the vicinity of San Luis and adjacent to the Rio Grande.

This report is concerned primarily with the part of the valley that lies north of the San Luis Hills, which generally is regarded as the San Luis Valley proper. It is about 85 miles long and includes the widest portion of the valley. The valley has not been mapped by modern methods, but the reconnaissance map prepared by Siebenthal (1910, pl. 1) gives a clear picture of its topography.

The majestic Sangre de Cristo Mountains, the eastern boundary of the valley, contain several peaks that have altitudes of more than 14,000 feet. Sierra Blanca, the highest peak in the range, has an altitude of 14,363 feet. The western boundary of the valley is formed by the San Juan Mountains, which attain altitudes of about 9,600 to more than 14,000 feet. The floor of the valley, relatively flat, ranges in altitude from about 7,500 feet in the sump area of the closed basin to more than 8,000 feet on the alluvial fans. The relief from the peaks to the valley floor is about 6,800 feet; the relief of the valley floor proper is about 500 feet.

The San Luis Valley is an asymmetric basin with a topographic depression along its eastern side. West of the depression the valley floor slopes eastward at the rate of about 6 feet per mile, except on the alluvial fans where the slope is as much as 50 feet per mile (fig. 3). East of the depression the valley floor rises steeply to the base of the Sangre de Cristo Mountains, the slope being as much as 150 feet per mile in places. The Rio Grande alluvial fan is the most extensive fan in the area, spreading out over the valley for a radius of nearly 20 miles from Del Norte, the point at which the Rio Grande enters the valley from the mountains to the west. The gradient of the alluvial fan is so slight that a topographic map is required to observe its extent.

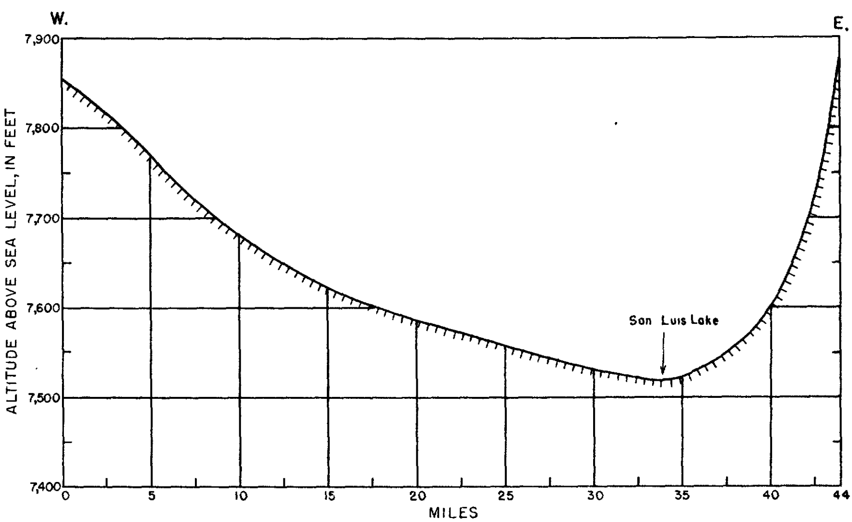


FIGURE 3.—Profile of San Luis Valley from a point 0.2 mile east of Del Norte to a point 10 miles east of San Luis Lake.

Small, subdued sand dunes afford local relief of 10 to 20 feet throughout a large area on the eastern side of the valley, and they are covered by vegetation in most places. Active sand dunes having a relief of about 800 feet are concentrated in an area at the base of the Sangre de Cristo Mountains near Mosca and Medano Passes. About 36,000 acres of this area was designated the Great Sand Dunes National Monument by an act of Congress in 1932.

Most of the area described in this report lies within the closed basin, which has no drainage outlet, but the remainder of the area is drained by the Rio Grande. The closed basin is separated from the basin of the Rio Grande by a ground-water and topographic divide that occupies a position roughly parallel to, and generally about 1 to 3 miles north of, the Rio Grande. From a point about 8 miles east of Alamosa, the divide curves and trends northeastward toward the Sangre de Cristo Mountains. (See pl. 9 and Robinson and Waite, 1938, pl. 11.) The topographic divide is barely perceptible at some places, but elsewhere it stands as much as 20 feet above the adjacent valley floor.

The Rio Grande enters the San Luis Valley from the west at Del Norte and follows a southeasterly course to Alamosa, whence it flows southward through a narrow cut in the San Luis Hills at Los Sauces. (See fig. 6.) All the larger tributaries of the Rio Grande, including the Conejos, La Jara, and Alamosa Rivers, originate in the Conejos Mountains (part of the San Juan Mountains), from which they flow generally eastward to the Rio Grande.

La Garita, Carnero, San Luis, and Saguache Creeks, which originate in the La Garita and Saguache Mountains (parts of the San Juan Mountains), are the principal streams entering the closed basin from the west; and Big Spring, Crestone, Zapato, and Sand Creeks, which head in the Sangre de Cristo Mountains, are the principal streams entering from the east.

The principal lakes in the area are Russell Lakes, which are north of Monte Vista, and Soda, Head, and San Luis Lakes, which are in the depression (sump area) of the closed basin (pl. 1). During periods of high water, Head Lake overflows southward into San Luis Lake, which is the largest of the three lakes in the sump area. Several playas contain water only during extremely wet periods; normally they are encrusted with salts.

The highly developed western part of the closed basin is supplied with irrigation water mainly from the Rio Grande through the Rio Grande canal, Farmers' Union canal, San Luis Valley canal, and Prairie ditch. Some of the lateral canals or ditches and several drainage ditches extend eastward to, or near, the axis of the closed basin, and thus they contribute water to the lakes.

CLIMATE

The climate of the San Luis Valley is arid. It is characterized by slight precipitation and rapid evaporation in the lower parts of the valley and moderate rainfall in the surrounding mountains. During July, August, and September, local light rainstorms, accompanied by moderate winds, are common throughout most of the valley. The summer days and nights generally are cool, owing to the high altitude. The winters are cold but generally are free from excessive snowfalls and cloudy days.

The mean annual temperature at Monte Vista is 41.8°F. The mean monthly temperatures and normal monthly precipitation at Monte Vista are shown in figure 4. Normal annual precipitation is 8.38 inches at Del Norte, 7.10 inches at Monte Vista, and 8.45 inches at Saguache (fig. 5). The average growing season for the three stations ranges from 94 to 140 days.

AGRICULTURE

Agriculture, the principal industry in the San Luis Valley, is dependent largely on irrigation with both surface water and ground water. Owing to the arid climate and relatively high altitude of the valley, the crops are restricted mainly to small grains, potatoes, hay, some vegetables, and native grasses. The

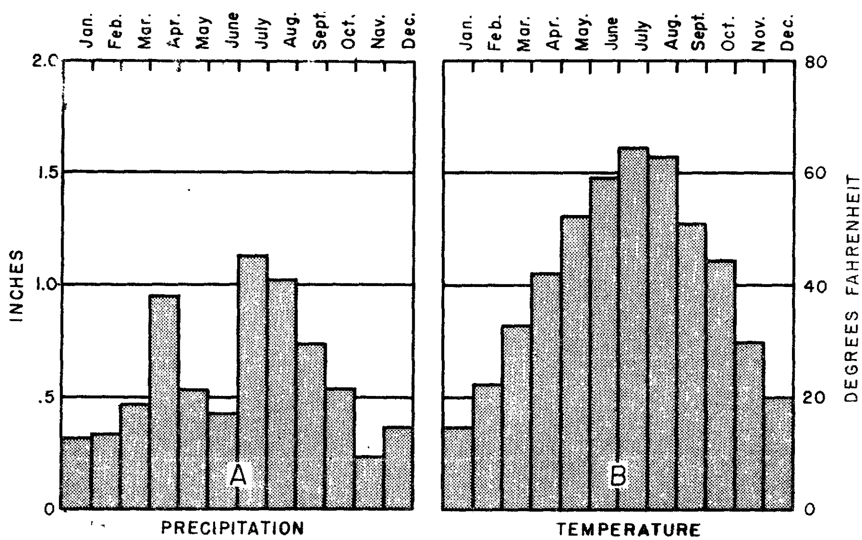


FIGURE 4.—Normal monthly precipitation and mean monthly temperatures at Monte Vista. *A*, Precipitation; *B*, temperature.

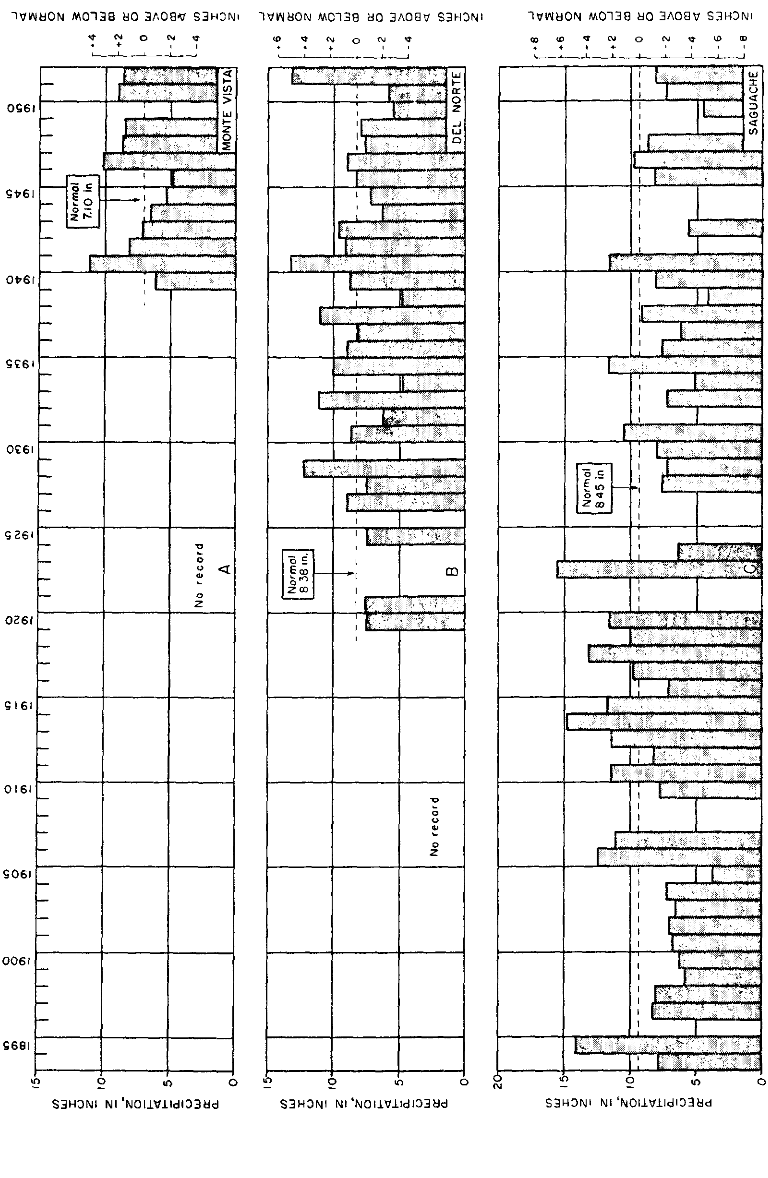


FIGURE 5.—Annual precipitation in San Luis Valley. *A*, Annual precipitation at Monte Vista; *B*, annual precipitation at Del Norte; *C*, annual precipitation at Saguache.

three principal types of farm enterprises in the valley are the potato farms and vegetable farms, the diversified farms, and the general livestock farms.

The potato farms and vegetable farms also generally produce some hay, grain, and livestock—primarily for soil conservation and crop rotation. Most of these farms are in areas having the best soils. They have the best sustained production, and they have fewer problems of alkalinity, salinity, and drainage.

Diversified farms, whose main crops are small grains, also produce potatoes, hay, and livestock. Diversification is necessary in order to make better use of the soils, which in part may be good but in part may be only fair or poor. Some of these farms have problems of alkalinity, salinity, and drainage.

General livestock farms coordinate the growth of crops with the major livestock program. Many of these farms are in areas in which the predominant pasturage is native meadow hay that is maintained by a shallow water table. Other parts consist of rangeland or wasteland, where the soil is alkaline or saline; parts are too high for meadowland, and other parts are of too poor quality to warrant development and reclamation for crops.

Most of the farms are "family-size"; that is, nearly 90 percent of them contain 160 acres or less, and most of these farms are under irrigation. Of the few very large farms in the valley, most consist chiefly of marginal land.

The steady development of communities in this agricultural area indicates the success of the farming. Development and improvement have been limited, however, by water supply and lack of research information. The best opportunities for improvement probably lie in the following directions: (1) stabilization of the water supply so that the oversupply of early spring water can be used to extend the short summer and fall supply; (2) minor changes in irrigation practices; (3) more research information concerning this particular area.

POPULATION

Because the area described in this report comprises parts of four counties, its exact population is not known. Much of the area consists of grazing and farm land, and so it is not heavily populated; many of the smaller towns and communities have a population of less than 100. The largest town in the area is Alamosa, which had a population of 5,354 in 1950, according to the United States Census Bureau. Other towns include Monte Vista (population 3,272), Del Norte (2,048), and Center (2,024).

TRANSPORTATION

The principal highways in the valley are U. S. Highways 285 and 160 and State Highways 15, 17, and 159. Highway 285 is the main north-south route in the western part of the area, serving the towns of Saguache, Monte Vista, Alamosa, Antonito, and the areas of concentrated farming north of Monte Vista and south of Alamosa. Route 160 is the main east-west highway through the area, connecting the towns of Fort Garland, Blanca, Alamosa, Monte Vista, and Del Norte. State Highway 15 is an oiled and graveled road extending southward from Monte Vista; and State Highway 17 is an oiled road that extends northward from Alamosa and joins Route 285 north of Saguache. State Highway 159, in the southeastern part of the valley, extends from Fort Garland southward to San Luis and into New Mexico. Most of the other State highways in the valley are graveled. In addition to the State and Federal highways, excellent county roads, most of which are surfaced with sand and gravel, traverse the area. Lines of the Denver and Rio Grande Western Railroad cross the valley in north-south and east-west directions, serving the towns of Alamosa, Monte Vista, Del Norte, La Jara, Antonito, Blanca, Fort Garland, Center, Mosca, Hooper, and Moffat. The Southern San Luis Valley Railroad extends southward from Blanca into New Mexico, and the San Luis Central railroad extends from Monte Vista to Center.

GEOLOGY

GENERAL FEATURES

The San Luis Valley is a structural basin bordered by faults on the east and perhaps also on the west. Structural relations on the west side of the valley are largely obscured by Tertiary volcanic rocks. The approximate location of the faults on the east side of the valley has been shown by Upson (1939). In contrast with some other structural basins, the area now occupied by the San Luis Valley probably was a highland during much of geologic time and, according to Siebenthal (1910, p. 29), did not receive sediments until Miocene time, when the deposition of the Santa Fe formation began. For the purpose of geologic description, the San Luis Valley area may be divided into four parts—the east range (Sangre de Cristo Mountains), the west ranges (San Juan Mountains), the San Luis Hills, and the valley proper (fig. 6).

The Sangre de Cristo Mountains (east range) consist of a northern part, which extends about 70 miles south-southeastward

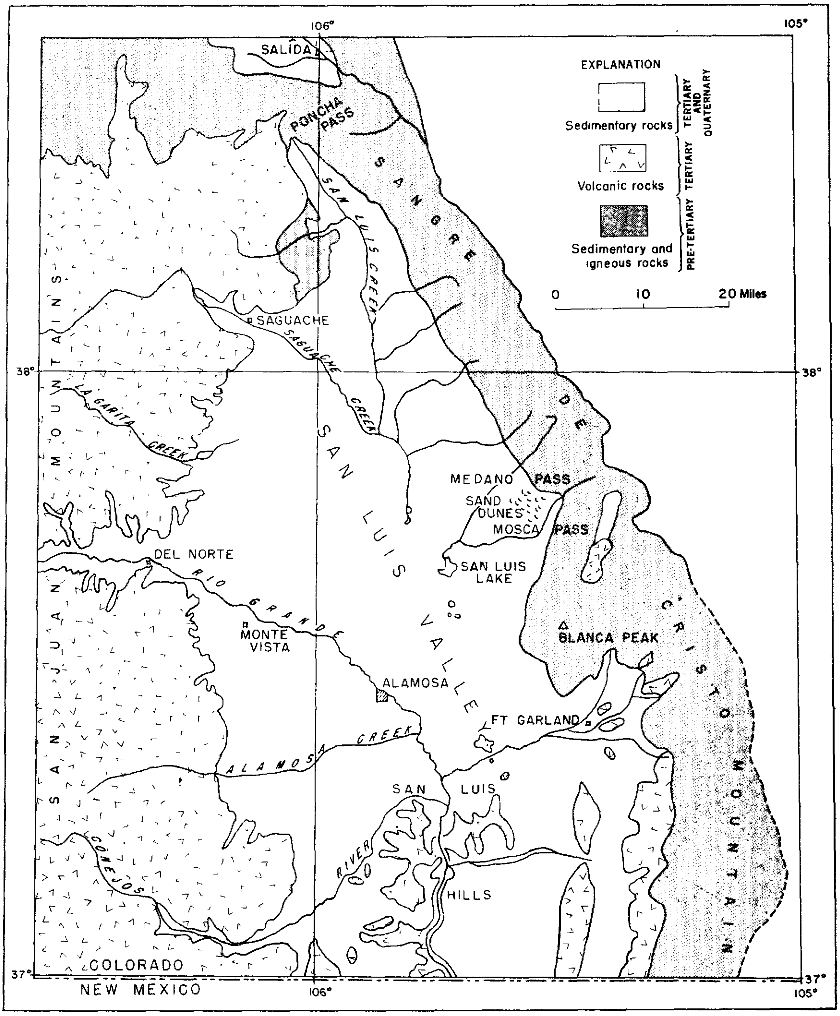


Figure 6.—Geologic sketch map of the San Luis Valley. (Modified from Burbank and Goddard, 1937, pl. 1.)

from a point near Poncha Pass to Sierra Blanca, and a southern part, locally called the Culebra Range, which is offset eastward from the northern part and extends southward into New Mexico. The Sangre de Cristo Mountains consist mainly of Paleozoic conglomerate, sandstone, shale, and limestone, and Precambrian granite, gneiss, and schist (Johnson, 1929). The range was subjected to at least two stages of Pleistocene glaciation (Siebenthal, 1910), which sculptured the present sharp peaks and produced moraines that extend to the heads of the large alluvial fans at altitudes of 9,000 to 9,500 feet.

The mountains on the west side of the valley are part of the San Juan Mountains and are composed principally of Tertiary volcanic rocks. Small areas northeast of Saguache, however, are underlain by Precambrian granite, schist, and gneiss, and by Paleozoic limestone, sandstone, and shale. The Tertiary volcanic rocks, which are of Miocene and Pliocene age, include rhyolite, latite, basalt, tuff, breccia, pumice, and andesitic flows. The volcanic rocks border the valley proper and slope toward the valley at 6° to 15°; they have been encountered in drill holes beneath the Pleistocene and Recent valley fill south of Monte Vista and beneath older sediments northeast of Center. The San Juan region was affected by three stages of glaciation in the Pleistocene epoch. A more complete discussion of the geology of the San Juan Mountains is given in the report by Cross and Larsen (1935).

The San Luis Hills consist of rhyolite, latite, and andesite, capped by younger basalt flows, which have been correlated with the Tertiary volcanic rocks of the San Juan Mountains.

The structural basin of the valley proper is filled with Tertiary and Quaternary deposits comprising the Santa Fe and Alamosa formations, which are described below.

TERTIARY DEPOSITS

SANTA FE FORMATION

CHARACTER

The type locality of the Santa Fe formation is in the region north of Santa Fe, N. Mex., between the Sangre de Cristo and Jemez Mountains, where the formation consists of gravel, sand, silt, volcanic ash, and a little clay. Most of those materials were laid down as coalescing alluvial fans in a basin which, at its maximum size, extended to the east, and probably far to the west, of its present limits (Denny, 1938). The most nearly complete exposures of the Santa Fe formation are north of Santa Fe, in gullies cut by tributaries of the Rio Grande. There, the formation consists of stream-laid gravel interbedded with andesite-basalt flows, volcanic tuff, silt, and clay. The most northerly outcrops of the gravel in the Santa Fe formation are at the north end of White Rock Canyon in northern New Mexico. Similar gravel occurs 20 miles south, at the south end of White Rock Canyon, where it is interbedded with andesite-basalt flows and with volcanic tuff (Bryan, 1938). Several outcrops of the Santa Fe formation occur in the San Luis Valley, but they are small and thus do not reveal fully the character of the formation. The most reliable data on the character of the formation in the San

Luis Valley are the logs of artesian wells and of deep oil tests. They reveal that the formation consists of conglomerate, sand, gravel, clay, lava, and volcanic debris.

Beds of lava have commonly been found in deep wells and oil tests in the valley, and in the area south of the Rio Grande the first lava flow encountered generally is considered to be the top of the Santa Fe formation. An analysis of available well logs, however, indicates that the flows are numerous and discontinuous and hence do not constitute a reliable stratigraphic marker, except locally. Many lava flows and great thicknesses of volcanic materials were found in a deep oil test north of the Rio Grande near Center (log 290), whereas only two flows have been found in the shallower wells south of the Rio Grande.

In the area south of the Rio Grande and west of Alamosa, the shallowest lava flow is generally found relatively near the surface—at a depth of 35 feet at Antonito (Siebenthal, 1910, p. 92), 235 feet at a point 17 miles north of Antonito (log 253), 390 feet at a point 20 miles north of Antonito (well 36–9–18bc), 435 feet in the Carmel district (well 37–9–32ac1), 420 feet at Monte Vista (well 39–8–31ca, log 265), and 900 feet at a point about 7 miles west-southwest of Alamosa (well 37–9–15dc). The town well at Alamosa, which was drilled to a depth of 1,802 feet, encountered no lava (log 261). It appears, therefore, that the first lava flow penetrated by wells south of the Rio Grande may be a single flow dipping steeply northeastward and terminating southwest of Alamosa and probably also southwest of well 37–9–15dc.

In the area north of the Rio Grande, several oil tests have revealed beds of lava, but the shallowest beds lie at such great depths (1,950 to 3,645 feet) they probably are not related to the relatively shallow lava south of the Rio Grande. It is likely, therefore, that none of the shallowest lavas north of the river are at the top of the Santa Fe formation, except perhaps locally.

The sand and gravel contained in the upper part of the Santa Fe is well rounded, indicating stream deposition. In places it is cemented with a calcareous material or clay. Hardpan and hard sand, which are mentioned in the drillers' logs and were reported to be beds of cemented sand, may range in thickness from about 4 feet (log 288) to about 50 feet (log 254) and are in places interbedded with loose sand and gravel, as indicated in log 251. The maximum size of the fragments found in the Santa Fe formation is about 12 inches in diameter. The layers of sand and gravel range in thickness from about 5 feet (log 257) to about 270 feet (log 254) and generally are interbedded with layers of clay or cemented sand.

The clay in the Santa Fe formation is firm, hard, and blocky, and it is pink, red, brown, and blue. Some clay layers are relatively thick, and others are thin and interfingered with sand and gravel. The logs indicate that the beds of clay are lenticular and may thin or pinch out within short distances. Well 36–9–18dc (log 258) penetrated 75 feet of clay below the first lava flow, whereas well 36–9–19dc (log 260), which is only 1 mile away, penetrated only 11 feet of clay mixed with sand and gravel below the first flow.

DISTRIBUTION AND THICKNESS

The Santa Fe formation underlies almost all the San Luis Valley. Many wells in the area south of the Rio Grande penetrate the formation; however, only three wells are believed to penetrate it in the area north of the Rio Grande, owing to the greater thickness of the overlying Alamosa formation in that area. The thickness of the formation in the San Luis Valley is not known, but it is reported to exceed 5,000 feet in northern New Mexico and there are indications that it may be greater in the San Luis Valley.

AGE AND CORRELATION

Vertebrate fossils taken from the Santa Fe formation were first considered by Cope (1874) to be of Miocene age, but more recent work by Frick (1933) has shown that the fauna originally described by Cope is early Pliocene. It has not been determined whether these fossils were taken from the upper or the lower part of the formation; in this report the formation is considered to be largely of Pliocene age but in part of Miocene age.

QUATERNARY DEPOSITS

ALAMOSA FORMATION

CHARACTER

The Alamosa formation, which was named after the town of Alamosa near the center of the valley, consists of beds of unconsolidated gravel, sand, silt, and clay. It underlies a large part of the valley but is well exposed only in the southern part, where the Rio Grande and its tributaries have cut into the upper part of the formation. As the formation is not well exposed, the most reliable data on its character are the logs of test holes, irrigation and artesian wells, and the few oil tests that have been drilled in the valley. The character of the upper part of the formation is best revealed by the logs of 52 test holes and test wells put down during the investigation at the points shown on plate 16. These logs are given in the Records section of this report and are shown graphically in plate 11. The most extensive exposure of the Alamosa formation in the valley is at Hansen Bluff, on the east bank of the Rio Grande southeast of Alamosa, where only 41.5 feet of sand, gravel, and clay crops out. The following is a description of a measured section in this area:

Measured section of the Alamosa formation along the east bank of the Rio Grande in NW¼ sec. 11, T. 36 N., R. 11 E., Alamosa County (measured by C. E. Siebenthal, 1910)

Description	Thickness (feet)
Recent deposits:	
Gravelly slope	4
Conglomerate, indurated sandy clay matrix	4
Alamosa formation:	
Fine gravel and sand, loose	3.5
Fine-grained, reddish sand	2.5
Black and red sand	.5
Drab joint clay, with a great many white indurated nodules	1.5
Coarse indurated sand and small quartz pebbles	4
Buff to light-drab sandy clay	10.5
Fine and coarse sand in laminae	5.5
Olive-green sandy joint clay, with shells	2.5
Banded, drab sand, with clay pockets	1
Fine and coarse pebbly sand in indurated laminae	4.5
Loose, black sand	1.5
Fine banded clayey sand	1.5
Coarse sand and clay, with quartz pebbles	2.5
Debris slope to river	12
Total thickness	61.5

The materials composing the Alamosa formation probably were laid down in a subsiding basin by streams that headed in the adjacent mountainous areas. Much of the coarser material was deposited near the heads of the steep alluvial fans that border the valley, and the finer material was deposited near the sump area of the valley. Recent deposits overlie the Alamosa formation, but the similarity of the materials makes it difficult to determine the contact between the two. In this report, therefore, the Recent deposits have been included with the Alamosa formation, except in some well logs. Siebenthal considered all the material above the first persistent layer of very fine sand or clay to be Recent deposits and the material below to be the Alamosa formation, but this investigation has shown that in the sump area of the closed basin the material generally is fine grained from the surface downward, and there are numerous lenses of clay that may easily be mistaken for the more persistent layers.

The material in the Alamosa formation becomes finer grained toward the low part of the valley, as indicated by the cross section along line *K–K′* (pl. 11), which was drilled as a part of this investigation. The westernmost test hole (22 in line *K–K′*), drilled on the alluvial fan near Del Norte, revealed fragments as large as 10 inches in diameter. The easternmost test hole (45), drilled in the sump area, disclosed fragments no larger than 2.5 inches in diameter. The log of a well (37–10–5db) at Alamosa, near the center of the valley, is the most complete sampled section of the Alamosa formation available and shows that none of the material obtained from the well exceeded 0.3 inch in diameter.

The clay in the Alamosa formation may be brown, green, or bluish-gray. The brown clay, generally soft and slightly sandy, is in the upper part of the formation. The bluish-gray and green clay generally is firm and blocky and contains lenses of fine sand. Test drilling has shown that most of the layers of clay are not continuous but are lenticular and interfingered with sand and gravel in a manner similar to that shown in the cross sections (pl. 11). Test hole 28, for example, was drilled through 2 thin layers of clay that did not continue to test holes 29 or 30, a distance of 2.2 and 2.8 miles respectively; and test hole 35 in line *C–C′* was drilled through 32 feet of silty to sandy clay that did not extend eastward to test hole 40, a distance of 2 miles.

The character of materials in the Alamosa formation also changes within relatively short vertical distances, as shown graphically in plate 3, which is the log of a well drilled into the Alamosa formation on the Baca Grant (southeast corner of North Sheds meadow, which does not show on map), at a point about 10 miles west of the Sangre de Cristo Mountains. The log shows that there are 164 changes in material in 1,000 feet and that below 378 feet there are 50 layers of blue clay alternating with layers of fine sand. The deepest bed of gravel was found at 72 feet; only the finer sediments were found below that depth.

DISTRIBUTION AND THICKNESS

The Alamosa formation (including Recent deposits) underlies most of the San Luis Valley in Colorado, from the alluvial fans on the east and west and from near Poncha Pass on the north to the Colorado-New Mexico State line on the south, the continuity being broken only by the San Luis Hills in the southern part of the valley. Many of the beds of sand and gravel in the formation extend from the heads of the alluvial fans to the floor of the valley and are interbedded with layers of silt and clay. The coarsest materials in the formation, hence those most productive of water, lie above the first confining layer of clay and generally are considered to be of Recent age. The thickness of materials above the first persistent layer of clay ranges from about 1 foot in the SW¼NW¼ sec. 4, T. 35 N., R. 9 E. (log 251) to about 110 feet in the NW¼NE¼ sec. 4, T. 41 N., R. 7 E. (log 275). The average thickness, as shown by the east-west cross section (pl. 11, line *K–K′*), is about 61 feet. Records of wells and test holes in the closed basin indicate that the thickness of materials above the first layer of clay increases toward the west and that the thickness of the clay may range from a featheredge to as much as 268 feet. The thicknesses of materials above the first layer of clay at various points in the valley are as follows:

Thickness of Alamosa formation above the first layer of clay

Approximate location	*Thickness (feet)*	*Log reference*
Alamosa	29	261
Baca Grant	1	251
Center	67	287
Hooper	52	35
Monte Vista	45	265
Mosca	44	11
Rio Grande alluvial fan:		
Sec. 4, T. 41 N., R. 7 E	110	275
Sec. 24, T. 41 N., R. 7 E	82	276
Sargents	79	28
San Luis Lake	48	47

The total thickness of the Alamosa formation appears to range from a featheredge in the vicinity of Antonito to more than 2,000 feet in the vicinity of Hooper, although the determination of the top and base of the formation is subject to considerable error. The principal sources of data on the thickness are the logs of deep artesian wells and oil tests. Twelve or more wells in the San Luis Valley are at least 1,000 feet deep and penetrate all or much of the formation. Data on these wells indicate that the Alamosa is thickest in Rs. 10 and 11 E., near the depositional center of the valley (sump area). Well 37–10–11cc at Alamosa bottomed in the Alamosa formation at a depth of 1,802 feet, and a well on the Baca Grant (pl. 3) bottomed in Alamosa-type beds at a depth of 1,000 feet. An oil test in T. 41 N., R. 10 E. (log 289) encountered a hard sandy bed at a depth of 2,139 feet, which appears to be the top of the Santa Fe formation; and another oil test in T. 39 N., R. 11 E. (log 288) appears to have found the Santa Fe at a depth of 1,950 feet. The Alamosa formation seems to thin rapidly toward the west, as indicated by a thickness of 885 feet near Center (log 290), 382 feet at Monte Vista (log 265), and 400 feet in the Carmel district (wells 36–9–6cc and 36–9–7cc).

AGE AND CORRELATION

Shells found in the layers of clay in Hansen Bluff and fragments of shells found in well cuttings represent four species of animals that are attributed to fresh-water life in the late Pliocene or early Pleistocene epochs. Fragments of vertebrate fossils collected from well cuttings during this investigation were classified by C. W. Hibbard as being parts of an astragalus (anklebone) of an animal attributed to the early Pleistocene.

GROUND WATER

The following discussion of the occurrence of ground water has been adapted in part from Meinzer (1923a, pp. 2–102), whose report includes a more detailed discussion of the subject.

The rocks that form the outer crust of the earth generally contain numerous open spaces called voids or interstices. These open spaces are the receptacles which hold the water that is found below the surface of the land and is recovered in part through wells and springs. The amount of water that can be stored in any rock depends upon the volume of the rock that is occupied by open spaces, that is, the porosity of the rock. The capacity of a rock to hold water is determined by its porosity, but its capacity to yield water is determined by its permeability. The permeability of a rock may be defined as its capacity for transmitting water under hydraulic head, and it is measured by the rate at which the rock will transmit water through a given cross section under a given difference of head per unit of distance. Rocks that will not transmit water are said to be impermeable. Some deposits, such as well-sorted silt or clay, may have a high porosity but, because of the minute pores, transmit water very slowly. Other deposits, such as well-sorted gravel containing large openings that are freely interconnected, transmit water readily. Part of the water in any deposit is not available to wells because it is held against the force of gravity by molecular attraction—that is, by the cohesion of the molecules of the water itself and by their adhesion to the walls of the pores. The ratio of the volume of water that a rock will yield by gravity, after being saturated, to its own volume is known as the specific yield of the rock.

Below a certain level, which in the San Luis Valley is near the land surface, the permeable rocks are saturated with water.

These saturated rocks are said to be in the zone of saturation, and the upper surface of this zone is called the water table. Wells dug or drilled into the zone of saturation will become filled with ground water to the level of the water table.

The permeable rocks that lie above the zone of saturation are said to be in the zone of aeration. As water from the surface percolates slowly downward to the zone of saturation, part of it is held in the zone of aeration by the molecular attraction of the walls of the open spaces through which it passes. In fine-grained material there is invariably a moist belt in the zone of aeration just above the water table, and it is known as the capillary fringe. Although water in the zone of aeration is not available to wells, much of it may be withdrawn by the transpiration of plants and by evaporation from the soil.

ARTESIAN WATER

Ground water that rises in wells above the point at which it is first encountered is said to be artesian or piestic water (Meinzer and Wenzel, 1942, p. 451). If the hydrostatic pressure is sufficient to cause the water to flow at the ground surface, the well is termed a flowing artesian well. The height to which this pressure raises the water above the land surface is called the pressure head, or simply the head. If the hydrostatic pressure is not sufficient to cause the water to flow at the surface, the well is termed a nonflowing artesian well.

The logs of test holes and wells in the San Luis Valley reveal that despite the heterogeneity common to alluvial deposits many of the beds of sand and gravel extend from the heads of the alluvial fans at the foot of the mountains to, or nearly to, the sump area at the eastern side of the valley and that they are interbedded with finer grained materials such as silt or clay. The beds dip gently basinward from the higher elevations along the periphery of the valley, and water entering the permeable beds at their areas of outcrop moves down dip between the confining layers of less permeable material. The structure and character of the beds are such that throughout a large part of the valley the water below the first extensive layer of silt or clay is under artesian pressure and rises to the surface at the lower elevations when the aquifer is penetrated by wells.

Water in both the Santa Fe and the Alamosa formations is under artesian pressure. The principal artesian aquifers in the Santa Fe are coarse materials interbedded with clay or lava, and the principal artesian aquifers in the Alamosa are beds of fine to coarse sand interbedded with clay.

HISTORY OF DEVELOPMENT

Before the discovery of artesian water in the San Luis Valley, shallow dug or driven wells supplied all the water for domestic and stock needs. According to Carpenter (1891, p. 17), artesian water was discovered by accident by S. P. Hoine in 1887 while he was driving a sand point. In about 4 years there were an estimated 2,000 flowing wells in the valley. The quality of the artesian water and the ease with which an artesian well could be drilled were the principal reasons for the early rapid well development. Carpenter reports that an artesian well could be sunk in less than a day at a cost as low as $25. Artesian wells were first concentrated in the towns of Alamosa, La Jara, and Monte Vista, and later in the rural areas. By 1890 almost every occupied quarter section within the limits of artesian flow had one or more wells, most of which were used for domestic purposes.

Most of the early artesian wells drilled in the valley tapped the shallow aquifers, generally at depths less than 200 feet. The deepest wells in the valley in 1890 were the town well and the Conrad Bucher well—both at Alamosa. The town well discharged 400 gpm from a depth of 865 feet, and the Bucher well, which was an abandoned oil test, discharged about 600 gpm from a depth of about 1,000 feet.

The number of wells in the San Luis Valley had increased to 3,234 by 1904 (Siebenthal, 1910, p. 56), and the demand for irrigation water had resulted in the drilling of artesian wells for irrigation. Siebenthal reports that artesian water was used exclusively for irrigation in the district between Henry Station and Bowen School (Tps. 36 and 37 N., Rs. 9 and 10 E.), along Rock Creek (T. 38 N., Rs. 7 and 8 E.), and in the vicinity of Warner School (Tps. 43 and 44 N., R. 8 E.). By 1916 there were an estimated 5,000 flowing wells in the valley (White, 1916, p. 12, 13). The continued use for irrigation of high sodium bicarbonate water from flowing wells had developed areas of alkali which caused low crop yields and, in some places, crop failures. Conditions observed by White in 1916 caused him to consider artesian wells of little importance to irrigation in the valley, because most of the artesian water used for irrigation was diluted with river water. White called attention to an area between Swede Corners, sec. 6, T. 43 N., R. 8 E., and the south line of T. 43 N., R. 8 E., where crops irrigated with artesian water had largely failed. Siebenthal mentioned that this was one of several areas in which irrigation with water from artesian wells was of considerable economic importance in 1904.

The number of flowing wells in the valley has continued to

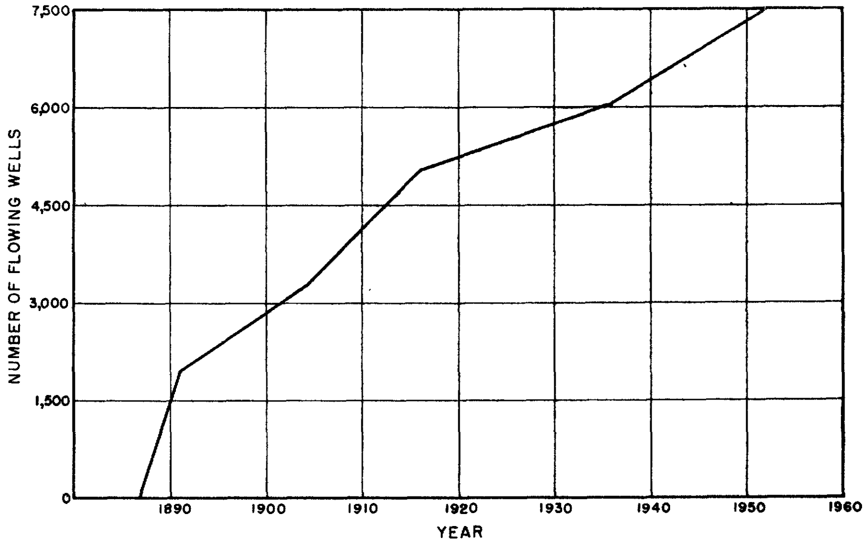


FIGURE 7.—Graph of artesian-well development in San Luis Valley.

increase steadily. Robinson and Waite (1938, p. 266) estimated that there were 6,074 flowing wells in 1936, on the basis of an inventory of all the flowing wells in the odd-numbered sections. At the time of this investigation, it was estimated that the number had increased to about 7,500 (fig. 7).

AREAS OF FLOW

The area in the San Luis Valley in which flowing wells could be drilled was outlined by Carpenter in 1890 (1891, map facing p. 17) and comprised about 1,400 square miles. The limit of flow outlined by Siebenthal in 1906 (1910, pl. 1) included practically the same area, except for a southward extension of about a mile in the vicinity of Manassa and a southward reduction in the vicinity of Saguache. The limits of flow in 1936, as determined by Robinson and Waite (1938, pl. 5), comprised an area of 1,430 square miles. The most noticeable change in the limits in the 30-year period 1906–36 was an increase of about 1 mile westward on the Rio Grande alluvial fan and an increase of about 2 miles southward in the vicinity of Manassa. There was seemingly an increase of several miles eastward in the vicinity of Blanca, but this probably was caused by inadequacy of data in 1906. The size of the area of flow at the present time is about the same as in 1936. Contrary to the usual history of artesian basins, there apparently has been no major change in the area of flow in the San Luis Valley since the beginning of development. At least part of the small changes indicated by published maps were no doubt errors in map compilation due to inadequate data.

PRESSURE HEAD

The pressure head of water at a given point in an aquifer is its hydrostatic pressure expressed as the height of a column of water that can be supported by the pressure. It is the height that a column of water rises in a tightly cased well that has no discharge (Meinzer, 1923b, p. 37).

GENERAL FEATURES

The heads of 13 flowing wells were measured during this investigation by means of an ink-well mercury gage (pl. 4), which was designed and built by S. W. Lohman; the results are given in table 10. The heads of more wells were not measured because that phase of the hydrology of the valley was not a primary objective of the investigation. In addition, most of the wells are not equipped with valves with which the discharge can be stopped, and a large proportion of them are poorly cased in unconsolidated materials and may collapse if shut in.

Heads of 20 flowing wells were measured during the 1936 investigation, but it was not possible to make such measurements on the same wells during this investigation. The measured heads ranged from 0.36 foot to 54 feet in 1936 and from 4.27 to 64.50 feet in 1949–51. The lowest head measured during this investigation was of a well only 106 feet deep, and the highest was of a well reported to be 1,400 feet deep. In general, the head appears to increase with the depth of the aquifer, as indicated by the measurements listed in the following table:

Range of head of flowing wells as related to depth of aquifer

Well	Depth to aquifer (feet)	Pressure head above land surface (feet)[1]	Discharge (gpm)	Drawdown (feet)	Specific capacity (gpm per foot of drawdown)
38-8-29dd2	106	4.27	20	3.37	6 5
37-8-7bc5	150	6.44	12	4.26	2.8
43-8-31bc1	185	45.60	7		
37-8-6dc5	200	20.39	65	16.79	3.9
37-8-3bc	342	31.93	122	23.76	5.2
37-8-1cc	480	[2] 36.71	8		
37-8-13dc2	500	33.03	184	20.74	8.9
37-8-13ab	520	38.13	145	27.74	5.2
37-9-15dc	1,400	64.50	372	64.50	5.8

[1] Wells generally shut in for about 24 hours before measurement.
[2] Well shut in for about 30 days before measurement.

The pressure head of wells in an aquifer of a particular depth differs from one part of the valley to another, primarily because of differences in topographic position and hydraulic gradient. Wells in the vicinity of Russell Lakes, for example, have a head of about 50 feet at a depth of about 200 feet; in the area south of the Rio Grande, only those wells tapping aquifers at depths of 500 feet or greater have comparable heads.

FLUCTUATIONS IN PRESSURE HEAD

Pressure heads of eight wells were measured periodically during this investigation in order to determine the nature and extent of the fluctuations. The fluctuations ranged from 0.41 foot in a well 185 feet deep to 15.41 feet in a well 500 feet deep. Normally it would be expected that the head of the shallower well would fluctuate more than the head of the deeper well because the shallower aquifer is more readily accessible to recharge from the application of surface water for irrigation. It is believed that the large fluctuations in the deep well were caused by the heavy pumping of other wells tapping the same aquifer. The measured fluctuations are shown in the following table:

Fluctuations of head of flowing wells

Well	Depth of well (feet)	Date of measurement	Head (feet above land surface)
37–8–3bc	343	Aug. 15, 1949	31.41
		Aug. 15, 1950	28.93
		Sept. 20, 1950	27.81
		Nov. 2, 1950	33.08
		Jan. 15, 1951	34.21
		Apr. 27, 1951	30.48
37–8–13ab	520	Aug. 16, 1949	38.23
		Aug. 16, 1950	31.04
		Nov. 2, 1950	38.01
37–8–13dc2	500	Aug. 11, 1949	33.03
		Sept. 20, 1950	27.23
		Nov. 2, 1950	31.94
		Jan. 16, 1951	35.15
37–9–15dc	1,400	Aug. 22, 1949	63.87
		Aug. 9, 1950	58.32
		Nov. 23, 1950	61.37
		Jan. 17, 1951	64.50
37–9–20cc1	500	Aug. 24, 1949	25.13
		Oct. 3, 1950	25.74
		Nov. 2, 1950	21.57
		Jan. 16, 1951	34.95
37–9–32ac2	500	Aug. 9, 1950	20.34
		Nov. 2, 1950	27.49
		Jan. 16, 1951	35.75
38–8–29dd2	106	May 11, 1949	14.48
		Aug. 15, 1949	4.27
		Sept. 20, 1950	15.48
43–8–31bc1	185	Sept. 3, 1950	45.60
		Jan. 15, 1951	46.01

The local declines in pressure head in several parts of the valley have been due to close spacing and resultant mutual interference between wells. In the town of Center, for example, flows of water were obtained at depths of 155 and 168 feet in 1904 (Siebenthal, 1910). By the time of this investigation, however, wells drilled to those depths in Center did not flow and were equipped with pumps. Well 41–8–33cc encountered the first flow of water at a depth of 196 feet, the level at which the fourth flow was encountered as reported by Siebenthal. The decline in head at Center is of local extent—well 41–8–27dc1, only half a mile from the town, flows 158 gpm from a depth of only 102 feet.

PIEZOMETRIC SURFACE

The piezometric surface is the imaginary surface to which water in a confined aquifer will rise. It is not a plane surface but, like the water table, has irregularities and variations in slope. It does not remain stationary but fluctuates up and down.

The shape and slope of the piezometric surfaces in the San Luis Valley have not been determined accurately and probably never can be determined accurately because of the multiplicity of aquifers and the difficulty of correlating them over wide areas. Although the preparation of a map of the piezometric surface of any of the artesian aquifers was not an objective of this investigation, the data obtained in this and previous investigations were adequate for the preparation of a reconnaissance piezometric map of the valley (pl. 5). The data used consisted of the altitudes of measured and reported heads of both flowing and nonflowing artesian wells and the altitudes of various points along the limits of artesian flow as determined from maps compiled by Siebenthal (1910) and Robinson and Waite (1938). Only the heads of those wells tapping the shallower aquifers were used. Although the map is not accurate in detail, it does show the general shape and slope of the piezometric surfaces that may be expected in the shallower aquifers. And the map reveals, for the first time, that not only is some of the artesian water lost by upward leakage through the confining layers (where it is dissipated by evapotranspiration in the sump area of the closed basin) but also that the remainder appears to move southward beneath the shallow ground-water divide and discharge into the Rio Grande.

The map shows that the piezometric surface is roughly parallel to the ground surface: the contours are widely spaced in the area of the valley floor, closely spaced in the areas of the Rio Grande alluvial fan east of Del Norte and the much steeper alluvial fan at the base of the Sangre de Cristo Mountains on the east side of the valley. The 7,650-foot contour marks the approximate base of the fans on both sides of the valley. The eastward bulge of the 7,600-foot contour in the vicinity of Hooper probably is the result of recharge by the application of surface water for irrigation in the area west of Hooper.

The gradient of the piezometric surface is about 50 feet per mile on the eastern alluvial fans, about 25 feet per mile on the Rio Grande fan, between 5 and 10 feet per mile on much of the valley floor, and a minimum of less than 2 feet per mile along the trough of the valley. Gradients probably differ in different aquifers, but data are not available for such a determination. In addition, the gradient in any one aquifer may change seasonally as a result of pumping or recharge during the irrigation season. Changes of gradient between 2 wells tapping a 500-foot aquifer are illustrated in figure 8.

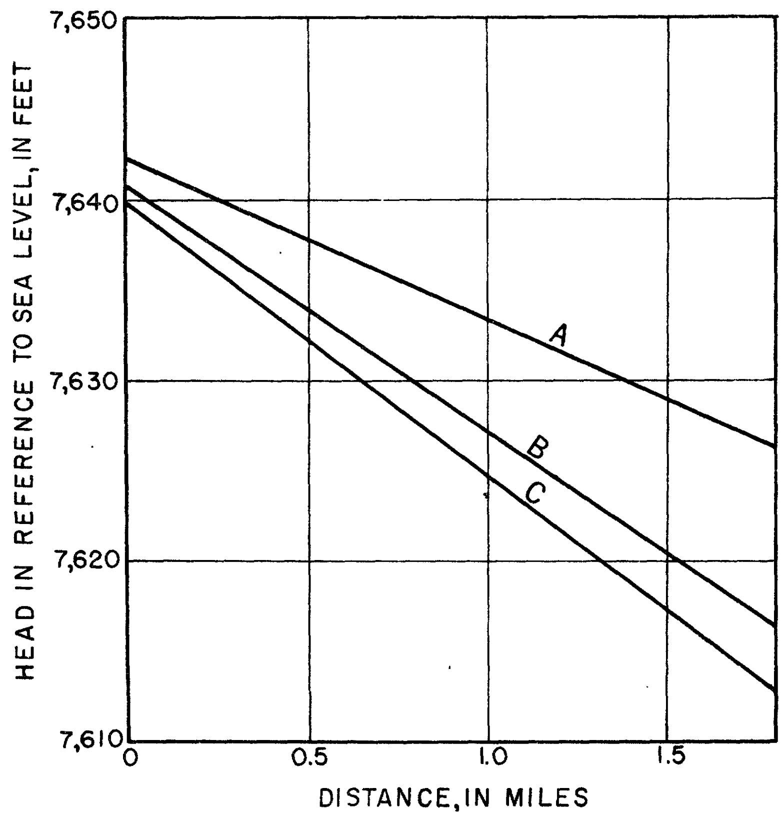


FIGURE 8.—Gradient of piezometric surface between wells 37-8-13dc2 (at point 0) and 37-9-20cc1. *A*, In January before irrigation began; *B*, in August during irrigation; *C*, in November after irrigation ceased.

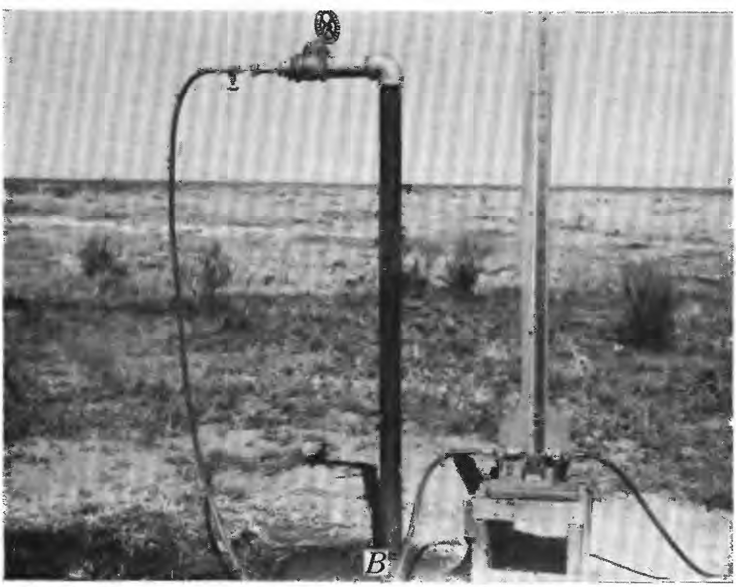
RECHARGE

The artesian aquifers in the San Luis Valley are recharged by infiltration of precipitation, water from stream channels, and water applied for irrigation. As the average precipitation on the valley floor is only about 8 inches annually, it is likely that only a small amount percolates downward and reaches the shallow ground-water reservoir as recharge; and it is probable that only a very small percentage of the recharge to the shallow ground-water reservoir eventually reaches the artesian aquifers. Most of the recharge to the artesian aquifers is derived from the loss of flow from the major streams along their courses across the alluvial fans and from the application of surface water for irrigation in areas where the piezometric surface is directly below the land surface.

Infiltration from streamflow probably is greatest along the upper part of the alluvial fans, where the materials are coarse and are conducive to a high rate of infiltration. The Rio Grande, the largest stream in the valley, probably is the principal contributor of water to the artesian aquifers. Records of the Bureau of Reclamation indicate that during the 4-year period 1949–52 the monthly loss of water in the 12-mile section between Del Norte and Monte Vista ranged from 200 acre-feet in March 1949 to 7,400 acre-feet in June 1949. Siebenthal (1910, p. 16) reported losses in the 57-mile segment between Del Norte and State Bridge (not on map) ranging from 142,272 acre-feet in 1902 to 278,713 acre-feet in 1900. He reports, however, that the discharge of artesian springs in Embudo Canyon (not on map) causes a gain in the flow of the Rio Grande below State Bridge. Records are not available to determine the losses of flow of other streams in the area of study.

A large amount of water is added to the artesian aquifers by the application of surface water for the irrigation of lands on the lower slopes of the Rio Grande alluvial fan. Irrigation water percolates downward and enters the artesian aquifers beyond the western limits of many of the layers of clay that separate the aquifers in the central part of the valley. The amount of this recharge is not known and cannot be determined readily. The eastward flexure of the 7,600-foot contour on the piezometric map (pl. 5) in the vicinity of Hooper indicates a distinct increase in pressure head in that area, which probably is caused by recharge from the application of surface water for irrigation in the area immediately to the west.

A. WELL 43-8-31bc2 DISCHARGING AT THE RATE OF ABOUT 580 GALLONS A MINUTE.



B. MERCURY PRESSURE GAGE USED IN MEASURING HEAD OF FLOWING WELL.

ARTESIAN WELLS.

DISCHARGE

The discharge of water from artesian aquifers in the area of study is principally through wells. Large quantities of water from artesian aquifers are used for irrigation, particularly south of the Rio Grande in the Bowen and Carmel districts, and for domestic, stock, and public supplies. This water is discharged from flowing wells, pumped from flowing wells, pumped from nonflowing wells, and discharged by artesian springs.

DISCHARGE FROM WELLS

FLOWING WELLS

The principal discharge of water from artesian aquifers is from nonpumped, flowing wells. Development of flowing wells has increased rapidly since its beginning in 1887, as indicated in figure 7. The average discharge per well, of 2,000 flowing wells in 1890, was reported to be about 25 gpm (Carpenter, 1891), or a total of about 80,000 acre-feet a year. By 1916 the average discharge of 5,000 flowing wells was estimated by W. N. White (1916), to be on the order of 30 gpm, or a total of about 240,000 acre-feet a year. In more detailed study in 1936 (Robinson and Waite, 1938), more than half of the 6,074 flowing wells were visited and the discharge measured or estimated. The average flow at that time was reported to be 12 gpm, or about 117,500 acre-feet a year from all the wells. The sharp decrease in average observed flow between 1916 and 1936 may have been due largely to errors in estimating discharge, but it was probably due in part to the extreme drought at the time of, and prior to, the 1936 investigation and to the deterioration of well casings.

The discharges of 842 flowing wells were measured or estimated during the course of this investigation (not counting 8 large-diameter flowing wells equipped with large pumps). Discharge was measured by the jet method (pl. 4), with a Parshall flume (pl. 6*A*), or by means of a container and a stopwatch. The yields ranged from less than 1 to 2,260 gpm and averaged about 47 gpm. Assuming that the wells are representative, the total potential discharge of the estimated 7,500 wells in the valley, therefore, is on the order of 570,000 acre-feet a year. The increase in average yield of wells between 1936 and the time of this investigation probably is due in part to increased precipitation but largely to the fact that many of the newer wells penetrate deeper, more permeable aquifers and have relatively large discharges.

During this investigation, 95 of the flowing wells measured in 1936 were measured again in order to determine more accurately whether discharges of flowing wells increased or decreased during that period. Of the 95 discharges measured, 28 had increased by amounts ranging from 1 to 37 gpm, 55 had decreased by amounts ranging from 1 to 107 gpm, and 12 had remained about the same. The discharges had decreased an average of about 5 gpm by 1947, about 7 gpm by 1948, and about 8 gpm by 1949. It appears that the average discharge of these wells has been declining steadily since 1936, but it must be recognized that the decline may have been caused in large part by the deterioration of well casings and the resultant leakage of water into other aquifers.

Since the completion of the field work for this report, very large flows have been obtained from deep wells in the San Luis Valley. A well drilled in sec. 18, T. 42 N., R. 8 E., to a depth of 638 feet, has a reported flow of 4,400 gpm, which is larger than the flow of any other artesian well in the State. Another well drilled in sec. 7 of the same township is reported to have obtained a flow of about 2,000 gpm at a similar depth. Neither of these figures was used in determining the average discharge of flowing wells in the valley.

Data obtained during this investigation indicate that the shallow aquifers are most productive in the vicinity of Russell Lakes, where there are about 150 flowing wells. The discharges in that area range from 1 to about 700 gpm and average about 62 gpm. The principal aquifers tapped lie at depths ranging from about 120 feet to about 250 feet, and the yields of wells appear to increase with the depth of the aquifer. Depths and discharges of tightly cased wells that obtain water from several aquifers in that area are listed in the following table:

Discharges of flowing wells in the vicinity of Russell Lakes

Well	Depth of well (feet)	Discharge (gpm)
43-8-19bb2	123.5	44
43-8-19bb1	152.4	100
43-8-31bc3	180	120
43-8-19bb3	214.2	136
43-8-31bb	250	250

The flow of wells obtaining water from the same artesian aquifer in the vicinity of Russell Lakes may vary considerably from place to place because of differences in well construction. Part of the water from an aquifer that is being tapped by an improperly cased well may leak upward into overlying aquifers

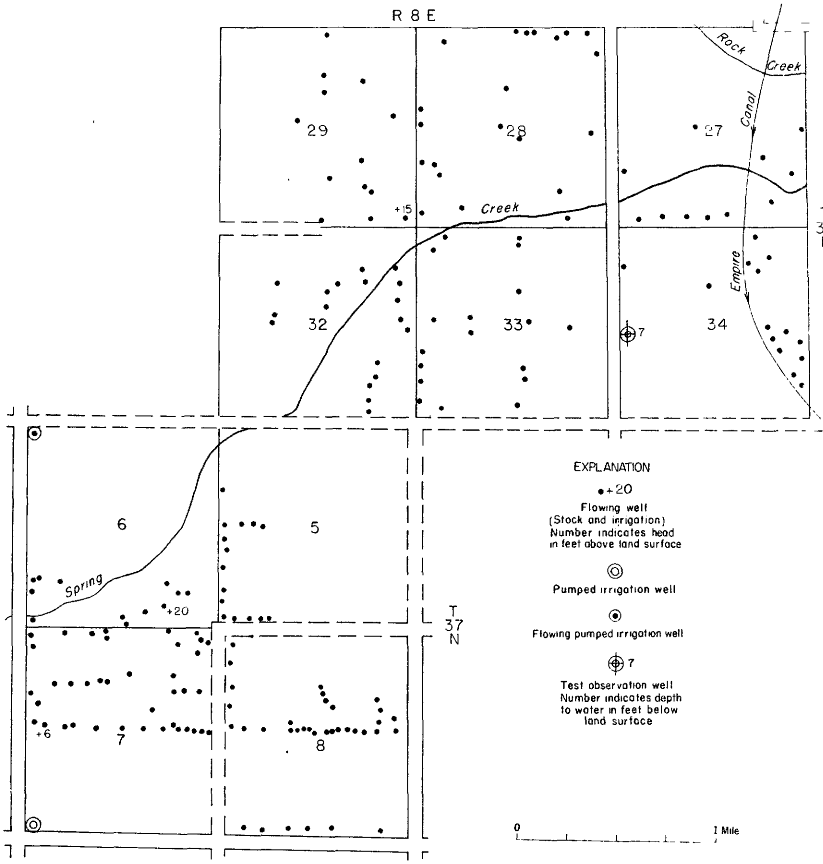


FIGURE 9.—Map of part of Spring Creek artesian area, showing location of wells.

by way of the well so that the discharge of the well at the surface is reduced appreciably.

Records of flowing wells in the Spring Creek area south of Monte Vista (pl. 1 and fig. 9) indicate a much smaller average discharge and a less consistent increase of discharge with depth than was observed in the vicinity of Russell Lakes. Near Spring Creek there are about 200 flowing wells in an area of about 9 square miles. The discharges range from about 1 gpm from a few shallow wells to nearly 600 gpm from the deeper wells, the average being about 34 gpm. The lesser average discharge in the Spring Creek area probably is the result of the unusually heavy concentration of flowing wells and a consequent reduction in pressure head. Most of the flowing wells in this area obtain water at depths ranging from 90 to about 350 feet. Although discharge does not increase consistently with depth of aquifer, the deeper wells in general yield more water than the shallower wells, as indicated in the following table:

Discharges of flowing wells in the Spring Creek artesian area

Depth of aquifer (feet)	Range in discharge (gpm)	Average discharge (gpm)
90	1–89	18.8
110	1–50	15.3
130	2–57	15.5
150	2–17	10.3
190	20–140	60
220	11–15	13.6
240	11–75	37
270	11–120	38.4
300	10–300	170
320	150–350	238
340	250–300	275

PUMPED WELLS

Another means of discharge of ground water from artesian aquifers is through flowing and nonflowing artesian wells equipped with large pumps. Such wells may be either in or outside the areas of artesian flow and are used exclusively for irrigation. They generally are drilled in areas where the supply of surface water is inadequate for irrigation and where the shallow unconfined water is in materials that have a low permeability and are not capable of yielding large supplies of water to wells. Most of these are deep, large-diameter wells having large yields. Of the 61 wells of this type that were inventoried during this investigation, 35 had measured discharges averaging 1,400 gpm each. If this is assumed to be the average discharge of all 61 wells, they would be capable of discharging a total of about 138,000 acre-feet of water a year. The wells have a natural flow of about 1,000 acre-feet a year and are pumped for a period of about 2 months each year; the total annual discharge, therefore, is on the order of 24,000 acre-feet.

DISCHARGE FROM SPRINGS

The four large springs in the San Luis Valley are believed to be artesian. Russell Springs and Spring Creek are within the area of study. McIntire and Diamond Springs, beyond the limits of the area of study, were included in this investigation because of their hydrologic importance. The locations of Russell Springs and Spring Creek are shown on plate 1 of this report, and the locations of McIntire and Diamond Springs are shown on plate 11 of the report on the Rio Grande Joint Investigation (Robinson and Waite, 1938). The four springs were measured periodically during the period of this investigation in order to determine the fluctuations in discharge, which are tabulated below. The average total discharge of the springs was 52 cfs, or about 38,000 acre-feet annually.

Discharges of artesian springs

Date of measurement	Discharge (cfs)	Date of measurement	Discharge (cfs)	Date of measurement	Discharge (cfs)
McIntire Springs (NW¼ sec. 18, T. 35 N., R. 11 E.)					
7- 8-49	21.29	7-20-50	19.25	1-22-51	18.71
9-20-49	16.19	8-16-50	20.31	2-20-51	18.86
2-28-50	13.22	9-18-50	18.48	3-22-51	20.08
4- 7-50	20.12	10-10-50	16.32	4-17-51	18.78
5- 9-50	19.04	11-16-50	19.48	6-20-51	17.44
6-16-50	21.15	12-15-50	19.64	7-26-51	18.39
				Average	18.7
Diamond Springs (N½ sec. 31, T. 35 N., R. 9 E.)					
2-10-49	19.05	6-16-50	28.07	1-18-51	23.24
7-11-49	37.90	7-20-50	33.37	2-19-51	21.52
9-19-49	25.53	8-17-50	23.68	3-22-51	20.35
4- 6-50	19.95	11-23-50	22.60	5-23-51	22.56
5- 9-50	16.29	12-15-50	21.80	Average	24.0
Russell Springs (NE¼ sec. 23, T. 43 N., R. 7 E.)					
4-16-48	3.08	5- 2-50	3.47	11-17-50	3.70
6-15-49	2.85	6-14-50	3.46	1-22-51	3.17
7-16-49	3.34	7-19-50	3.11	2-19-51	3.39
9-15-49	2.54	8-18-50	3.31	3-22-51	3.04
3- 1-50	4.18	9-14-50	2.75	7-26-51	2.54
4- 4-50	3.37	10-10-50	3.64	Average	3.2
Spring Creek Springs (Sec. 12, T. 37 N., R. 7 E.)					
9-16-47	6.93	5-10-50	6.79	2-19-51	5.67
9-16-49	7.64	6-15-50	9.16	3-22-51	3.04
1-18-50	6.72	7-19-50	5.99	7-26-51	2.54
4- 5-50	8.78	8-17-50	6.13	9- 1-51	Trickle
		12-21-50	5.91	Average	6.3
Total of averages					52

MC INTIRE SPRINGS

McIntire Springs, formerly known as Los Ojos, are on the south side of the Conejos River in the NW¼ sec. 18, T. 35 N., R. 11 E. (pl. 6*B*). The springs, which discharge at the base of the San Luis Hills near the contact of Alamosa formation and the volcanic rocks of the San Luis Hills, are believed to be sustained by artesian water rising to the surface along a fault plane. The water discharges into a marshy area that is about 450 feet in diameter. People in the town of Los Sauces have used the springs for nearly 100 years.

The temperature of the water in McIntire Springs appears to be increasing; however, no systematic measurements have been made. The temperature was 60°F in 1904, 65°F in 1936, and 68°F in 1950. Discharge of the springs appears to remain relatively constant; it was 21 cfs during 1 measurement in 1904, averaged 18.9 cfs in 4 measurements in 1936, and averaged 18.7 cfs in 18 measurements during this investigation.

DIAMOND SPRINGS

Diamond Springs, the largest in the valley, are in the N½ sec. 31, T. 35 N., R. 9 E. They emerge in an area of about 160 acres, an area of thick growths of tules and open pools of water. Residents report that before 1916 Diamond Springs was a seep confined to a small marshy area, but that since 1916 the flow has increased steadily. The springs probably are of artesian origin, and the increase in discharge probably is due to the recharge of artesian aquifers by the application of surface water for irrigation. They were outside the area of artesian flow as determined by Siebenthal (1910) in 1904, but they were inside the area of flow in 1936 (Robinson and Waite, 1938, pl. 5) and at the time of this investigation.

The discharge of Diamond Springs, measured three times in 1936, ranged from 19.29 to 26.52 cfs and averaged 24.5 cfs. It was measured 14 times during the present investigation, when it ranged from 16.29 to 37.90 cfs and averaged 24.0 cfs. There appears to have been little change in average discharge of Diamond Springs since 1936. The discharge fluctuates seasonally, however, and is greatest during the summer when surface water is being applied for irrigation.

RUSSELL SPRINGS

Russell Springs discharge near the western limit of artesian flow in the NE¼ sec. 23, T. 43 N., R. 7 E. The springs were active before the development of irrigation in this area, and they are situated beyond the limits of present irrigation development. Their supply of water is dependent upon the infiltration of precipitation and streamflow. The springs rise from vents in the grassy turf at a temperature of about 60°F, which is nearly 20°F warmer than the unconfined water in that area. They are the source of water for Russell Lakes (pl. 1), a series of interconnecting lakes about 2 miles away. The discharge was 3.60 cfs on November 23, 1936. In 17 measurements made during this investigation, the discharge ranged from 2.54 to 4.18 cfs and averaged 3.2 cfs.

SPRING CREEK

Spring Creek is a small perennial stream fed by a group of springs in the SW¼ and N½ sec. 12, T. 37 N., R. 7 E. The source of the water is in part the unconfined aquifer and in part a shallow artesian aquifer. It is believed that the springs originally represented discharge from the unconfined aquifer, but some of them were later developed by means of trenching through a layer of clay into the underlying artesian aquifer. The uppermost artesian aquifer is at unusually shallow depths in that vicinity and yields water to the shallowest flowing well in the valley (17 feet deep).

The discharge of Spring Creek was 9.74 cfs on November 27, 1936. As measured 11 times at Gunbarrel road during this investigation, the discharge ranged from a trickle to 9.16 cfs and averaged 6.3 cfs. During recent periods of low flow, the discharge generally has been increased materially by additional trenching into the artesian aquifer; however, after the period of abnormally low runoff in 1951 the flow almost ceased (5–8 gpm), for the first time in nearly 50 years. It is reported that by August 1952 the discharge had increased to about half its average rate as determined by this investigation.

HYDROLOGIC PROPERTIES OF ARTESIAN AQUIFERS

The rate of movement of ground water is determined by the size, shape, number, and degree of interconnection of the interstices; the density and viscosity of the water; and the hydraulic gradient. The capacity of a water-bearing material for transmitting water under a hydraulic gradient is known as its permeability.

Meinzer's coefficient of permeability is the rate of flow, in gpd, through a cross section 1 foot square, under a hydraulic gradient of 100 percent, at a temperature of 60°F, that is conducted laterally through each mile of the water-bearing bed under investigation (measured at right angles to the direction of flow) for each foot of thickness of the bed and for each foot per mile of hydraulic gradient (Stearns, 1927, p. 148). The field coefficient of permeability is the same unit except that it is measured at the prevailing temperature of the ground water rather than at 60°F.

The coefficient of transmissibility, a similar measure for the entire thickness of the water-bearing formation, may be defined as the number of gallons of water a day transmitted through each 1-foot strip extending the height of the aquifer, at the existing temperature, and under a hydraulic gradient of 100 percent (Theis, 1935, p. 520). This is Meinzer's coefficient of permeability adjusted for temperature and multiplied by the thickness of the aquifer, in feet.

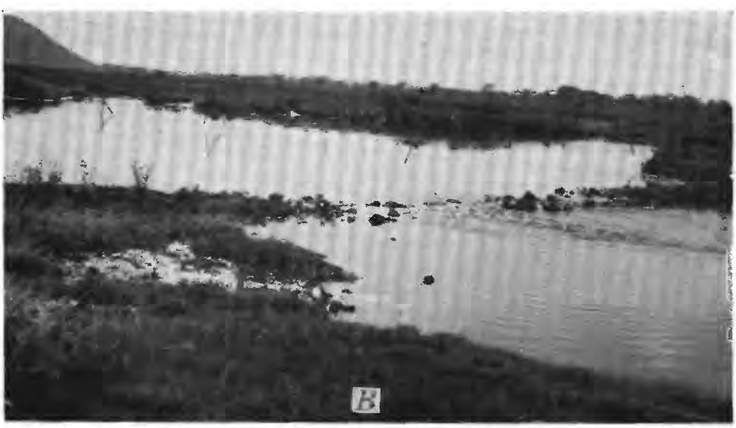
Specific yield is the quantity of water that saturated water-bearing material will yield by gravity. Specific yield may be expressed as a percentage or as a decimal fraction of the ratio of the volume of this water to the total volume of the material that is drained.

Under field conditions, the amount of water yielded from storage is expressed by the coefficient of storage. Under artesian conditions, in which aquifers generally are not dewatered by the withdrawal of water through wells, the coefficient of storage represents the water released from storage by the compression of the aquifer and the expansion of the water, and it is proportional to the thickness of the aquifer. It is defined (Theis, 1935) as the amount of water, expressed as a decimal fraction of a cubic foot, that is discharged from each vertical column of the aquifer—a column with a base 1 foot square—as the water level or head declines 1 foot. Under water-table conditions the coefficient of storage is equivalent to the specific yield of the top foot of material, unwatered by a 1-foot lowering in head, plus an "artesian coefficient" for the rest of the aquifer below. The specific yield generally is between 1 or 2 percent and 20 or 30 percent, whereas the coefficient of storage is generally between 0.001 and 0.00001. Therefore, no significant error is introduced by assuming that under water-table conditions the specific yield and the coefficient of storage are the same.

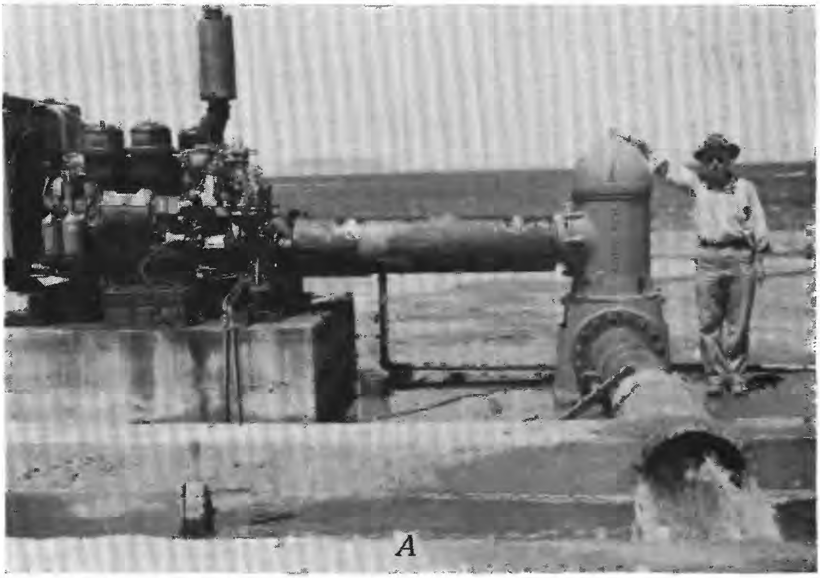
During this investigation, flow tests were run on 8 wells in order to determine the coefficient of transmissibility of the artesian aquifers in the Alamosa and Santa Fe formations. The flow tests were made in 1949, using an ink-well mercury gage (pl. 4*B*) that was designed and constructed by S. W. Lohman. Each well was shut off for a period sufficiently long to permit the head to return to approximately its normal position, generally 8 hours or longer, and the static head was determined by means of the mercury gage. The well was then allowed to flow freely for a period of several hours until the discharge had ceased to decline appreciably. During this time the discharge was measured periodically in order to determine its rate of decline. The well was again shut off and the head allowed to return nearly to its original position. During this interval, the rate of recovery of the head was determined by periodic measurements by means of the mercury gage.

A method developed by Jacob and Lohman (1952), based on

A. PARSHALL FLUME USED IN MEASURING DISCHARGES OF LARGE WELLS.



B. DISCHARGE OF MCINTIRE SPRINGS.



A. STRIBLING WELL IN SE¼SE¼ SEC. 33, T. 31 S., R. 74 W., ABOUT 20 MILES SOUTHWEST OF BLANCA, DISCHARGING 3,500 GALLONS A MINUTE.

B. WATER FROM STRIBLING WELL BEING DISTRIBUTED THROUGH SPRINKLER SYSTEM BY PORTABLE DIESEL-POWERED CENTRIFUGAL PUMPS.

DEEP-WELL IRRIGATION.

the natural rate of decline of the discharge of a flowing artesian well under conditions of constant drawdown, permits the determination of the coefficients of transmissibility and storage from tests of a single flowing well, provided that the effective well radius (r_w) is known. The flowing wells available for testing in the San Luis Valley generally were not cased or screened through the unconsolidated aquifers; therefore, because of actual or suspected caving, it was not possible to determine the effective well radius.

An alternative method of Jacob and Lohman (1952, p. 566) permits the determination of the coefficient of transmissibility (T) only, even though the effective radius is not known, and this method was used in determining T for 8 flow tests by the following equation:

$$T = \frac{264}{s_w[\delta(1/Q)/\delta(\log t)]}$$

in which T is in gpd per foot; s_w is the constant drawdown, in feet; Q is the discharge, in gpm; and t is the time since discharge began, in minutes.

On semilog paper, values of $(1/Q)$ are plotted on the linear scale against corresponding values of t on the logarithmic scale. The slope of the straight line drawn through the plotted points may be determined simply by taking the change in $(1/Q)$ over 1 log cycle of t (for which the value of $\log_{10} t$ is unity), whence the solution is simplified to:

$$T = \frac{264}{s_w \Delta(1/Q)}$$

As a means of checking the values of T determined by the above method, the head measurements taken during the recovery period also were used to determine T by the recovery method of Theis (1935). From his equation expressing the relation between the drawdown and the rate and duration of discharge of a well, Theis developed the following recovery formula:

$$T = \frac{264Q}{s} \log_{10} \frac{t}{t'}$$

in which T is in gpd per foot; Q is the discharge rate, in gpm; t is the time since pumping began, in minutes; t' is the time since pumping stopped, in minutes; and s is the residual drawdown, in feet.

On semilog paper, values of s are plotted on the linear scale against corresponding values of t/t' on the logarithmic scale. By a procedure similar to that just described for the Jacob-Lohman method, the solution of the Theis recovery formula is simplified to:

$$T = \frac{264}{\Delta s}$$

The coefficients of transmissibility were determined by the 2 methods from the 8 tests. Average values for the Santa Fe formation ranged from 14,800 to 61,700 gpd per foot; those for the Alamosa formation ranged from 6,800 to 14,400 gpd per foot. Such a wide range is to be expected, because the artesian aquifers in both formations range widely in thickness and texture. The coefficients of transmissibility are given in the following table:

Determinations of coefficient of transmissibility of artesian aquifers by flow and recovery tests

Well	Coefficient of transmissibility (gpd per foot)		
	Jacob-Lohman method	Theis recovery method	Average value
Santa Fe formation:			
37–8–13dc1	30,800	28,600	29,700
37–8–13dc2	60,300	63,100	61,700
37–9–20cc1	12,800	16,700	14,800
37–9–34cc	30,200	30,800	30,500
Alamosa formation:			
37–8–3bc	(1)	7,000	7,000
37–8–6dc5	14,500	14,300	14,400
37–8–7bc5	13,000	11,400	12,200
38–8–29dd2	6,600	6,900	6,800

[1] Not determined.

UTILIZATION OF ARTESIAN WATER

Data on 870 flowing and 61 nonflowing artesian wells equipped with large pumps were obtained during this investigation and are listed in table 10. Almost all the wells are used for domestic, stock, and irrigation supplies, but a few are used for public supplies, fish hatcheries, and a swimming pool. The water from more than half of the wells is used for more than one purpose, such as irrigation and stock supply or domestic and stock supply. Of the 931 artesian wells, 647 were used wholly or in part for irrigation, and 260 were used primarily for domestic and stock supplies. Ten wells were used to supply water to fish hatcheries, 1 was used to supply water for a swimming pool, and 6 were used to supply water for municipalities. In addition to the flowing wells listed in table 10, an estimated 375 flowing wells were used for domestic purposes in Center, 850 in Monte Vista, and 350 in Alamosa.

DOMESTIC AND STOCK SUPPLIES

Domestic wells supply water for homes and schools that are not served by municipal wells. Stock wells supply water for livestock—principally cattle, sheep, and poultry. Most of the artesian wells that are used for domestic and stock purposes are small-diameter (2- to 4-inch), drilled wells. Artesian wells that have low pressure heads, or do not flow, are equipped with small electrically operated jet pumps. Water from artesian wells generally is satisfactory for most domestic and stock uses; however, some of the water contains large amounts of fluoride. (See "Quality of water" section.)

PUBLIC SUPPLIES

Alamosa and Monte Vista are the only cities in the San Luis Valley having municipal water systems that are dependent upon artesian wells for their supplies.

ALAMOSA

The City of Alamosa is supplied by 4 artesian wells (37–10–10bb, 37–10–10bd1, 37–10–10bd2, and 37–10–11cc), which were drilled into sand and gravel in the Alamosa formation.

Well 37–10–10bb, 6 inches in diameter, was drilled in 1937 to a depth of 760 feet. It is reported to flow 40 gpm through a 6-inch main into a reservoir that has a capacity of 200,000 gallons.

Well 37–10–10bd1 was drilled in 1939 to a depth of 1,500 feet. It is 12 inches in diameter and is cased with blank casing from the ground surface to 900 feet and with slot-perforated casing from 900 to 1,500 feet. The well is reported to discharge 400 gpm by natural flow, but when it is pumped with a 6-inch turbine pump having the bowls set at 28 feet it is reported to discharge 900 gpm. Water from the well can be pumped directly into the mains or into an elevated reservoir that has a capacity of 150,000 gallons.

Well 37–10–10bd2, 12 inches in diameter, was drilled in 1936 to a depth of 1,001 feet. Equipped with a 6-inch turbine pump having bowls set at 40 feet, it is reported to discharge 600 gpm directly into the mains.

Well 37–10–11cc, the newest well in the Alamosa water system, was drilled in 1950 to a depth of 1,802 feet (log 261). The well is gravel packed and cased from the surface to 650 feet with 24-inch iron casing, cemented in place, and from 650 to 1,802 feet with 24-inch torch-perforated casing. It has a measured natural flow of 2,260 gpm and is equipped with a 12-inch turbine pump powered by a 150-horsepower electric motor. The pumped discharge of the well is not known. The well is connected to the city water system through a 12-inch main, but at the time of this report the water was not being used in the city system because its temperature of 96°F is too high for general use. The bottom-hole temperature of the water is reported to be 100°F, but the water is cooled to 96°F as it rises to the surface and is mixed with water from shallower aquifers.

The Alamosa water system had 1,112 outlets in 1950 and at that time was prepared to operate with a total of 1,240 outlets. The quantity of water pumped by the city has increased fourfold since 1936; the pumpage was 110,224,400 gallons in 1936, 467,985,000 gallons in 1950, and estimated to be 491,400,000 gallons in 1951. Pumping, heaviest during the summer, reaches a peak in June. The quantity of water pumped monthly by the city in 1950 is listed in the following table:

Quantity of artesian water pumped monthly by the city of Alamosa in 1950

Month	Quantity of water pumped (gallons)	Month	Quantity of water pumped (gallons)
January	24,010,000	July	56,428,000
February	26,648,000	August	51,810,000
March	25,451,000	September	43,090,000
April	35,202,000	October	31,069,000
May	54,384,000	November	22,041,000
June	73,202,000	December	24,560,000
		Total	467,985,000

MONTE VISTA

The municipal water supply at Monte Vista is obtained from wells 39–7–36db and 39–8–31cd, which tap the Alamosa and Santa Fe formations, respectively.

Well 39–7–36db, 365 feet deep and 14 inches in diameter, is cased with slotted iron pipe. The well has a natural flow and is reported to have a pressure head of about 5 feet above the ground surface. Equipped with an 8-inch turbine pump powered by a 20-horsepower electric motor, it yields 853 gpm with a drawdown of 3.5 feet below ground surface. The total drawdown, therefore, is 8.5 feet below static head. Temperature of the water is 50°F.

Well 39–8–31cd, 475 feet deep, has the following casing record: 46 feet of 20-inch casing, 99 feet of 18-inch casing, 97 feet of 16-inch casing, 120 feet of 12-inch casing, and 113 feet of open hole at the bottom. The well has a natural flow and is reported to have a pressure head of 6 feet above ground surface. Equipped with an 8-inch turbine pump powered by a 75-horsepower electric motor, it has a measured yield of 520 gpm with a reported drawdown of 11 feet below ground surface. The total drawdown, therefore, is about 17 feet. The temperature of the water is 52°F.

Water from both wells is pumped directly into the city mains, which range in diameter from 4 to 12 inches, and it is distributed through about 700 outlets. As the Monte Vista water system was new at the time of this investigation, accurate data on consumption are not yet available. The city manager, Mr. Ronald Iske, estimates that the daily consumption in 1952 ranged from 250,000 to 1,500,000 gallons. The total annual consumption probably is on the order of 250,000,000 gallons.

IRRIGATION SUPPLIES

The principal method of irrigation in the San Luis Valley is known as "subbing," wherein surface water is carried to the farm areas by means of canals and is allowed to percolate through ditches spaced about 6 rods apart until the water table is raised to or near the root zone. The water table is then regulated by means of a series of check drains that hold it in the proper position for subirrigation. During periods of low runoff, when the quantity of surface water available is not adequate to maintain the subbing system, large-capacity wells are used to supply supplementary water.

Large-capacity artesian wells that are equipped with pumps and that are used for irrigation have been drilled primarily in areas where the shallow nonartesian aquifer is fine grained and will not yield large quantities of water and in areas where the interference between large-capacity wells tapping the shallow aquifer has increased pumping lifts materially. Artesian wells of this type have been drilled in other areas in order to tap the coarser materials of the Santa Fe formation, which yield large quantities of water under sufficient pressure head to reduce pumping lifts appreciably. Only 2 large-capacity, pumped artesian wells were used for irrigation in 1936, whereas records of 61 were obtained during this investigation.

In addition to the records of the 61 artesian wells equipped with large pumps, records of 586 flowing wells, which were without pumps and were used wholly or in part for irrigation, were obtained during this investigation. These wells generally have relatively small discharges and are used primarily for irrigating hay. Of the 586 flowing wells, 184 were used exclusively for irrigation, 379 were used for both irrigation and stock purposes, and 23 were used for both irrigation and domestic supplies. As the requirements for domestic and stock uses are very small in comparison with the average discharge (39 gpm), most of the water is used for irrigation.

YIELDS OF WELLS

Records of the yields of most of the artesian wells used for irrigation in the area of study were obtained during this investigation. Yields of the large-diameter, pumped artesian wells were determined by means of current meters, and yields of the small-diameter artesian wells were determined by the method described on page 33. The drawdowns of some of the small, flowing wells not equipped with pumps were determined by measuring the pressure head in feet above ground surface and subtracting the height of the point of discharge above ground surface. The drawdowns of large, pumped, nonflowing artesian wells were determined by means of an electrical-contact device or a steel tape. The drawdowns of large, pumped, flowing wells (8 of the 61, and 2 of the 20 shown in table 1) could not be determined

TABLE 1.—*Yield, drawdown, and specific capacity of 20 pumped artesian wells*

Well (pl. 1, table 10)	Discharge (gpm)[1]	Drawdown (feet)	Specific capacity (gpm per foot of drawdown)
36–9–17bc[2]	[3] 1,410	[4] 35+	<40
36–9–19ac[2]	2,230	36+	<62
36–9–19dc	2,500	[5] 34	74
38–9–31bb	700	36	19
39–9–27bb	600	164	4
39–12–24cc1	2,230	43	52
40–7–6dc	1,470	126	11
40–7–11bc	1,020	23	44
40–7–26db	1,020	22	46
40–9–5ac	1,200	37	32
40–9–9cc	2,120	38	56
40–10–5bc	1,290	30	43
40–10–30dc	1,040	58	18
41–7–8dc	1,500	17	88
41–7–24ac	1,750	19	92
41–8–19bc1	1,260	18	70
41–8–20bc	2,490	20	125
41–8–32bc	1,960	22	89
41–8–36cc	2,110	34	62
41–9–30ac	1,560	20	78

[1] Figures rounded.
[2] Flowing well. Head not known, hence the drawdown listed is the drawdown below ground surface and the specific capacity listed is a maximum.
[3] Well flows 408 gpm when not being pumped.
[4] Drawdown below ground surface was reported.
[5] Drawdown below static level was reported.

accurately because, although the drawdown below ground surface was measured, the pressure head above ground surface could not be measured.

The yields of the 61 large, pumped artesian wells that are used for irrigation in the area of study ranged from about 600 to about 2,500 gpm and averaged 1,400 gpm. The measured drawdowns ranged from 17 to 164 feet. The specific capacity (gallons a minute per foot of drawdown) of the wells tested ranged from 4 to 125 and averaged 55. Data on the 20 wells for which rates of both discharge and drawdown were available are given in table 1. The yields of flowing artesian wells that were not equipped with large pumps and that were used for irrigation ranged from about 1 to 1,000 gpm and averaged 56 gpm. The drawdowns of only a few of these wells were determined; hence, no conclusions concerning the minimum, maximum, and average drawdowns and specific capacities can be made.

CONSTRUCTION OF SMALL-DIAMETER WELLS

Small-diameter wells, as considered in this report, are wells having a casing less than 8 inches in diameter at the top.

During the early stages of development of artesian wells in the San Luis Valley, the methods and materials used in construction were very inferior to present standards. It was the general practice at that time to insert only enough casing in the well to prevent the caving of loose materials in the upper part of the shallow aquifer. Some of the earlier wells were cased with only 20 to 30 feet of stovepipe or wooden casing; the remainder of the wells were left open. Most of the wells were not equipped with valves or other means of regulating the flow because there was great danger that the well would collapse if the discharge were stopped. The flow of some wells was reduced by means of a wooden plug driven into the open end of the casing in a manner that allowed sufficient leakage to prevent freezing in winter. Some of the wooden casings were in use in the Waverly and Carmel districts south of the Rio Grande until about 1940. It has been reported that an attempt was made to recase one of the older wells in the NW¼SW¼ sec. 20, T. 37 N., R. 9 E. When the casing, consisting of wood and stovepipe, was pulled the well collapsed, but water continued to come to the surface; attempts to plug the well failed. An area of about 80 acres surrounding the original well site is now waterlogged.

Installation of artesian wells during the early stages of development was, according to Carpenter (1891, p. 17), a rather simple job. He states:

They [artesian wells] are so numerous that the residents give no more than a passing glance to one, and, as they are frequently sunk in less than half a day with the simplest of outfits, it is not remarkable that it is impossible to secure any kind of complete list even for a limited locality. Wells are often sunk for $25, and they range from this price upward according to circumstances. In consequence, it is cheaper to bore artesian wells than it is to attempt to dig wells of the ordinary kind, without the added inducement of the purer water.

Most of the artesian wells drilled during this period had a diameter of only 2 or 3 inches.

Most of the small-diameter artesian wells of recent years were drilled by means of cable-tool drilling rigs, although some were put down by means of jetting or rotary drilling rigs. The shallower water-table aquifer generally is cased off by blank casing, seated in the first substantial layer of clay; the remainder of the hole usually is left open. Although this method prevents or reduces the mixture of artesian water with the shallow unconfined water, it allows the free mixture of water from all the artesian aquifers tapped by the well. The wells usually are cased with iron pipe, 2 to 4 inches in diameter; however, some of the newer and deeper artesian wells have casings of larger diameter. Some wells are equipped with valves for regulating the flow and some are controlled by means of wooden plugs, but most of them are allowed to flow unrestricted.

CONSTRUCTION OF LARGE-DIAMETER WELLS

The large-diameter wells are, for the purpose of this report, those wells having a casing 8 or more inches in diameter at the top. They have been drilled almost exclusively by cable-tool drilling rigs, although a few have been put down by rotary rigs. Large-diameter artesian wells in the area south of the Rio Grande generally are drilled through the first lava flow (locally called cap rock) and into the sand and gravel of the underlying Santa Fe formation. They usually are equipped with 14- to 16-inch blank casing from the ground surface through the lava flow and with 10- to 12-inch perforated casing from the lava flow to the bottom of the hole. A few of the wells, however, have perforated casing opposite the shallow artesian aquifers lying above the lava flow, with the result that the pumping of these large-diameter wells is reported to reduce or stop the flow of nearby small-diameter flowing wells that tap the shallower aquifers. Some of these wells have been recased with blank casing above the lava flow in order to prevent further interference.

Most of the large-diameter artesian wells used for irrigation in the area north of the Rio Grande obtain water from artesian aquifers lying above the first lava flow. They generally are equipped with blank casing from the ground surface to the first substantial layer of clay and with perforated casing below. The bottoms of the perforated casing generally are seated in clay to prevent the casing from slipping and to prevent the entry of sand through the bottoms of the wells. The bottoms of wells that are not seated in clay usually are filled with 2 or 3 feet of rocks or gravel to prevent the entry of sand through the bottom. Perforations, most of which are cut with a torch, are commonly not of the proper size to prevent entry of sand into the well; as a result, some wells may require frequent cleaning. Many wells are reported to have filled with 50 to 100 feet of sand. Difficulties of this type can be prevented or reduced by means of gravel packs or well screens, but the added expense of such construction may not be justified, in many wells, by the benefits gained.

Some of the water-bearing materials penetrated by large, deep artesian wells in the area of study are sufficiently coarse and well sorted to make gravel-packing unnecessary in order to obtain large yields or to prevent entry of sand into the wells. Wells in materials of this type can be finished less expensively by means of slotted casings, without the use of screens or gravel packs. Many of the deep wells in this area, however, encounter artesian aquifers consisting of a mixture of sand and gravel, and they may be gravel-packed. The several advantages of gravel-packing these wells may offset the greater initial cost. The envelope of gravel that is placed around the slotted casing greatly increases the effective diameter of the well and decreases the velocity of the water entering the well, thus preventing or retarding the entry of fine sand and increasing the production of sand-free water. The drawdown generally is reduced appreciably because the loss of head by friction as the water enters the well is reduced.

In gravel-packing the importance of using gravel of the proper size, roundness, and uniformity has not been appreciated adequately in most areas in the San Luis Valley where ground water is used for irrigation. It is a popular misconception that the permeability of a water-bearing material is dependent entirely upon the size of the grains, whereas it generally is dependent upon three properties: (1) roundness of grains, (2) uniformity of grain size, and (3) grain size. Clay, which is composed of uniform-sized but angular grains, has a high porosity but a low permeability because its pore spaces are so small that capillary attraction retards or prevents the movement of water. A uniform-sized sand or gravel generally has both high porosity and

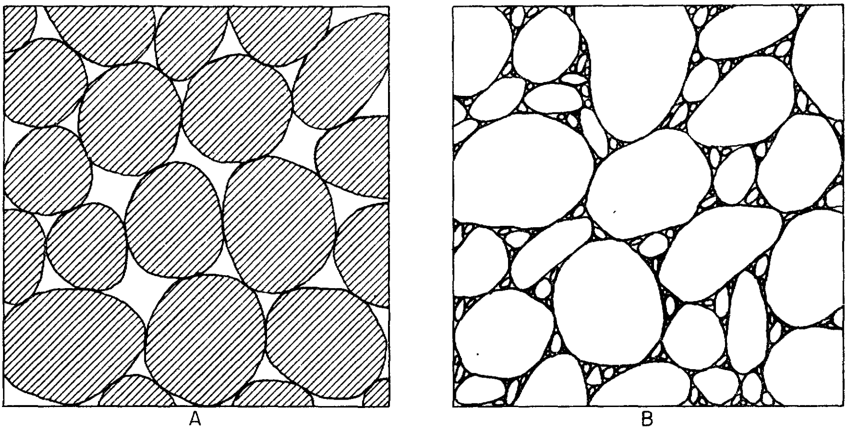


FIGURE 10.—Relation of uniformity of grain size to porosity and permeability. *A*, Well-sorted rounded sand or gravel having high porosity and permeability; *B*, poorly sorted angular sand and gravel having relatively low porosity and permeability.

high permeability. This type of deposit, which is illustrated in figure 10*A*, contains grains that are well rounded and large pore spaces that are not filled with finer materials. Artesian aquifers in many parts of the San Luis Valley may consist of pebbles mixed with fine gravel and sand. This type of deposit, which is illustrated in figure 10*B*, contains large spaces between the pebbles, but these are filled with smaller fragments and the spaces between the small framents are filled with sand; therefore, the porosity and permeability of this material are not as great as those of a uniform-grained fine gravel or coarse sand.

METHODS OF LIFT

At the time of this investigation, 61 of the large-diameter artesian wells were equipped with deep-well turbine pumps, and one (well 41–8–19bc1) was equipped with a centrifugal pump. The size of the turbine pumps ranged from 6 to 12 inches but generally was either 8 or 10 inches. The centrifugal pump had an 8-inch discharge. Of the 61 wells, 31 were powered with electric motors, 15 with gasoline engines, 8 with butane or propane engines, and 7 with tractors.

QUANTITY OF WATER DISCHARGED

The determination of the total quantity of artesian water discharged for irrigation in the area of study was not an objective of this investigation, but an effort was made to inventory all artesian wells used for irrigation in the area of inflow-outflow study (pl. 15) and in the area of study lying south of the Rio Grande and west of the east line of R. 9 E. The discharges of

35 of the 61 large pumped wells were measured, and the discharges of 571 of the 586 other artesian wells used for irrigation were either measured or estimated. If it is assumed that the large pumped wells are in use for 2 months each year, their total annual discharge (including the natural discharge, about 1,000 gpm, of the 8 wells that flow when not being pumped) amounts to about 24,000 acre-feet. The amount of water discharged by other artesian wells used for irrigation in those areas is difficult to determine because more than two-thirds of them are used also for domestic or stock purposes. As domestic and stock requirements are very small in comparison with the average quantity of water discharged, it is assumed that practically all the water discharged by irrigation-domestic and irrigation-stock wells is used for irrigaton. The annual discharge of all artesian wells used for irrigation in the two areas is on the order of 75,000 acre-feet. The rates and amounts of water discharged by artesian wells used wholly or in part for irrigation (excluding the 61 large pumped wells) are given in the following table:

Discharges of flowing wells used for irrigation[1]

Use	Number of wells	Total discharge (gpm)	Average discharge per well (gpm)	Total annual discharge of all wells (acre-feet)
Irrigation	184	16,800	91	27,100
Irrigation and stock	379	15,300	40	24,700
Irrigation and domestic	23	500	22	800
Total	586	32,600	56	52,600

[1] Exclusive of 8 flowing wells equipped with large pumps.

POSSIBILITIES OF ADDITIONAL DEVELOPMENT

The feasibility of making available additional supplies of artesian water from wells for irrigation, public supply, or other uses is dependent upon the safe yield of the ground-water reservoir (broadly defined as the amount of water that can be practicably withdrawn annually over a long period of years without depletion), the cost of drilling and pumping, the types of soil, the quality of water, the crops raised, the market conditions, and perhaps other factors. The capacity of the ground-water reservoir to yield water over a long period of years is limited, as is that of a surface reservoir. If water is withdrawn by pumping and by other means (natural flow, seeps, springs, evaporation, and transpiration) faster than it enters, the water levels or pressure heads of wells decline and the supply ultimately may be depleted. The amount of water that can be withdrawn annually over a long period of years without depleting the ground-water reservoir is dependent upon the capacity of the underground reservoir to yield water to wells and upon the amount of water that is added annually to the reservoir by recharge. The cost of obtaining and pumping water is determined in part by the depth to the aquifer and in part by the depth to water level. In areas where the water table or piezometric surface is relatively deep, the wells must be deep and the pumping lift may be great. The cost of the well is determined in part also by the permeability and thickness of the water-bearing materials. Wells may be sunk in relatively fine-grained materials and their yield may therefore be relatively small. Gravel packing may increase the yield of some of these wells, but it also adds to the cost. The character of the soil and the contour of the land surface also are important factors. The soil may be very sandy or porous, causing excessive loss of water in ditches or requiring the use of sprinkler systems. The land may be poorly drained or it may not have the proper slope, and thus may require large expenditures for leveling.

There are two possibilities for drilling large-capacity wells in artesian aquifers in the area of study; namely, the sinking of wells outside the areas of present development, and the sinking of wells within areas of present development but in aquifers heretofore not extensively tapped. It appears that there may be large areas outside the limits of present development in which additional supplies of water can be obtained, although not all may be suitable for large-scale operations. Wells drilled recently southwest of Blanca, outside the limits of this investigation, give some indication of the ground-water potential in similar localities within the area of study. One of the most productive wells in Colorado was drilled southwest of Blanca in the SE¼SE¼ sec. 33, T. 31 S., R. 74 W., in an area where the land had previously been used primarily for grazing. The well was drilled to a depth of 450 feet and encountered artesian water, which rose to within 60 feet of the land surface. Equipped with a 14-inch turbine pump powered with a 260-horsepower twin-diesel engine, the well discharged 3,500 gpm with a drawdown of 60 feet (pl. 7). The water, used to irrigate about 700 acres of barley, was pumped from ditches into a sprinkler system by means of two 6-inch centrifugal pumps powered by diesel engines. The well, pumping equipment, and sprinkler system were reported to have cost $130,000, and the operating costs were reported to be $60 a day. Other large-capacity wells are now operating in the area, and it is reported that the piezometric surface has declined about 12 feet in 2 years. It appears, therefore, that although an appreciable amount of new land can be brought under irrigation with water from wells in this particular area, the permeability of the aquifer and the recharge facilities may not be adequate for large-scale development.

Similar conditions may exist in the vicinity of Hansen Bluff (Siebenthal, 1910, pl. 1) near the Rio Grande, along the alluvial slopes on the east side of the sump area of the valley, and along alluvial fans on the west side of the valley.

Within the area of present development of ground water from artesian aquifers, the earlier wells tapped shallow aquifers at depths ranging from 100 to 200 feet. As the wells became more numerous and more closely spaced, there was mutual interference between them and a gradual decline in head and discharge. Wells drilled during the past 20 years have generally tapped deeper aquifers from which larger flows under higher pressure head have been obtained. Wells drilled in the vicinity of Russell Lakes since the time of this investigation have obtained flows ranging from 2,000 to more than 4,000 gallons a minute. Those tapping shallower artesian aquifers in the same vicinity flow less than 1,000 gallons a minute. Additional artesian water was being made available in the vicinity of Moffat (S½ T. 45 N., Rs. 9 and 10 E.) at the time of this investigation. New wells in this area tap artesian aquifers at depths ranging from 95 to 236 feet. Although these aquifers have long been the source of water for many small artesian wells, they have not previously been tapped by large-diameter wells. The new wells do not have large natural flows, as in the vicinity of Russell Lakes, but their discharges are increased by means of large pumps. The wells range in diameter from 16 to 18 inches and discharge from 600 to more than 2,000 gallons a minute with drawdowns ranging from about 20 to 120 feet. The largest well in the area (45–9–36aa), 236 feet deep, yielded 2,340 gallons a minute with a drawdown of 21 feet. Although the well flowed when drilled in 1948, the water level was about 3 feet below the ground surface in June 1950, indicating a slight decline in pressure head in that area. The principal water-bearing material in that area is medium to coarse gravel interbedded with clay, the thickness ranging from 4 to 100 feet.

It appears that there are many areas within the limits of present development of ground water from artesian aquifers in which additional supplies can be obtained. The piezometric map (pl. 5) indicates that a relatively large amount of water moves through the artesian aquifers toward the sump area of the closed basin and that part of this water moves upward through the less permeable confining layers and is lost by evapotranspiration. Properly distributed wells to tap new supplies of water from artesian aquifers would salvage much ground water heretofore lost by evapotranspiration and would make it available for irrigation or other uses. In some places, however, problems of chemical quality will prevent development for such uses. Details of these problems are given in the "Quality of water" section of this report.

Two fundamental factors affect the procurement of additional large supplies of ground water from artesian aquifers either inside or outside the present limits of development; namely, the productivity of the aquifers and the amount of recharge. When water is pumped from a shallow unconfined aquifer (nonartesian), the area around the well is unwatered, and a large part of the water pumped is derived by gravity drainage of the unwatered section of the aquifer. When water is pumped from an artesian aquifer, the pressure head is lowered in an area around the well, but the aquifer generally is not unwatered—the water is derived largely by the compression of the aquifer and by the expansion of water upon the release of pressure. The amount of water so released from storage is much smaller than the amount released by gravity drainage of an unconfined aquifer.

It is obvious, therefore, that much larger quantities of water can be pumped from nonartesian aquifers than from artesian aquifers with the same lowering of head. In addition, the recharge to the shallow nonartesian aquifers is much greater than the recharge to the deeper artesian aquifers. The artesian aquifers are overlain by confining layers of less permeable materials, such as clay or silt, which produce the artesian pressures but which also retard the downward percolation of water and, hence, reduce the recharge. The shallower artesian aquifers probably crop out along the sides of the valley and probably receive considerable recharge from the surface water that is used for irrigation, particularly on the Rio Grande alluvial fan. Also, in areas where their piezometric surface is lower than the water table in the shallow unconfined aquifer, they no doubt receive considerable recharge by the movement of water from the shallow aquifer through the underlying leaky confining layers. Some of the deeper artesian aquifers are believed to crop out on the higher slopes of the valley beyond the limits of application of surface water for irrigation, where their recharge is limited primarily to the infiltration of precipitation and of water through stream channels, although they are no doubt recharged to a small extent by the slow downward movement of water through the leaky confining layers. Many of the deeper artesian aquifers, however, probably do not crop out and therefore must depend upon downward percolation as the only source of recharge.

In view of the small storage coefficient of the artesian aquifers as compared with the relatively large coefficient of the nonartesian aquifer and of the limited sources of recharge to the deeper artesian aquifers, considerable caution must be exercised in the development of large supplies of artesian water from wells in the San Luis Valley in order to prevent excessive declines of pressure head. Data obtained during this investigation indicate that the deeper artesian aquifers are more permeable and will yield larger quantities of water to wells but that the recharge to these deeper aquifers is much less than the recharge to the shallower aquifers; therefore, large-scale withdrawals by wells may cause large declines in pressure head. It appears, however, that to date none of the artesian aquifers have been developed fully except locally, where hundreds of closely spaced small-diameter flowing wells tapping shallow artesian aquifers have been concentrated in relatively small areas and where large-diameter wells tapping deeper aquifers have been spaced too closely. This is indicated by the fact that pressure heads have declined seriously in only a few places and large quantities of water are still being discharged from the artesian aquifers into the sump area of the closed basin, where it is lost by evapotranspiration.

Large-capacity wells in the artesian aquifers should be developed slowly and cautiously, with due consideration to proper well spacing. Records of water levels should be maintained in order to foresee and prevent serious overdevelopment. In areas where the shallower artesian aquifers have not yet been tapped by large-capacity wells and where the thickness of water-bearing gravel is known to range widely, proper test drilling should precede development in order to avoid well failures.

UNCONFINED WATER

Ground water that does not rise in wells above the level at which it is encountered in the aquifer is said to be nonartesian, or unconfined. Unconfined ground water underlies the entire area of study in the San Luis Valley, generally at depths of less than 20 feet. Most of the water is in Recent deposits, here considered to be the upper part of the Alamosa formation, and lies above the first confining layer of clay, which generally is 25 to 125 feet below ground surface and averages about 60.

Unconfined ground water is contained in several types of materials but principally in sand and gravel. The deposits that contain unconfined ground water were laid down primarily by streams carrying sediments into the valley from the adjacent mountains, and so they are heterogeneous and discontinuous. Test holes drilled as a part of this investigation (pl. 16) reveal that the materials are not of uniform texture and that the sorting action of streams resulted in the deposition of many distinct beds of sand, gravel, mixtures of sand and gravel, and lenticular beds of clay. Where the sand is fine grained and poorly sorted, it generally yields only small quantities of water to wells; but where it is coarse and well sorted, it may yield moderate quantities to properly constructed wells. Coarse, well-sorted gravel has a relatively high permeability and specific yield and will give up large quantities of water.

HISTORY OF DEVELOPMENT

Ground water from the shallow unconfined aquifer was not used extensively in the San Luis Valley until the relatively recent irrigation activities. Irrigation was first practiced in the valley by early Spanish-American settlers, who diverted water from tributaries of the Rio Grande.

Large-scale diversions of water began in the period 1880 to 1890, when an extensive network of canals was built. Water, first applied to lands about 8 miles northeast of Monte Vista, was later carried northward and eastward until, within a relatively short time, the whole central portion of the valley as far north as Hooper was under irrigation. The method of subirrigation, or "subbing," which was practiced, was accompanied by a rise in ground-water level and the seeping (waterlogging) of lands in the lower areas along the eastern side of the closed basin. As these lower areas became waterlogged and damaged by alkali, new lands at higher elevations to the west were placed under irrigation. As a result, there was a migration of farming from east to west, so that by 1910 or 1915 the agricultural areas around Mosca and Hooper were largely abandoned and the irrigation was centered at the west side of the valley. Part of the abandoned land has been reclaimed by drainage.

Before the lands on the west side of the valley were placed under irrigation, the water table was reported to have been 50 to 100 feet below ground surface, which is near the level of the first substantial layer of clay at or near the base of the shallow aquifer that now supplies thousands of acre-feet of unconfined ground water annually for irrigation. The present productive shallow ground-water aquifer, therefore, is essentially an artificial aquifer developed over a period of years by the infiltration of surface water applied for irrigation.

Drilling of wells in the shallow aquifer for irrigation probably began in a period of low runoff, when supplies of surface water were inadequate. The first irrigation well tapping the shallow aquifer in the valley was reported to have been constructed in 1903. Apparently there was little or no development of irrigation from wells tapping the shallow aquifer for the next 25 years, for Code (1952, p. 51) states that there was but one shallow irrigation well in the valley in 1928. But the severe drought of the 1930's and the corresponding deficiency of streamflow brought a rapid development of shallow pumped wells—176 by 1936. Of the 1,300 wells in 1952, 675 were in the area covered by this investigation and are listed in table 10. Irrigation with water pumped from the shallow aquifer is now an important factor in the economy of the valley, but the two methods of irrigation (subbing and pumping) are at cross purposes, because one method depends upon holding the water table near the ground surface and the other tends to lower the water table.

WATER TABLE

The upper surface of the zone of saturation in ordinary permeable soil or rock has been defined as the ground-water table, or simply the water table. Where the upper surface is in impermeable material, as it may be in parts of the San Luis Valley, the water table is absent. The water table is not a plane surface in all parts of the valley but has irregularities comparable with and related to those of the land surface, although generally it is less rugged. It does not remain stationary but fluctuates up and down in a manner similar to that of the water level in a surface reservoir. The irregularities of the water table are due chiefly to local differences in gain or loss of water, and the fluctuations are due to variations from time to time in gain or loss.

During the course of this investigation, the water levels and altitudes of hundreds of wells tapping the shallow aquifer were determined in order to facilitate the preparation of a water-table contour map showing the shape and slope of the water table and the direction of movement of the shallow underground water (pl. 8). More detailed maps of the sump area were prepared in order to show the shape and slope of the water table near the line of the proposed sump drain during periods of high and low water level (pls. 9 and 10).

SHAPE AND SLOPE

The shape and slope of the water table in the area of study are shown on the maps (pls. 8, 9, and 10) by contours connecting points on the water table that have the same altitude. The water-table contours show the configuration of the water surface just as topographic contours show the shape of the land surface. The direction of movement of the ground water is at right angles to the contours in the direction of the downward slope.

The maps show that the general movement of shallow unconfined ground water in the San Luis Valley is toward the sump area of the closed basin but that the slope and the direction of movement vary appreciably from one part of the area to another. Maximum slope of the water table is along the periphery of the valley beneath the alluvial fans, where the slope of the ground surface is greatest; the minimum slope is in the sump area. The slope of the water table beneath the Rio Grande alluvial fan averages about 10 feet per mile in the vicinity of Del Norte. Beneath the alluvial fans on the east side of the valley, the slope was mapped in only a small area near San Luis Lake, where it attains a maximum of 37 feet per mile. On the floor of the valley between the Rio Grande alluvial fan and the sump area, the slope ranges from about 2 to 10 feet per mile and averages about 5 feet per mile. The water table in the sump area of the closed basin is so nearly flat that maps having contour intervals of 1 foot were required to show its configuration (pls. 9 and 10). The shallow ground water moves from all directions toward the sump and discharges into marshy areas and lakes. In some parts of the sump, the slope of the water table is less than 1 foot per mile. The lowest point on the water table centers around a small lake on a section corner common to secs. 1, 6, 7, and 12, T. 38 N., Rs. 11 and 12 E. South of the ground-water divide, the shallow ground water moves toward and discharges into the Rio Grande.

The shape and slope of the water table, which determine the rate and direction of movement of ground water, are controlled by several factors. In the area of study, they appear to be affected primarily by (1) the topography, (2) the discharge of water by evapotranspiration in the sump area, and (3) the discharge of water into the Rio Grande. The shape and slope of the water table resemble the topography so closely that there is a striking resemblance between the water-table contour map (pl. 8) and the topographic map (Siebenthal, 1910, pl. 1). From the water-table contour map, the position of the sump area and the distribution of the alluvial fans can be determined readily. The shape of the water table must conform closely to the shape of the ground surface because the water table is held near the ground surface by subirrigation, a method by which the water table is raised by the infiltration of surface water from closely spaced ditches and is then controlled by a series of drains.

The most prominent feature of the water table is the large depression lying beneath the sump area. This depression, which resembles the cone of depression around a large well field, is maintained by the discharge of large volumes of water by evapotranspiration. The lowest point on the water table is about 6 feet below the crest of the ground-water divide, where it borders the sump area on the south.

Irregularities in the shape of the water table that are caused by the discharge of water into the Rio Grande are much less pronounced than the irregularities caused by the discharge through evapotranspiration in the sump area. The discharge into the Rio Grande has created a depression, or trough, in the water table along the course of the river and is reflected in the upstream flexure of the contours as they cross the river. The contours are displaced upstream in the amount of about one-half to one contour interval, indicating that the trough in the water table is on the order of 5 to 10 feet deep.

Other factors, no doubt, affect the shape and slope of the water table in the area of study, but they are of minor importance and their effects are not of sufficient magnitude to be determined easily by means of the water-table contour map. These factors may include the recharge of the ground-water reservoir by ephemeral streams, local differences in the permeability and thickness of the aquifer, and the pumping of water from wells. Water percolating downward through the channels of influent (losing) streams recharges the ground-water reservoir and tends to develop a linear mound on the water table beneath the course of the channel. Although there is little doubt that recharge of this type occurs in the area of study, the water-table contour map is not of sufficient detail to show the effects of such recharge. There are indications that during periods of very low runoff and of very heavy pumping of ground water for irrigation the Rio Grande becomes, in part, a losing stream. The water table in the area of heavy pumping north of Monte Vista declined by as much as 12 feet as a result of the low runoff and relatively small diversions in 1951. A decline of this magnitude is sufficient to shift the ground-water divide by a considerable distance.

The relative flatness of the water table in the sump area probably is the result of the relatively low rate of evaporation from the permanent lakes in that area (2,000 acre-feet a year, according to U. S. Bureau of Reclamation). Although the total amount of water entering and leaving the shallow aquifer is great, the discharge is largely near the point of recharge and the net movement to the sump is relatively small.

Local differences in permeability and thickness of the aquifer may cause local differences in the shape and slope of the water table. A decrease in permeability and thickness generally causes a steepening of the water table and results in the closer spacing of the water-table contours; conversely, an increase in permeability tends to cause a flattening of the ground-water gradient. Although these factors no doubt influence the shape and slope of the water table in the area of study, data are not adequate to determine the extent of the influence.

Pumping of water from wells may have a pronounced influence on the shape and slope of the water table as cones of depression form around wells during periods of pumping. Data for the water-table contour map (pl. 8), however, were obtained during a period of high runoff and low pumping. The map, therefore, does not show pronounced irregularities due to pumping. If data could have been obtained during the period of heavy pumping in 1951, a contour map compiled from them would no doubt display a large depression in the water table in the area north of Monte Vista, where about 280,000 acre-feet of ground water was pumped from shallow aquifers during the irrigation season.

GROUND-WATER DIVIDE

The closed basin is separated from the Rio Grande basin by a low topographic divide, which in some places is barely discernible and in other places can be traced only by careful mapping. And ground water in the closed basin is separated from that in the Rio Grande basin by a ground-water divide of low relief that roughly parallels the topographic divide. If reports are true that the water table was once 50 to 100 feet below ground surface in the area north of Monte Vista, then the ground-water divide must at one time have been very pronounced and must have followed the course of the Rio Grande very closely as far downstream as the bend of the river in T. 37 N., R. 11 E. As the shallow, porous materials in the area north of Monte Vista became filled with water through recharge from irrigation, the ground-water divide became less and less pronounced until it is now barely discernible, except in the area northeast and east of Alamosa near the large water-table depression beneath the sump area. At the same time, it is likely that the ground-water divide moved northward away from the Rio Grande.

At the present time, the divide has such low relief and is so difficult to determine from the water-table contour map that it is doubtful if it now forms an effective barrier to the movement of ground water between the two basins. In recent years, building up the water table by subirrigation and lowering the water table during periods of low runoff by pumping have been great enough to cause considerable lateral displacement of the ground-water divide. At the time of this investigation, the ground-water divide in the vicinity of Del Norte was less than a mile north of the river, whereas in 1936 it crossed the north line of T. 40 N., R. 6 E. at a point nearly 4 miles north of the river. Similarly, during the drought of 1951 the decline of water level in some of the most heavily pumped areas north of Monte Vista exceeded 10 feet, which is sufficient to depress the water table below the level of the Rio Grande in some places and to cause the Rio Grande to become a losing stream locally and to contribute water to the ground-water reservoir. At such times the ground-water divide locally may be directly beneath the stream, although the recharge of the ground-water reservoir by infiltration through ditches and canals north of the river probably prevents the southward movement of the divide in most parts of the valley. It is believed that the position of the ground-water divide in the area south and southeast of the sump has remained about the same.

FLUCTUATIONS OF WATER LEVEL

The water table does not remain stationary but fluctuates much like the water surface of any surface reservoir. Whether the water table rises or declines depends upon the amount of recharge into the ground-water reservoir and the amount of discharge. If the inflow exceeds the draft, the water table will rise; if the draft exceeds the inflow, the water table will decline. The water table fluctuates more by the addition or depletion of a certain quantity of water than the level of a surface reservoir, because ground water occupies only part of the volume of a ground-water reservoir. If the sand and gravel of a water-bearing formation has an average specific yield of 25 percent, the addition of 1 foot of water to the sand and gravel will raise the water table in that material about 4 feet. Changes of water levels in wells record the fluctuations of the water table and, hence, the recharge and discharge of the ground-water reservoir.

The principal factors that control the rise of the water table in the San Luis Valley are (1) recharge from irrigation, (2) recharge from precipitation, (3) recharge from artesian aquifers through leakage or surface discharge, and (4) recharge from influent (losing) streams. The principal factors that control the decline of the water table in this area are (1) discharge by evapotranspiration, (2) discharge into streams and drains, and (3) discharge from wells.

If the quantity of ground water discharged from a ground-water reservoir during a year is greater than the recharge during that year, the water table will decline. During a period of dry years the water table may decline even if there is little or no pumping from wells, but in a subsequent period of wet years the water table may rise. The decline of the water table during a dry year, therefore, does not necessarily mean that there has been an excessive withdrawal of water from the ground-water reservoir; but it does indicate less recharge of the ground-water reservoir because of decreased precipitation and surface-water diversions and, at the same time, greater discharge by evapotranspiration and by increased pumping from wells. Conversely, a rise of the water table during wet years indicates that recharge from precipitation and surface-water diversions is increased and the loss of water by evapotranspiration and pumping is reduced.

Fluctuations of the water table in the San Luis Valley were determined by measuring the water levels in wells periodically. Beginning in 1946, water levels were measured twice monthly in 211 wells, most of which were small-diameter wells constructed as a part of this investigation (pl. 2). In 1948 the investigation was expanded to include the heavily irrigated area of the closed basin lying north of Monte Vista, and the number of observation wells being measured periodically was increased to 505. In 1949, 52 observation wells were added in the area south of Monte Vista and measurements of selected wells in the closed basin were discontinued, leaving a total of 284 observation wells in the area of study. When field work for this report was completed, the observation-well program was reduced to a network of about 60 carefully selected representative wells.

RECHARGE

Recharge, the addition of water to the underground reservoir, may be accomplished in several ways. The shallow, unconfined ground-water reservoir in the area of study is recharged primarily by the infiltration of water used for irrigation. Other sources for the recharge are precipitation, contributions by artesian aquifers, and infiltration from streams and canals.

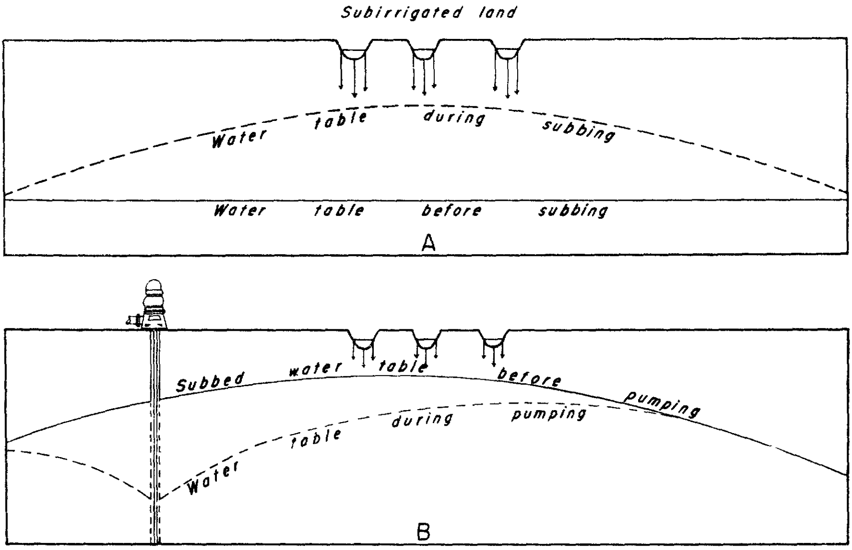


FIGURE 11.—Subbing method of irrigation. *A*, Local rise in water table in area where the subbing method of irrigation is practiced; *B*, interference between the pumping and the subbing methods of irrigation.

RECHARGE FROM IRRIGATION

Large quantities of water are diverted annually from the Rio Grande for irrigation in the San Luis Valley, principally on the Rio Grande alluvial fan. Two methods of irrigation are practiced: the subirrigation method, by which the water table is held near the ground surface; and the pumping method, which tends to lower the water table. The methods are described in more detail on page 45 and are illustrated in figure 11. Although the two methods work at cross purposes in that one tends to hold the water table near the ground surface and the other tends to lower the water table, they create almost ideal conditions for recharge. Pumping of wells lowers the water table and makes room in the aquifer for a great deal of recharge that otherwise would be rejected. The porous soils readily absorb the large quantities of surface water diverted from the Rio Grande.

The effects of recharge from irrigation upon water levels in wells are illustrated clearly in figures 12, 13, and 14. In the heavily irrigated areas north and south of Monte Vista, the water levels rise abruptly in the spring, when surface water is diverted for irrigation, and decline abruptly in the fall after irrigation ceases. Minor modifications of this general trend are caused mainly by rises due to precipitation and declines due to pumping. The effect of the unusually small diversions of surface water for irrigation in 1951 are reflected in the water levels

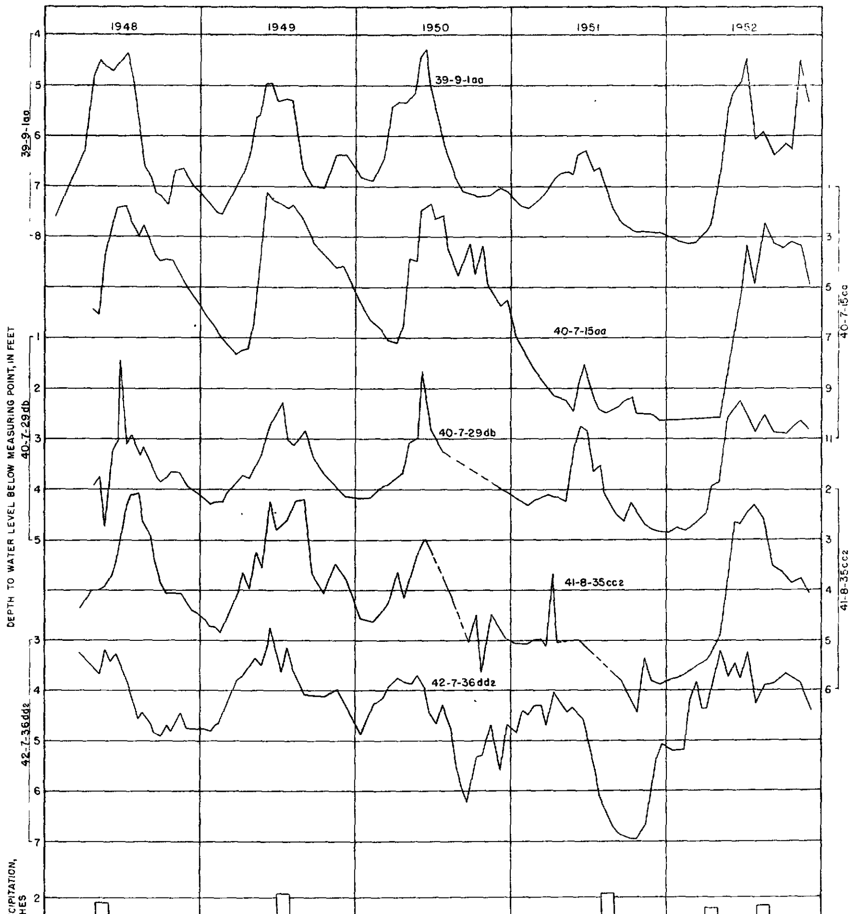


FIGURE 12.—Fluctuations of water levels in 5 wells in the subbed and pumped irrigation areas in the closed basin and graphs showing monthly precipitation at Monte Vista.

in most of the wells in those areas; in most places the water levels rose only slightly during the irrigation season and then declined to record lows during the succeeding fall and winter. In the sump area of the closed basin the water levels in wells display a similar annual rise and fall. Here, however, the water levels generally begin to rise in late summer or early fall and decline in the spring or summer. This probably is a delayed effect of the recharge from irrigation in the western part of the basin and the large discharge by evapotranspiration during the growing season. Recharge from irrigation in the western part of the closed basin raises the water table and increases its gradi-

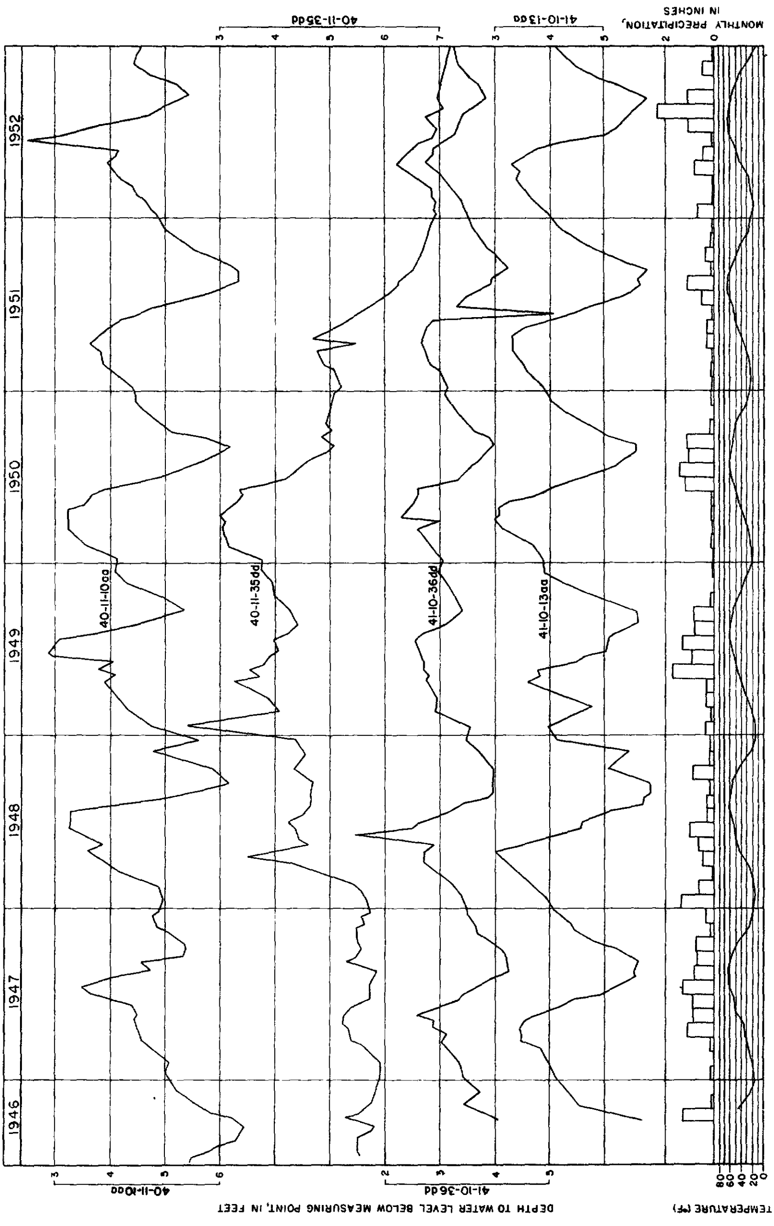


FIGURE 18.—Fluctuations of water levels in 4 wells in the sump area of the closed basin and graphs showing monthly precipitation 8 miles west of San Luis Lake.

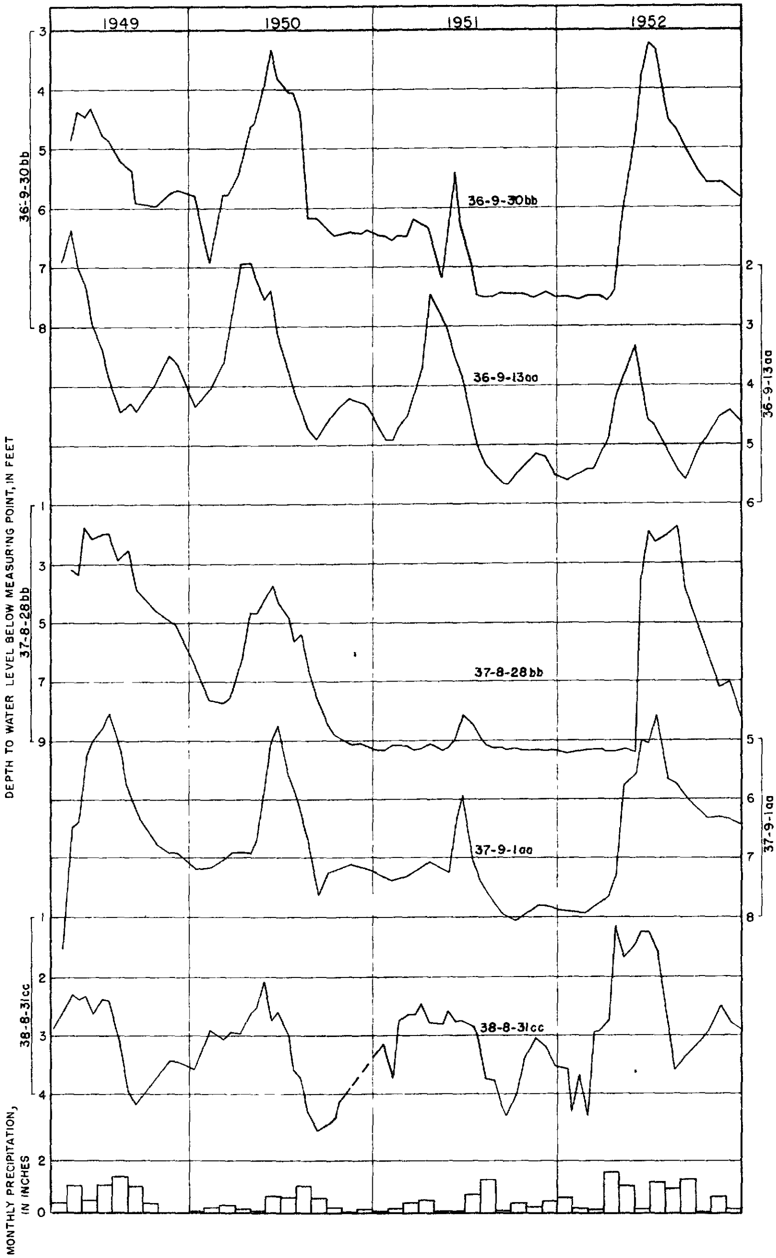


Figure 14.—Fluctuations of water levels in 5 wells south of the Rio Grande and graphs showing monthly precipitation at Alamosa.

ent toward the sump, which probably accounts for the delayed rise in water levels in wells near the sump.

No attempt was made during this investigation to determine the amount of recharge from irrigation, but it is believed to be large. This is indicated by the considerable rise in water levels in wells north of Monte Vista after the small diversions and heavy pumping during the 1951 irrigation season. Records obtained as a part of the study of the inflow-outflow area (p. 118) indicate that recharge from the application of surface water for irrigation in 1952 amounted to at least 135,000 acre-feet in an area of 291 square miles. This figure, based on the change in ground-water storage, does not take into account the water added to the ground-water reservoir as recharge and then discharged by evapotranspiration or other means.

RECHARGE FROM PRECIPITATION

Recharge from precipitation in the San Luis Valley probably is small in relation to the recharge from irrigation, because the total annual precipitation on the valley floor is only about 7 or 8 inches. The amount of water that reaches the water table and becomes recharge to the ground-water reservoir is determined by the intensity and duration of the precipitation; the slope of the land surface; the porosity and permeability of the soil and subsoil; and the vegetative cover.

Most of the precipitation falls during the summer, when thunderstorms are common; slow, steady rains are relatively infrequent. Much of the rainfall that accompanies the sudden, brief thunderstorms is lost by runoff and evaporation.

The slope of the land surface is an important factor in the determination of the amount of precipitation that will escape by runoff and the amount that will penetrate the soil and reach the ground-water reservoir as recharge. Steeper slopes, of course, are conducive to greater runoff. The surface slopes of the alluvial fans on the periphery of the valley are relatively steep, but the slopes in the large area composing the floor of the valley are gentle, allowing the water a longer period of access to the soil before running off. In the Rio Grande basin the runoff eventually reaches the Rio Grande. In the closed basin the runoff reaches the series of lakes in the sump area, where it is dissipated largely by evaporation.

The porosity of the soil is another important factor in the infiltration of precipitation. Soils on the Rio Grande and other alluvial fans generally are gravelly and sufficiently porous to admit water readily, as indicated by the rapid infiltration through ditches in areas where subirrigation is practiced. Soils on the valley floor are sandy locally, particularly on the east side of the valley, and absorb water readily.

In view of the gentle slopes and porous soils that occur in a large part of the valley, it appears that the portion of the precipitation that reaches the water table may be moderate to relatively large, perhaps as much as 20 percent; nevertheless, the amount of recharge from precipitation is relatively small in comparison with the recharge from irrigation because of the low annual rate of precipitation. The fluctuations of water levels in wells, as shown in figures 12, 13, and 14, do not give a clear picture of the effect of precipitation upon recharge, because fluctuations caused by precipitation are largely obscured by greater fluctuations caused by other factors. Recharge from irrigation is the dominant factor controlling the fluctuations of water level in the area north of Monte Vista (fig. 12), and minor fluctuations caused by precipitation are difficult to discern. The effects of some storms, however, are shown clearly by the hydrographs of water-level fluctuations. The heavy rainfall in July 1949, for example, was accompanied or followed by rises of water levels in wells 41–8–35cc2 and 40–7–29db and was followed by a retardation of the rate of decline of water levels in wells 40–7–15aa and 39–9–1aa. Rainfall of comparable magnitude in August 1951 appears to have affected the water level in only one well (40–7–15aa), for the water levels at that time were declining rapidly because of the deficiency of surface water available for irrigation and because of heavy pumping. The effects of precipitation upon recharge are equally difficult to discern by means of the hydrographs of wells in the sump area of the closed basin (fig. 13), because of the much greater fluctuations caused by the delayed effects of recharge on the west side of the basin and because of the large amount of water lost by evapotranspiration. The hydrographs indicate that there have been a few slight rises of water levels and a few slight retardations of decline associated with some of the larger storms.

RECHARGE FROM ARTESIAN AQUIFERS

LEAKAGE FROM ARTESIAN AQUIFERS

There probably is considerable recharge of the shallow ground-water reservoir by the upward movement of water from the underlying artesian aquifers. This is indicated by the large depression in the piezometric surface in the sump area of the valley (pl. 5). Most, if not all, of the artesian aquifers tapped by wells in the San Luis Valley are leaky. They are not the type of artesian aquifers commonly observed elsewhere, aquifers that are overlain and underlain by thick sequences of clay or shale of very low permeability. In the San Luis Valley, artesian aquifers are created in part by differences in permeability of the water-bearing materials themselves, but they are formed largely by layers of clay that generally are relatively thin and do not extend over wide areas (pl. 11). And in the lower part of the valley, the head of water in the artesian aquifers is as much as 60 feet greater than the head of water in the shallow aquifer. Thus, much artesian water moves slowly upward and recharges the shallow ground-water aquifer.

CONTRIBUTIONS FROM FLOWING WELLS

The shallow ground-water aquifer receives water from the artesian aquifers also by means of flowing wells—either by leakage out of the wells through faulty or inadequate casing or by discharge at the ground surface and later downward percolation. Many flowing wells in the valley are equipped with only a few feet of surface casing, and artesian water moves freely from the well into the shallow aquifer. Others were properly cased but the casings have deteriorated and now permit the passage of artesian water into the adjacent shallow aquifer. It is not possible to estimate accurately the amount of recharge to the shallow ground-water aquifer as the result of leakage from flowing wells, but there is no doubt that it is a large amount. And in addition to the leakage from artesian wells, part of the water that is discharged from the approximately 7,500 flowing wells in the valley eventually reaches the shallow ground-water reservoir by percolation. Owing to the low surface gradients and the porous soils in the valley, only a relatively small percentage of the water escapes as runoff, the remainder reaching the water table or being discharged by evapotranspiration. The potential yield of all the flowing wells in the valley is on the order of 480,000 acre-feet a year. Some of the wells, however, are shut in during a part of the year, and so the total actual yield is not known—perhaps 300,000 to 400,000 acre-feet a year. It is obvious, therefore, that large quantities of water discharged from artesian wells are added to the shallow ground-water reservoir as recharge.

RECHARGE FROM STREAMS AND CANALS

Recharge to the shallow ground-water reservoir of water from streams and canals probably is small in comparison with the recharge from irrigation, but it may be relatively large in certain places and at certain times. The Rio Grande, for example, gen-

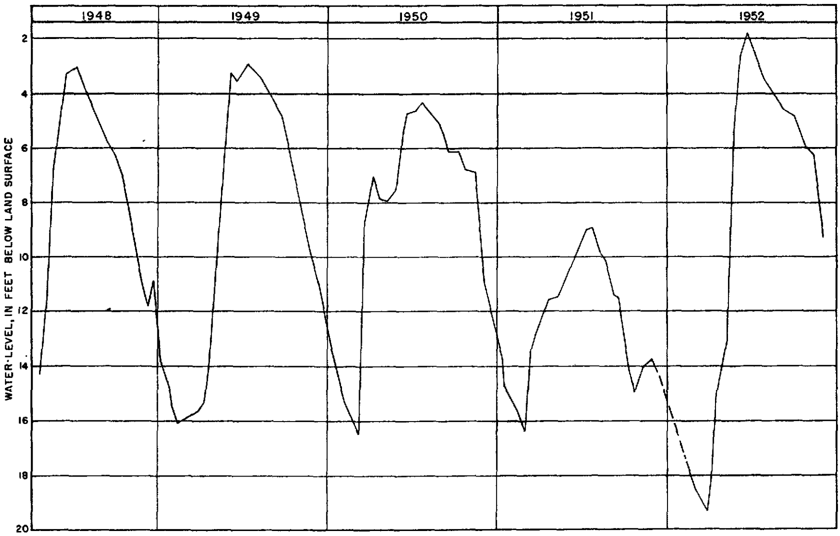


FIGURE 15.—Fluctuation of water level in well 40-6-16cc caused by water in nearby Rio Grande canal during periods of irrigation.

erally is a gaining stream, but after periods of low runoff and heavy pumping, as occurred in 1951, the water table may be lowered below the level of the channel and large quantities of water may move from the stream into the shallow ground-water reservoir. The reservoir doubtlessly receives some recharge from a few of the small ephemeral streams in the valley.

Records indicate that there is recharge to the ground-water reservoir by infiltration of water through canals, particularly in areas immediately adjacent to the canals. The water level in well 40-6-16cc, for example, fluctuates widely with the distribution of water through the nearby Rio Grande canal, as illustrated in figure 15. The water level in the well rises abruptly in the spring when water is turned into the canal and declines abruptly when water in the canal is shut off. The relatively small quantity of water distributed through the canal in 1951 is reflected in a relatively low peak in the water level in the well that year. Records of the effect of infiltration of water through canals upon water levels in other areas are not available, but probably there is considerable recharge to the ground-water reservoir adjacent to canals.

DISCHARGE

Ground water may be discharged from the zone of saturation or from the capillary fringe (a belt that overlies the zone of saturation and contains capillary interstices—some or all of which are filled with water) through evapotranspiration and from the zone of saturation as hydraulic discharge through seeps, springs, infiltration galleries, and wells and ditches or other man-made structures. The principal types of ground-water discharge in the San Luis Valley are discussed below.

DISCHARGE BY EVAPOTRANSPIRATION

Ground water, taken into the roots of plants directly from the zone of saturation or from the capillary fringe, is discharged from the plants by transpiration. The depth from which plants will lift ground water varies with species of plant and type of soil and ranges from only a few feet for ordinary grasses and field crops to 50 feet or more for alfalfa and certain types of desert plants. Evapotranspiration is one of the principal methods of discharge of water from the shallow aquifer in the San Luis Valley. Inasmuch as the water table is held at or near the root zone of most plants—either naturally or artifically—during most of the growing season, large volumes of shallow ground water are discharged into the atmosphere by this process. The average depth to the water table in much of the area of study is less than 10 feet and may be as little as 2 feet in the subirrigated areas during the growing season. The water table, or capillary fringe, is easily reached by the roots of both the cultivated crops and the native vegetation. Vegetation in the uncultivated areas consists mostly of greasewood, rabbitbrush, and saltgrass, all of which use large amounts of ground water.

Where the water table is near the land surface, ground water moves upward through the small pore spaces in the soil and is discharged at the surface by evaporation. The rate of discharge varies with the depth to the water table, the porosity of the soil, the climate, the season, and perhaps other factors. Discharge is greatest in areas where the soil is fine textured, as indicated by the large areas of alkaline soils and alkali flats in the eastern part of the closed basin where the soil is fine grained.

Determining the discharge of ground water from the shallow aquifer by evapotranspiration was not an objective of this investigation, and so studies were not made to determine its rate. Studies made in other areas having a vegetative and climatic setting comparable with that of the San Luis Valley, however, give some indication of the rate of evapotranspiration that may be expected in the San Luis Valley. White (1932), in a study of Escalante Valley, Utah, determined that in the lowlands of that valley the rate of evapotranspiration was approximately 1 acre-foot per acre annually where the vegetative cover consisted predominantly of saltgrass, associated with greasewood, rabbitbrush, and pickleweed, and where the depth to water ranged from the ground surface to 3 feet in the spring and from 3 to 5 feet in the fall. The rate of evapotranspiration was approximately 5 acre-inches per acre annually in areas where the native vegetative cover was largely greasewood, rabbitbrush, shadscale, and a light growth of saltgrass, and where the depth to water ranged from ground surface to 5 feet in the spring and from 3 to 8 feet in the fall. The rate of evapotranspiration was approximately 2 acre-inches per acre annually in the uncultivated areas at higher elevations where the native vegetation included greasewood, rabbitbrush, and shadscale, and where the depth to water ranged from 8 to 30 feet. Escalante Valley is at a lower altitude and has a slightly greater annual precipitation than the San Luis Valley but is otherwise comparable with the San Luis Valley in climate, topographic situation, and vegetative cover. It is probable, therefore, that the rates of evapotranspiration in the San Luis Valley are comparable with those in the Escalante Valley.

Fluctuations of water level in well 39–9–2bb, in the eastern part of the closed basin, give some indication of the order of magnitude of evapotranspiration in the San Luis Valley. The well is surrounded by native vegetation consisting of rabbitbrush and greasewood, and there is a heavy growth of cottonwood trees about 1,000 feet from the well. The water level in the well, which averages about 8 feet below ground surface, declines during the growing season and rises during the fall and winter. The rate of decline during the growing season is essentially a measure of the rate of evapotranspiration in the vicinity of the well, because the decline is largely the result of discharge of ground water by evapotranspiration. During the growing season of 1948 (June 23 to September 22), for example, the water level in the well declined 1.62 feet, or 19.44 inches. As the specific yield of the aquifer in the vicinity of the well is on the order of 30 percent, the rate of evapotranspiration in the vicinity of the well appears to be on the order of 6 acre-inches per acre annually.

Discharge of ground water by evapotranspiration is illustrated further by the diurnal fluctuations of water level in well 39–9–2bb, which was equipped with an automatic water-stage recorder. As shown in figure 16, the water level in the well exhibited a marked daily fluctuation in early July, *A*, during the height of the growing season; the water level declined during the day and rose during the night but had a net decline, owing to the depletion of the ground-water reservoir by evapotranspiration. At least part of the vegetation had matured by early Sep-

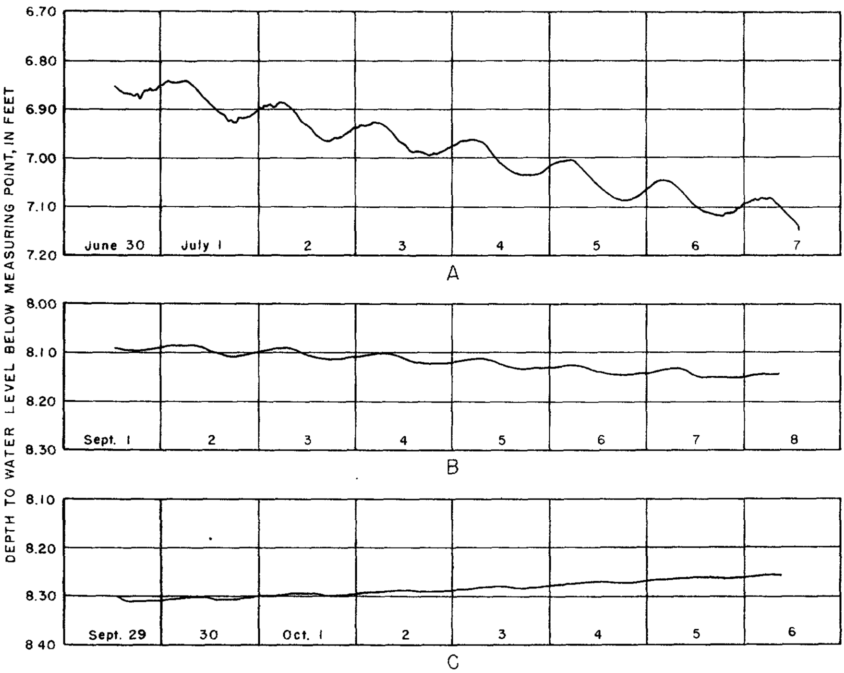


FIGURE 16.—Diurnal fluctuations of water level in well 39-9-2bb.

tember, *B*, and the days had become cooler, with the result that the daily fluctuations of water level were of lower magnitude and the net daily decline in water level had become much less. The daily fluctuations had practically ceased after the first killing frost, and by early October, *C*, there was a daily net rise of water level in the well.

DISCHARGE FROM WELLS

Discharge of water from wells has become one of the principal means of discharge from the shallow ground-water reservoir. The use of shallow unconfined water for irrigation was of little significance before 1930 but has since increased rapidly. By 1936, the 176 large-capacity wells that tapped the shallow aquifer discharged about 850 gallons a minute each; the combined discharge, if the wells were pumped continuously and simultaneously, was about 660 acre-feet daily (Robinson and Waite, 1938, p. 248). By the time of this investigation, 675 large-capacity wells tapped the shallow aquifer. On the basis of the measurements of 251 discharges, the average discharge of these wells was found to be on the order of 1,000 gpm; and the total discharge, if the wells were pumped continuously and simultaneously, would be about 3,000 acre-feet daily. The total annual discharge of all the large-capacity wells tapping the shallow aquifer in the San Luis Valley is estimated to be on the order of 500,000 acre-feet during periods of very low runoff, such as the period in 1951. Details of the discharge of ground water in the area of inflow-outflow study are given on page 125.

DISCHARGE BY DRAINS AND CANALS

Drains have been used in the agricultural areas of the San Luis Valley since about 1910, particularly in areas where subirrigation is practiced and in areas where the soil has become waterlogged. The drains in the subirrigated areas form an integral part of the irrigation system in that check gates are used to control the position of the water table, whereas the drains in the waterlogged areas are used primarily to lower the water table. Some of the canals also function as drains in parts of the valley when they are not carrying diverted surface water and when the water table adjacent to the canals is higher than the bottoms of the canals. No estimate has been made of the quantity of ground water discharged from the shallow ground-water reservoir in the San Luis Valley as a whole, but the Bureau of Reclamation has made periodic measurements of the amount of water carried out of the area of inflow-outflow study by means of canals and drains (p. 125). Part of the data compiled by that agency are tabulated below, and they show that relatively large quantities of water are discharged from the shallow aquifer in this manner.

Discharge of ground water by drains and canals in the inflow-outflow area, in acre-feet

Year	Discharge of drains	Discharge of canals	Total discharge
1949	42,600	5,400	48,000
1950	21,100	4,200	25,300
1951	8,400	1,600	10,000
1952	21,500	4,200	25,700

HYDROLOGIC PROPERTIES OF THE UNCONFINED AQUIFER

Definitions of hydrologic properties, discussed below, are included in the section on "Hydrologic properties of artesian aquifers."

PERMEABILITY AND TRANSMISSIBILITY

As the permeability of the shallow unconfined aquifer is dependent upon the number, size, and degree of interconnection of the pore spaces in the aquifer, it is obvious that it ranges widely within the San Luis Valley; it is relatively high in the coarse materials that make up the alluvial fans on the sides of the valley, and it is progressively lower toward the sump area of the closed basin, where the materials are fine grained. Two methods have been used to determine the coefficients of permeability and transmissibility of the shallow aquifer in the San Luis Valley; they are discussed below.

LABORATORY DETERMINATIONS

The coefficients of permeability of 22 samples of the shallow unconfined aquifer were determined in the laboratory of the U. S. Geological Survey as a part of the Rio Grande Joint Investigation (Robinson and Waite, 1938, p. 233). They ranged from less than 1 gpd per square foot for a sample taken from a layer of clay to 1,500 gpd per square foot for samples of sand and gravel. Inasmuch as the average saturated thickness of the shallow aquifer is about 50 feet, the maximum coefficient of transmissibility, according to the laboratory determinations, would be about 75,000 gpd per foot. These coefficients of permeability and transmissibility, however, are probably too low to be representative, because the samples were collected from the upper part of the aquifer where the materials are known to be finer grained than at greater depths. The coefficients that were determined by means of pumping tests during this investigation are probably more reliable.

PUMPING-TEST DETERMINATIONS

Thiem method.—The Thiem method (Wenzel, 1942, pp. 77–81) of determining the permeability of a water-bearing material consists of analysis of the decline in water level during the pumping period in several observation wells near the pumped well. The method is based on the consideration that after approximate equilibrium is established around a pumped well, approximately equal quantities of water move toward the well in a given unit of time through a successive series of concentric cylindrical sections around the well. Because the areas of the larger cylinders through which the water percolates are greater than the areas of the smaller cylinders, the velocity of the ground water passing through the larger cylinders is proportionately less and the hydraulic gradient is proportionately smaller. The Thiem formula may be written:

$$T = \frac{528Q \log_{10} \frac{r_2}{r_1}}{s_1 - s_2}$$

in which T is the coefficient of transmissibility in gpd per foot; Q is the discharge of the pumped well, in gpm; r is the distance of the observation wells from the pumped well, in feet; s_1 and s_2 are the drawdowns, in feet, of the water levels in observation wells at distances r_1 and r_2, respectively.

Observed drawdowns (s_1 and s_2) can be used in the above equation for confined aquifers or for thick unconfined aquifers. If an unconfined aquifer is thin, however, so that there is an appreciable diminution of depth of flow near the pumped well, the drawdowns should be corrected in the following manner, according to Jacob (1944):

$$s' = s - \frac{s^2}{2m}$$

in which s' is the corrected drawdown, in feet; s is the observed drawdown, in feet; and m is the thickness of the saturated part of the aquifer before pumping begins, in feet. As the thickness of saturated materials tested by the Thiem method ranged from 18 to 78 feet and averaged only 43 feet, the drawdown corrections were applied in each pumping test, and the corrected drawdowns ($s'_1 - s'_2$) were used in the denominator of the Thiem equation.

Solution of the Thiem equation is simplified by plotting the data on semilogarithmic paper. Values of s' in 2 or more observation wells, which were pumped sufficiently long to establish approximate equilibrium, are plotted on the linear scale, and corresponding values of r are plotted on the logarithmic scale. The slope of the straight line connecting the plotted points is determined by taking the change in s' over one log cycle of r (for which the value of log r_2/r_1 is unity), so that the solution is simply:

$$T = \frac{528Q}{\Delta s'}$$

Jacob (1944, equation 11) has shown that, after T has been determined in this manner, the specific yield (S) may be determined from the intercept r_e on the axis of r (or, $\log_{10} r$), at which point $s' = 0$, by the following equation:

$$S = \frac{0.3Tt}{r_e^2}$$

in which T and r_e are in units previously defined, and t is the duration of pumping, in days.

The coefficient of transmissibility of the shallow unconfined aquifer in the vicinity of 39 wells was determined by means of pumping tests as a part of this investigation (table 6). All but one of these determinations were made by the Thiem method; one was made by the recovery method. Most of the tests were in the sump area of the closed basin, where data on the coefficients of transmissibility of the aquifer were needed to determine the probable yield of the proposed closed basin drain (p. 102); the remainder were in or near the east line of the area of inflow-outflow study, where data were needed to determine the ground-water outflow. As there were no wells suitable for test pumping in the sump area at the time of this investigation, it was necessary to construct temporary wells for the tests. Inasmuch as the Thiem method was considered to be the most reliable method of determining the coefficient of transmissibility of unconfined aquifers under the conditions prevailing, and as that method requires the use of observation wells, it was necessary to construct observation wells in the vicinity of all wells tested.

Three pairs of wells were jetted at each test site, the pairs being spaced at distances of 1*m*, 2*m*, and 4*m* from the pumped well (*m* is the initial saturated thickness of the aquifer being tested). One observation well of each pair penetrated the entire thickness of the aquifer, whereas the other penetrated only the upper part of the aquifer. Use of 3 pairs of observation wells in this manner, all in a straight line on one side of the pumped well, was suggested by Jacob (written communication, January 28, 1946) as an effective means of correcting for partial penetration of the aquifer by the pumped well and for local inhomogeneities of the aquifer. The water levels in the pumped wells during both pumping and recovery periods and in the observation wells during the pumping period were measured with a steel tape or an electrical-contact device. The discharges of the pumped wells were measured with a current meter, Parshall flume, orifice, or a barrel and stopwatch. A typical pumping test is described below and is illustrated in figures 17 and 18.

Test well 50, 6 inches in diameter and 50 feet deep, was equipped with a 4-inch turbine pump powered by a gasoline engine. The average thickness of saturated materials in the vicinity of the test well and of the observation wells was about 49 feet. The locations of the pumped well (*PW*) and observation wells are shown in figure 17. Observation wells labeled *S* penetrated the entire thickness of the aquifer, whereas those labeled *N* penetrated only the upper part of the aquifer. The well was pumped at the rate of 94 gallons a minute for 70 hours

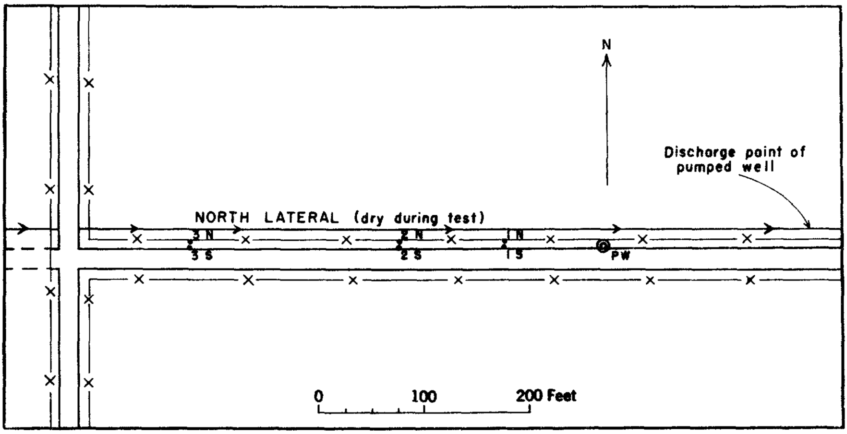


FIGURE 17.—Location of test well 50 (PW) and observation wells (SE¼SE¼, sec. 7, T. 41 N., R. 10 E.). Observation wells labeled *S* penetrated entire thickness of aquifer; observation wells labeled *N* penetrated only upper part of aquifer.

during the period October 4–6, 1949, during which time the water levels in the pumped well and observation wells were measured. The pump was then shut off, and the recovery of the water level in the pumped well was measured periodically for several hours. The corrected drawdowns (s') at a given time in each of the 6 observation wells were plotted on a semilogarithmic graph against the distance of the observation well from the pumped well, in feet (r). The corrected drawdowns of each pair of partly and fully penetrating observation wells were averaged graphically (points x in fig. 18), and a straight line was drawn through those points. From this curve, it was determined that the coefficient of transmissibility of the aquifer in the vicinity of test well 50 was about 60,000 gpd per foot and, hence, that the coefficient of permeability (60,000 divided by 49) was about 1,200 gallons a day per square foot. Test well 50 was not pumped long enough to permit the determination of the coefficient of storage.

Theis recovery method.—The Theis recovery method, described on page 41, is adaptable to the determination of the coefficients of transmissibility and permeability of artesian aquifers, but it may give erroneous results if applied to unconfined aquifers such as the shallow aquifer in the San Luis Valley, particularly if the water-bearing materials are fine grained and if the tests are of short duration. The materials tested during this investigation are largely fine grained and poorly sorted, and the duration of the tests was generally not sufficiently long to permit adequate drainage of the unwatered part of the aquifer in the cone of

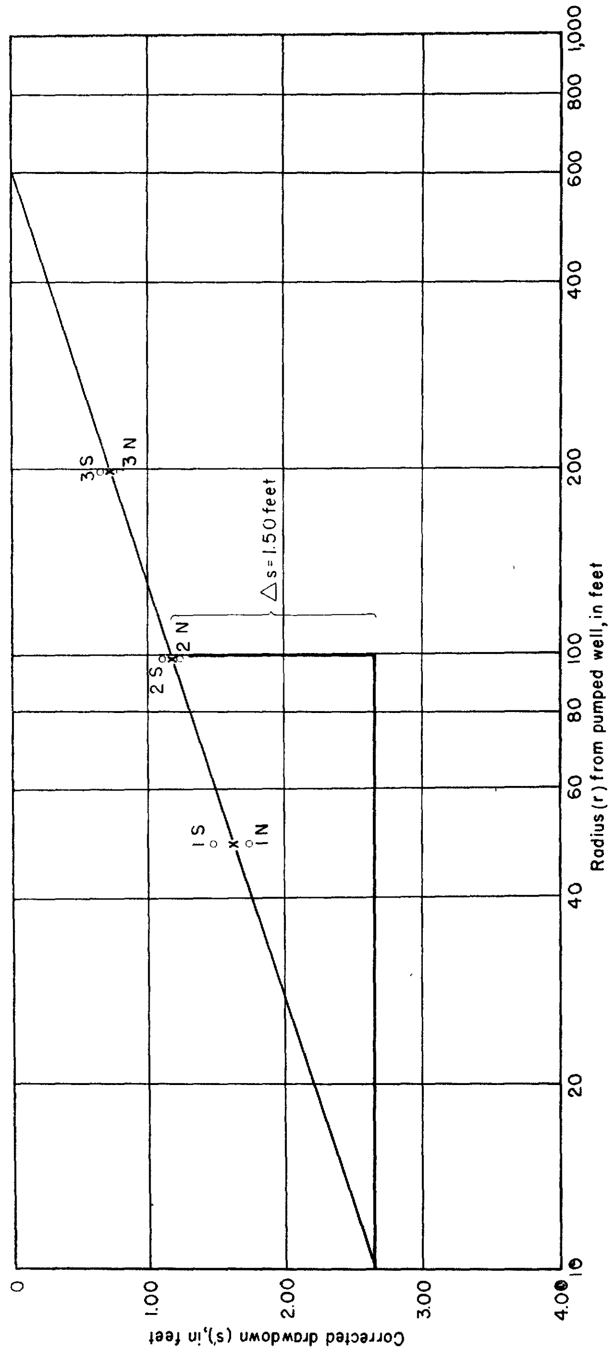


FIGURE 18.—Semilogarthmic plot of the results of pumping test well 50. (See p. 76 for explanation of symbols.)

depression; hence, the results obtained by the Theis recovery method are probably too great. Some of the coefficients of transmissibility, as determined by the Theis recovery method, were of the same order of magnitude as those determined by the Thiem method, but most were larger—some were as much as 6 times as large.

Summary of determinations.—Owing to the greater adaptability of the Thiem method for determining the coefficient of transmissibility of slow-draining, unconfined aquifers, such as those in the sump area of the San Luis Valley, only the coefficients determined by that method have been used in this report. They are itemized in table 6. The coefficients of transmissibility ranged from 1,000 to 319,000 gallons a day per foot and averaged 45,200 gallons a day per foot. As the average thickness of saturated materials in the area of the tests is about 45 feet, the average coefficient of permeability of the shallow aquifer in that area is about 1,000 gallons a day per square foot. These tests were made in specific localities to answer specific problems, and so the coefficients obtained are not necessarily representative of the shallow aquifer in the entire valley. Most of the tests were in the sump area of the closed basin, where the water-bearing materials are finest grained; and the remainder of the tests were along the eastern edge of the area of inflow-outflow study, where the water-bearing materials, although somewhat coarser, are considerably finer than those along the periphery of the valley. The character of material penetrated by the test wells and test holes is shown in plate 11. The shallow aquifer no doubt has a considerably larger coefficient of permeability on the Rio Grande alluvial fan, where the water-bearing materials are much coarser.

SPECIFIC YIELD

Only a few of the pumping tests were of wells in materials sufficiently coarse or were of sufficient duration to enable the determination of the ultimate specific yield of the shallow aquifer. (See p. 40.) The specific yield, determined at various times during each test, is plotted against the time since pumping started. A curve is then drawn through the plotted points. The computed value for specific yield increases with time during the early stages of a pumping test of a well in materials of the type present in the area of study, because the adhesion of water to the particles of fine sand prevents rapid drainage within the cone of depression. If the test is of sufficient duration, however, the portion of the aquifer above the lowered water table will become practically drained, and the curve showing the relation of specific yield to time will flatten and will approach asymptotically a line that essentially designates the ultimate specific yield of the aquifer. Only a few of the tests in the San Luis Valley were continued long enough for the line to flatten and to indicate the true specific yield of the aquifer.

From 9 of the 39 pumping tests that were run for 24 to 48 hours, values of specific yield ranging from 5 to 24 percent were obtained, but at the end of each of these tests the specific yield was still increasing, thus indicating that the material was still draining. The specific yield of 19 samples of water-bearing material tested in the hydrologic laboratory of the Geological Survey (Robinson and Waite, 1938, p. 237) ranged from 7.8 to 36.7 percent and averaged 29 percent. As the water-bearing materials are known to become progressively coarser and more permeable toward the west and are very coarse in the alluvial fans bordering the west side of the valley, a specific yield of 30 percent probably is a conservative estimate for the irrigated area considered in the inflow-outflow study.

Records of wells that were test-pumped are given in table 6, page 130.

UTILIZATION OF UNCONFINED WATER

Information on 699 wells tapping the shallow aquifer, obtained during the course of this investigation, is itemized in table 10. Records were obtained of all irrigation and public-supply wells drawing from the shallow aquifer in the area of study, but no attempt was made to obtain data on all the domestic and stock wells. Most of the wells supply water for irrigation and stock use; domestic supplies are obtained largely from wells tapping the deeper artesian aquifers.

DOMESTIC AND STOCK SUPPLIES

Domestic wells supply water for drinking, cooking, and washing, and for those schools not supplied by municipal wells. Stock wells supply water for livestock, principally cattle, sheep, and poultry. Most domestic and stock supplies of ground water are obtained from artesian wells because the water generally is of better quality and most of the wells do not require pumps. Shallow wells, however, are used in a few of the rural areas and smaller communities. The wells, which are between 10 and 40 feet deep and 1¼ to 6 inches in diameter, are finished with slotted casings or sand points. Most are equipped with centrifugal, reciprocating, or jet pumps operated by electric motors or gasoline engines, or with hand-operated pitcher pumps. The wells generally discharge only small quantities of water, which commonly is distributed by means of a pressure system.

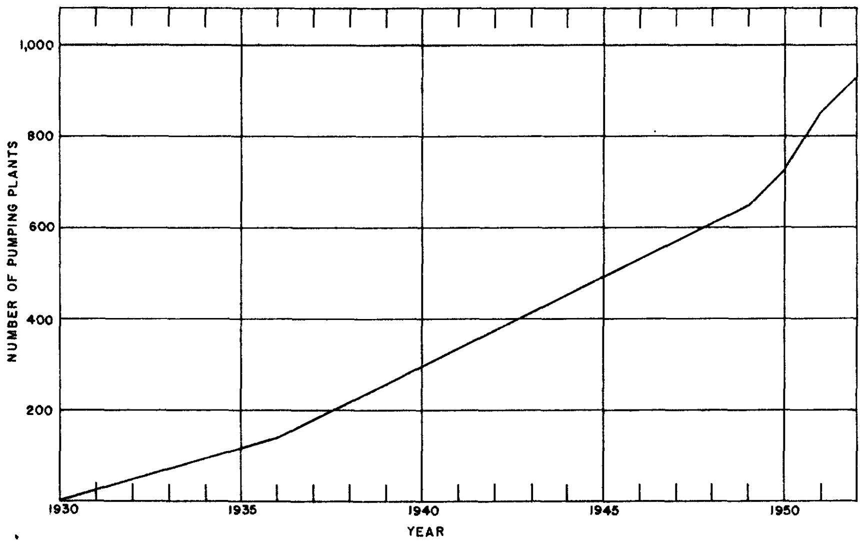


FIGURE 19.—Graph of irrigation-well development in the inflow-outflow area.

IRRIGATION SUPPLIES

Data on the development of irrigation with water from shallow wells throughout the valley are not available, but it is believed that the rate of growth in the area of inflow-outflow study, where records are more complete, is indicative of the rate of growth in the entire valley (fig. 19).

YIELDS AND DRAWDOWNS OF WELLS

Yields of irrigation wells tapping the shallow aquifer in the valley range between wide limits. Small-diameter wells used to irrigate lawns and small garden plots generally yield less than 100 gallons a minute, whereas wells of larger diameter may yield more than 2,000 gallons a minute. Of the yields listed in the table of well records (table 10), some were reported by drillers or owners and a few were estimated; however, most of the yields were measured by means of a Hoff current meter or Parshall flume. Drawdowns were determined with a steel tape or an electrical contact device. The yields appear to have increased considerably since 1936, owing perhaps to the improvement in well construction and pumping equipment. The average of 99 measured yields in 1936 was 850 gallons a minute, whereas the average of 251 measured yields in 1951 was about 1,000 gallons a minute.

Irrigation plants that draw water from the shallow aquifer are of two types—those consisting of a single well and those consisting of a battery of wells. A battery of wells generally is used to increase yields and reduce drawdowns in areas where the permeability of the shallow aquifer is relatively low and where single wells have relatively small yields or excessive drawdowns. The wells in a battery system are connected either to a single horizontal centrifugal pump or, by a siphon, to the main well, which is equipped with a turbine pump. The use of a battery of wells increases the yield, but not to the extent that several widely spaced wells equipped with separate pumps would increase it. This type of plant, however, is particularly adaptable to areas, such as the San Luis Valley, where the water table is shallow. The measured yields of battery-well plants in the area of study ranged from 487 to 3,030 gallons a minute and averaged 1,100. The measured yields of single-well plants ranged from 300 to 2,505 gallons a minute and averaged about 1,000.

Drawdowns in about 30 single-well and battery-well plants tapping the shallow aquifer were measured. In the battery-well plants they ranged from 6 feet, in a plant discharging 890 gallons a minute, to 38 feet in a plant discharging 1,769 gallons a minute. In the single-well plants they ranged from 5 feet, in a well discharging 623 gallons a minute, to 45 feet in a well discharging 750 gallons a minute.

The specific capacity (gpm per foot of drawdown) of battery-well plants ranged from 33.5 to 224 and averaged about 90, whereas the specific capacity of single-well plants ranged from 16 to 155 and averaged 59. The wide range in specific capacity indicates a wider range in the permeability of the aquifer, which accounts in part for the very wide range in yields. The range in yields, however, probably is partly due to well construction and to the age and condition of the plants. The discharge, drawdown, and specific capacity of 30 wells which tap the unconfined aquifer are listed in the 2 following tables:

Yield, drawdown, and specific capacity of single-well irrigation plants

[Type of pump: C, centrifugal; T, turbine. Type of power: E, electricity; G, gasoline; T, tractor]

Well (pl. 1, table 10)	Type of pump	Type of power	Discharge (gpm)	Drawdown (feet)	Specific capacity (gpm per foot of drawdown)
37-8-35cc	T	E	618	17	36
39-7-12ba	T	E	944	31	30.5
39-7-13db	T	E	1,491	21	71
39-8-13ab1	T	E	1,474	17	86.5
39-9-18cc	C	E	1,030	12	86
40-7-15cb	T	G	1,287	40	32
40-7-20db	T	E	1,157	38	30.5
40-8-14db	C	E	1,114	9	124
40-8-27db1	T	E	1,440	11	131
41-8-15bc2	T	G	1,556	10	156
41-8-22bc2	C	G	940	12	78.5
41-9-7bc	C	T	[1] 500	[1] 9	56
41-9-19cc2	T	E	825	15	55
41-9-3bc1	T	G	1,500	31	48.5
41-10-29cc2	T	G	900	39.5	23

[1] Reported.

Yield, drawdown, and specific capacity of battery-well irrigation plants

[Type of pump: C, centrifugal; T, turbine. Type of power: E, electricity; G, gasoline]

Well (pl. 1, table 10)	Number of wells in battery	Type of pump	Type of power	Discharge (gpm)	Draw-down (feet)	Specific capacity (gpm per foot of drawdown)
38-8-11ad	2	T	E	920	[1] 20	46
39-8-5cb	2	C	E	2,240	10	224
39-8-17bb	2	C	E	1,221	11	111
39-8-20cb	2	C	E	890	6	148.5
39-8-23db	3	T	E	1,168	21	55.5
39-9-9cc2	2	C	E	791	13	61
40-8-6bc	2	C	E	1,260	15	84
40-8-11ac	3	C	E	1,742	11.5	151.5
40-8-14bb1	2	C	G	1,105	13.5	82
40-8-21bc	2	C	E	1,194	19	63
40-8-21db2	2	C	E	1,645	14	117.5
40-8-32ac1	2	C	E	1,026	30	34
40-9-7bc2	2	C	G	1,250	7	178.5
41-8-10ca	3	T	E	3,030	19	159.5
41-8-29ac	2	C	G	1,151	9	128

[1] Reported.

CONSTRUCTION OF WELLS

Most of the irrigation wells that draw water from the shallow aquifer in the San Luis Valley have been put down by local well drillers using cable-tool or rotary drilling machines. Wells have been drilled by means of cable-tool machines in many areas in the valley. They are constructed by sinking a casing as the well is being drilled; the casing is forced down by means of a weight or a pryboard as the material is removed from the hole. Wells drilled by means of rotary drilling machines are more common in areas where the water-bearing materials are fine, such as in the sump area of the closed basin. The casing is inserted after the hole has been completed. The wells generally are equipped with commercial, galvanized-iron slotted casings, but some are equipped with torch-perforated oil-well casings, and a few are cased with oil barrels, wooden cribs, or boiler steel. Although a few of the wells that are used to irrigate small plots have diameters less than 8 inches, most of the irrigation wells have diameters between 10 and 32 inches, the most common sizes being from 14 to 18 inches.

It has been common practice in recent years to gravel-pack the irrigation wells that tap the shallow aquifer, particularly in areas where the water-bearing materials are fine grained. Gravel-packing increases the cost of the well but it also increases the yield, reduces the drawdown, and retards or prevents the movement of fine sand through the perforated casing into the well. A large-diameter hole generally is drilled and, if necessary, cased with blank casing, and a smaller diameter perforated casing is inserted in the well. The annular space around the inner perforated casing is filled with gravel. As gravel-packing adds to the cost of construction, it is economical mainly where water in satisfactory quantities cannot be obtained by the usual methods of construction, and then only after a careful study of the water-bearing material to determine the proper size of gravel to be used and, therefore, the proper slot size of screen or perforation of casing. Some wells in the valley have been packed with gravel so coarse as to be of little benefit, or with poorly sorted gravel having a permeability less than that of the water-bearing materials it replaced.

Most of the wells tapping the shallow aquifer in the valley are single wells that penetrate the entire thickness of the aquifer and end in the first substantial layer of clay. The uppermost 10 to 20 feet of the wells generally are cased with blank casing, and the remainder of the wells are cased with perforated casing that is seated in the underlying clay. Some of the irrigation plants consist of a battery of two or more wells connected to a single pump. The wells in a battery system generally are between 10 and 40 feet apart and may penetrate as little as one-fourth to as much as two-thirds of the saturated thickness of the aquifer. They commonly are connected by a suction pipe to a centrifugal pump set in a pit just above the water table, although in some plants the water is siphoned into a well equipped with a turbine pump. Battery-well systems are more adaptable to areas that have a shallow water table and that are underlain by water-bearing materials of low permeability. If the wells of a battery system are properly spaced, the yield should be larger and the drawdown smaller than from a single-well system. The yield from all the wells pumping simultaneously, however, is considerably less than the total yield of the wells when pumped separately.

Detailed discussions of the methods of well construction are given in Davison (1939), Rohwer (1940), and Bennison (1947).

METHODS OF LIFT

The irrigation wells tapping the shallow aquifer generally are equipped with deep-well turbine pumps, but some are equipped with horizontal centrifugal pumps. Most of the pumps are powered by electric motors, and the remainder are powered by stationary engines or by tractors. The pumps are connected to the source of power by means of single- or multiple-belt drives or by shafts. They discharge through pipes ranging in diameter from 4 to 12 inches, the most common size being 8 inches.

QUANTITY OF WATER DISCHARGED

Large quantities of water are pumped annually from the shallow ground-water aquifer for irrigation in the San Luis Valley. The determination of the total quantity of water pumped from the shallow aquifer was not an objective of this investigation, but records obtained in the area of inflow-outflow study are adequate for an estimation of the order of magnitude of that pumpage. The quantity of water pumped annually and used for irrigation during the period 1949–52 is itemized in table 2. The quantity pumped in the entire valley no doubt varies widely from

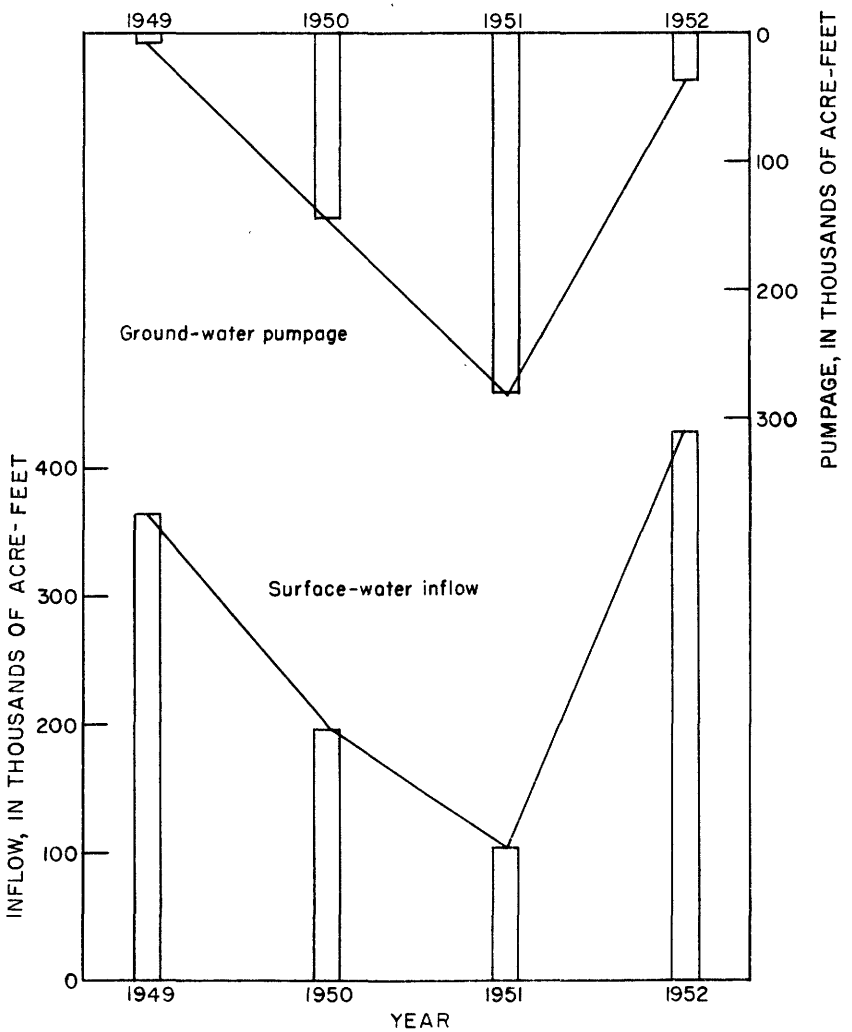


FIGURE 20.—Surface-water inflow and ground-water pumpage in the inflow-outflow area.

year to year and probably is governed largely by the amount of surface water available for irrigation. The quantity pumped in the area of inflow-outflow study ranged from about 7,000 acre-feet in 1949 to about 280,000 acre-feet in 1951, and the average quantity pumped by each well ranged from 33 acre-feet in 1949 to 327 acre-feet in 1951. The very close relation of the quantity of water pumped in the inflow-outflow area to the quantity of surface water diverted to that area is illustrated graphically in figure 20.

If it is assumed that the quantity of water pumped from the shallow aquifer by each well in the entire valley is the same as the average quantity pumped by each well in the area of inflow-outflow study, the total quantity pumped from the shallow aquifer can be estimated. If each well pumped 33 acre-feet annually, as in 1949, the estimated 1,300 shallow irrigation wells in the valley would pump a total of about 43,000 acre-feet. If each well pumped 327 acre-feet annually, as in 1951, the total quantity pumped would amount to about 425,000 acre-feet.

The amounts of water pumped annually from the shallow aquifer in the area of inflow-outflow study for the period 1949–52 were estimated on the basis of the inventory of irrigation wells in 1949, the measurement of discharges during this investigation, the records of electric-power consumption supplied by the Rural Electrification Administration and the Public Service Company of Colorado, and field checks of the electric-power consumption of 76 selected wells within the area. The number of wells powered by electric motors was determined from records of the REA and of the Public Service Company of Colorado for each year of the study. The number of wells that were operated by other types of power was determined by the inventory of 1949 and was assumed to remain constant for the remainder of the period. This assumption probably is reasonably correct because many of the new wells were being equipped with engine-operated pumps, and electric motors were replacing engines as sources of power for many of the older plants. On the basis of the data collected, it was determined that about 71 kilowatt-hours of electricity was needed to pump 1 acre-foot of water from shallow wells in the area; thus, the total electric power consumption is a measure of the total amount of water pumped by the wells equipped with electric motors. As all pumps, regardless of the type of power, no doubt discharged about the same average quantity of water during any one year, it was possible to estimate the total quantity of water pumped from all irrigation wells tapping the shallow aquifer in the inflow-outflow area. Inasmuch as the pumpage varies widely with the availability of surface water for irrigation, not all the pumps are operated most years, and it was assumed that the percentage of engine-powered pumps in operation during any season was the same as the percentage of motor-powered pumps—a figure available from the records of the power companies. Listed in table 2 are the quantities of water pumped annually and the cost of fuel or electrical energy used during the period 1949–52.

TABLE 2.—*Estimated quantity and cost of water pumped from shallow irrigation wells in the inflow-outflow area*[1]

Year	Number of wells pumped	Average quantity pumped per well (acre-feet)	Total quantity pumped (acre-feet)	Estimated cost of water pumped (dollars)	Approximate cost per acre-foot (dollars)
1949	203	33	6,700	23,000	3.40
1950	561	278	156,000	228,000	1.45
1951	674	327	281,400	352,000	1.25
1952	525	57	37,600	86,000	2.30

[1] Cost refers only to fuel or electrical energy consumed.

POSSIBILITIES OF ADDITIONAL DEVELOPMENT

Irrigation wells of moderate to large capacity (500 to 2,000 gpm) can be developed in the shallow nonartesian aquifer in most parts of the area of study. But large supplies of water may be difficult to obtain locally, where the water-bearing materials are fine grained; therefore, the construction of irrigation wells should be preceded by test drilling to determine the character and thickness of the water-bearing materials to be tapped. Large-capacity wells are closely spaced in some parts of the area, with the result that there is mutual interference between wells and an increase in lift and in pumping cost; drilling still more wells in those places obviously would aggravate this situation.

As it is possible to develop large-capacity wells in the shallow aquifer in much of the valley, the problem arises as to the "safe yield" of the aquifer—the extent to which it can be developed without exhausting the supply of water. The aquifer is unique in that, in part, it was artificially created and is artificially maintained by the practice of subirrigation. Most of the water is derived from surface sources: diversions from streams, percolation from canals and ditches, and to a lesser degree from leakage and discharge from artesian aquifers, which in turn are recharged in large part from streams. The amount of water that can be developed from wells, therefore, is governed largely by the availability of surface water.

The aquifer is, in a sense, overdeveloped in the heavily pumped area on the west side of the valley, as is indicated by an analysis of surface-water diversions, pumpage, and water-level fluctuations in the area of inflow-outflow study. In this area the aquifer serves as a storage reservoir that can be called upon for large supplies of supplementary ground water during periods of low runoff.

In the 291-square-mile area of inflow-outflow study, the aquifer has an average saturated thickness of about 60 feet and a specific yield of about 30 percent. The quantity of ground water in storage in this area, therefore, is roughly 3 million acre-feet. During the period of low diversions in 1951, more than 280,000 acre-feet of ground water was pumped from the aquifer; thus it is obvious that if no surface water were available to the area and if it were physically possible for wells to unwater the aquifer, the supply would last only about 10 years at that annual rate of withdrawal. If it is assumed that only two-thirds to three-fourths of the aquifer in the inflow-outflow area can be unwatered by wells economically, then the supply would last only 6 or 8 years. When ground water was withdrawn from the aquifer in such large quantities in 1951, the water table declined as much as 12 feet in parts of the area, but with the application of large supplies of water for irrigation the following year the water table returned to, or nearly to, its normal position. The rise in water table in 1952 represented a gain in ground-water storage in the area of about 135,000 acre-feet.

Beyond the limits of the areas of intensive irrigation from wells, as in the sump area of the closed basin, the shallow ground-water aquifer is underdeveloped. The process of evapotranspiration is now consuming great quantities of water, a large part of which, except for local problems of quality, could be salvaged economically by means of large-capacity irrigation wells.

A policy of optimum development of the shallow ground-water reservoir in the San Luis Valley should be established at the earliest practicable time. The irrigation practices of subbing and pumping appear to be incompatible, for they tend to pull the water table in opposite directions. Many situations have been observed wherein one farm was irrigated by the subbing method and the neighboring farm at the same time was irrigated with water from a well near the boundary between the two farms. The area of influence of the pumped well was shown clearly by a circular pattern of withered crops on the subirrigated farm. During the season of below-normal runoff in 1951 the water table declined seriously, but the following season was, fortunately, one of above-normal runoff and the water table returned to its normal position in most places. In a few places, however, the water table did not rise sufficiently to permit subirrigation the following season. It appears entirely feasible that, with the present large-scale development of irrigation wells in the inflow-outflow area, a sequence of years of below-normal runoff and diversions may result in such heavy withdrawals of water from wells that the water table could not be raised sufficiently high during a subsequent irrigation season to permit subirrigation. It would be necessary then to irrigate entirely with wells, even though a normal supply of surface water may be available that year. In a few places, however, it is likely that subirrigating could be continued even under the most adverse conditions.

QUALITY OF WATER

The chemical character of the ground water in San Luis Valley is indicated by the analyses in tables 7, 8, and 9. Most of the analyses were made in laboratories of the Geological Survey, but some were made in laboratories of the Bureau of Reclamation. Analyses of 1,079 samples of water were made as a part of this investigation; 72 were complete analyses; 971 were partial analyses; and 36 were determinations of specific conductance only. In addition, the tables include the analyses of 48 samples collected by the Geological Survey and the Bureau of Reclamation during the period 1936–41. During the present investigation, 160 samples of water were collected from drains, canals, laterals, lakes, springs, and streams; 153 samples were collected from test holes as a part of the test-drilling program; 41 were collected from artesian wells tapping the deeper artesian aquifers; and 271 were collected from wells in the shallow unconfined aquifer. In order to determine the nature and extent of changes in chemical quality of the water, samples were collected 2 or more times from 23 surface sources or springs, 11 artesian wells, and 143 shallow wells.

CHEMICAL CONSTITUENTS IN RELATION TO USE

The following discussion of the chemical constituents of ground water has been adapted in part from publications of the Geological Survey.

Analyses of water from typical wells are given in table 7, page 134; analyses of surface water, table 8, page 156; and analyses of water from wells that were test-pumped, table 9, page 162.

DISSOLVED SOLIDS

The residue after a natural water has evaporated consists of rock materials with which may be included some organic material and some water of crystallization. Water containing less than 500 ppm of dissolved solids generally is satisfactory for domestic use, except for the difficulties resulting from hardness and, in some areas, excessive corrosiveness and content of iron. Water having more than 1,000 ppm generally is not satisfactory, for it is likely to contain enough of certain constituents to produce a noticeable taste or to make the water unsuitable in some other respects.

Concentration of dissolved solids is expressed in many of the analyses in the chemical tables as the "sum"—the sum of the determined constituents. The sum includes the carbonate equivalent of the bicarbonate (bicarbonate ÷ 2.03), because the bicarbonate is decomposed upon heating. In those analyses for which the dissolved solids is the residue on evaporation, there is close agreement between the determined value and the computed sum.

The dissolved solids ranged from 52 to 13,800 ppm in samples of water collected from the shallow unconfined aquifer, from 70 to 437 ppm in samples from the artesian aquifers, and from 32 to 17,100 ppm in samples from surface sources. Water from wells tapping the unconfined aquifer generally had a higher concentration of dissolved solids than water obtained from the artesian aquifers or from surface sources. Only 1 sample of surface water had a dissolved solids content greater than 5,000 ppm, whereas 7 samples from the unconfined aquifer had such a content. No sample from the artesian aquifer contained more than 500 ppm. The amounts of dissolved solids found in water samples are shown in the following table:

Dissolved solids in samples of water

Dissolved solids (ppm)	Number of samples			
	Unconfined aquifer	Artesian aquifers	Surface water	Total
<350	95	29	56	180
350–500	39	2	3	44
501–1,000	57	0	6	63
1,001–5,000	21	0	0	21
>5,000	7	0	1	8
Total	219	31	66	316

HARDNESS

Hardness of water, which is the property that generally receives the most attention, is most commonly recognized by its effects when soap is used with the water in washing. Calcium and magnesium cause virtually all the hardness of natural waters.

These constituents, together with silica in some places, are also the active agents in the formation of the greater part of the scale formed in steam boilers and in other vessels in which water is heated or evaporated.

In addition to the total hardness, the tables of analyses show the noncarbonate hardness of some samples. Carbonate hardness is that caused by calcium and magnesium bicarbonate, and it is almost completely removed by boiling. This type of hardness is sometimes called temporary hardness. Noncarbonate hardness usually is caused by sulfate or chloride of calcium and magnesium; it cannot be removed by boiling and has been called permanent hardness. With reference to use with soap, there is no difference between the carbonate and the noncarbonate hardness. In general, the noncarbonate hardness forms a harder scale in steam boilers.

As calcium and magnesium are the principal constituents that cause hardness, the degree of hardness in the water is not necessarily governed by the concentration of dissolved mineral matter. Water having a very low concentration of dissolved solids generally is soft, but water having a very high concentration may also be soft if the principal cation is sodium rather than calcium or magnesium. Many of the samples of water taken from wells in the sump area of the closed basin have very high concentrations of dissolved solids but are also soft, for the dissolved solids consist almost entirely of sodium salts.

Water having a hardness of less than 50 ppm generally is rated as soft, and its treatment for the removal of hardness is seldom necessary. Hardness between 50 and 150 ppm does not seriously interfere with the use of water for most purposes, but it does increase the consumption of soap, and its removal by a softening process is profitable for laundries and some other industries. Hardness of more than 150 ppm can be noticed by anyone, and if the hardness is 200 or 300 ppm it is common practice in some areas to soften the water for household use or to install cisterns to collect soft rainwater. Where municipal water supplies are softened, an attempt generally is made to reduce the hardness to less than 100 ppm, depending on the hardness of the raw water. The additional improvement from further softening of the whole public supply is not deemed to be worth the increase in cost.

The hardness of water collected in the area of study ranged from 8 to 5,060 ppm for water from the unconfined aquifer, from 8 to 224 ppm for water from artesian aquifers, and from 26 to 578 ppm for water from surface sources. The degrees of hardness are shown in the following table:

Hardness of samples of water

Hardness[1] (ppm)	Number of samples			
	Unconfined aquifer	Artesian aquifer	Surface water	Total
<50	71	16	23	110
50–100	146	26	18	190
101–200	180	6	48	234
201–300	44	1	3	48
301–400	18	0	1	19
401–500	7	0	0	7
501–600	3	0	1	4
601–700	1	0	0	1
701–800	3	0	0	3
>800	8	0	0	8
Total	481	49	94	624

[1] Hardness calculated from calcium and magnesium when these constituents are reported, otherwise determined by soap method.

CHLORIDE

250 ppm

Chloride is dissolved in small quantities from rock materials, but locally it may be derived from sewage or from other sources. The presence of large quantities of chloride may indicate that the water supply is contaminated but, as the sources of chloride are many, its presence is not necessarily proof of pollution. Chloride has little effect on the suitability of water for ordinary uses unless there is enough to give the taste of salt. Water high in chloride may be corrosive to some metals when used in steam boilers or as a coolant.

The concentrations of chloride in 764 samples of water collected in the San Luis Valley are listed in the tables of chemical analyses. They ranged from 0 to 48 ppm in 110 samples of surface water, 0.5 to 24 ppm in 53 samples of artesian water, and 0 to 4,510 ppm in 601 samples of unconfined water.

FLUORIDE

1,4-2,4

Fluoride, in more than minute quantities, is not as common as other principal constituents of natural waters; however, it is desirable to know the amount of fluoride present in water that is likely to be used by children. Fluoride in water in above-normal concentrations has been shown to be associated with the dental defect known as mottled enamel, which may appear on the teeth of children who drink water containing fluoride during the period of formation of the permanent teeth (Dean, 1936). This condition becomes more noticeable as the quantity of fluoride in water increases above 1.5 ppm. Recent reports indicate that the incidence of tooth decay is decreased by quantities of fluoride that are not sufficient to cause permanent disfigurement from mottled enamel.

The fluoride content of 256 samples of water from the area of study has been determined. The concentrations were highest in water from the unconfined aquifer, and 88 of the 222 samples contained more than 1.5 ppm, the highest being 29 ppm. Six of the 16 samples of artesian water contained more than 1.5 ppm, but the maximum concentration was 9.5 ppm. Only 2 of the 18 samples of surface water contained more than 1.5 ppm, the highest concentration being 3.2 ppm.

BORON

The content of boron in water is of particular significance to the growth of many plants if the water is used for irrigation. Some crops, such as beans, may be very sensitive to the presence of boron, whereas others, such as sugar beets, may tolerate relatively large quantities. Concentrations of boron in excess of 2 ppm generally retard the growth of many crops. The concentrations of boron in 167 samples of ground water collected in the area of study have been determined. None of the 8 samples collected from wells tapping artesian aquifers contained more than 1 ppm of boron, but 24 of the 159 samples collected from the shallow unconfined aquifer contained more than 2 ppm, and 1 contained 13.8 ppm.

SODIUM

The following discussion of sodium, particularly in relation to the suitability of water for irrigation, has been taken largely from Richards (1954). Concentration of sodium in water may have an important bearing on the use of the water for irrigation, and it is of special significance to this investigation because of the standards of chemical quality outlined in the Rio Grande compact. The compact states that Colorado will not be credited for waters diverted from the closed basin to the Rio Grande for use by downstream States if the water contains more than 45 percent sodium when the concentration of dissolved solids exceeds 350 ppm. Water having a high percent sodium tends to reduce the permeability of the soil and impair its productivity. The percent sodium is determined by dividing the equivalents per million of sodium by the equivalents per million of the total cations (usually calcium, magnesium, sodium, and potassium) and multiplying by 100.

Concentration of dissolved constituents may be expressed in equivalents per million of anions or cations, in parts per million of dissolved solids, or in terms of electrical conductivity (generally as micromhos). Electrical conductivity is a measure of the ability of the inorganic salts in solution to conduct an electric current, and it is related to the concentration of dissolved solids. The conductivity of the water sampled is listed in tables 7, 8, and 9 and is roughly equal to the total equivalents per million of anions or cations multiplied by 100, or to the dissolved solids in parts per million divided by 0.7 (Wilcox, 1948, p. 4 and 5). The specific conductance of samples of water collected from the area of study have been plotted against the sodium-adsorption ratio (SAR) on a diagram prepared by the United States Salinity Laboratory (Richards, 1954). (See pl. 12.) The sodium-adsorption ratio of a soil solution is related to the adsorption of sodium by the soil; hence, the ratio has advantages for use as an index of the sodium or alkali hazard of water used for irrigation. The ratio is defined by the equation:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{(Ca^{++} + Mg^{++})}{2}}}$$

where Na^{+}, Ca^{++}, and Mg^{++} represent the concentrations in milliequivalents per liter of the respective ions (Richards, 1954, p. 72).

The lower margin of the diagram in plate 12 is a scale of conductivity ranging from 50 to 20,000 micromhos, and the left margin is a scale of sodium-adsorption ratio ranging from 0 to 34. Plotted on the diagram in plate 12 are 67 samples of confined water, 246 samples of unconfined water, and 46 samples of surface water, or a total of 359 samples. In addition to the samples plotted, there were 21 samples of unconfined water and one sample of surface water for which the SAR was too large to be shown on the diagram.

According to Richards (1954, p. 75–81), it is assumed when classifying irrigation waters that the water will be used under average conditions with respect to soil texture, infiltration rate, drainage, quantity of water used, climate, and salt tolerance of the crop. He states (p. 76) that—

> Large deviations from the average for one or more of these variables may make it unsafe to use what, under average conditions, would be a good water; or may make it safe to use what, under average conditions, would be a water of doubtful quality. This relationship to average conditions must be kept in mind in connection with the use of any general method for the classification of irrigation waters.

The salinity hazard is shown in the diagram (pl. 12) in 4 classes, divided with respect to the conductivity—the dividing points are 250, 750, and 2,250 micromhos. Low-salinity water

(*C*1) can be used for the irrigation of most crops on most soils with little chance that soil salinity will develop. Medium-salinity water (*C*2) can be used if a moderate amount of leaching occurs, and plants of moderate salt tolerance generally can be grown without special practices for salinity control. High-salinity water (*C*3) cannot be used on soils with restricted drainage. With adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected. Very high salinity water (*C*4) is not suitable for irrigation under average conditions but may be used occasionally where soils are permeable and well drained, where water can be applied in excessive amounts to provide considerable leaching, and where plants of good salt tolerance are used.

The diagram in plate 12 also divides the waters into four classes based on the sodium-adsorption ratio (SAR). The low-sodium water (*S*1) can be used for irrigation on almost all soils with little danger of adverse effects. The medium-sodium water (*S*2) may be used on coarse-textured or organic soils having good permeability, but it may be appreciably hazardous in fine-textured soils having high cation-exchange capacity, especially with low leaching, unless the soil contains gypsum. The high-sodium water (*S*3) may be harmful to most soils and will require special soil management—good drainage, high leaching, and additions of organic matter. The water may be used satisfactorily on some gypsiferous soils. Chemical amendments may be required, but they may not be feasible with waters of very high salinity. The very high sodium water (*S*4) generally is unsatisfactory for irrigation except at low and perhaps medium salinity, where the solution of calcium from the soil or application of gypsum or other amendments may make the use of these waters feasible.

The diagram shows that most of the samples of surface water were low-sodium and low- to medium-salinity waters. One sample from Head Lake was in class *C*4–*S*4 and could not be shown on the diagram because of the very high sodium-adsorption ratio. Another sample from Head Lake was of good quality and was in class *C*1–*S*1. Three samples from San Luis Lake were in classes *C*3–*S*1 and *C*3–*S*2. Of the 67 samples of artesian water analyzed, 44 were in class *C*1–*S*1 and 15 were in class *C*2–*S*1. Of the 246 samples of unconfined water shown in the diagram, 202 samples, or about 82 percent, were of low to medium sodium hazard and 137 samples, or about 56 percent, were of low to medium salinity hazard. The percent sodium in the area of the proposed sump drain generally is relatively high, but of the 31 samples collected from wells test-pumped in that area, 25 were of low sodium hazard and only 4 were of very high sodium hazard; similarly, only 3 were of very high salinity hazard.

The percent sodium in the samples of water collected in the area of study ranged from 0 to 100; the range was 1 to 100 in unconfined ground waters, 3 to 98 in artesian waters, and 0 to 97 in surface waters. (See table 3.)

TABLE 3.—*Percent sodium in samples of water*

Percent sodium	Number of samples			
	Unconfined aquifer	Artesian aquifer	Surface water	Total
<45	190	35	72	297
45– 59	82	2	4	88
60– 75	66	4	6	76
76–100	159	10	2	171
Total	497	51	84	632

SURFACE WATER

The quality of the surface water in the San Luis Valley is indicated by the analyses listed in table 8 and shown graphically in figure 21.

LAKES

Samples of water were collected for chemical analysis from Head, San Luis, and Soda Lakes during the course of this investigation. The lakes are in the sump area of the closed basin, and the quality of the water varies appreciably from season to season. The concentration of dissolved solids ranged from 223 to 17,100 ppm, but the total hardness was more uniform in that it ranged only from 126 to 578 ppm. Percent sodium in the water ranged from 30 to 97. The analyses indicate a relatively high concentration of bicarbonate in Soda Lake (as much as 630 ppm) and a relatively high fluoride content in San Luis Lake (as much as 3.2 ppm).

CANALS AND LATERALS

The Rio Grande canal, which is the largest in the area of study, was sampled 10 times in a 2-year period at a point in the NE¼ NE¼ sec. 2, T. 40 N., R. 6 E. Water in the canal is diverted from the Rio Grande at Del Norte and generally is of excellent quality. Concentration of dissolved solids ranged from 32 to 58 ppm, and the concentration of bicarbonate ranged from 35 to 66 ppm. The percent sodium did not exceed 36 in any of the samples analyzed.

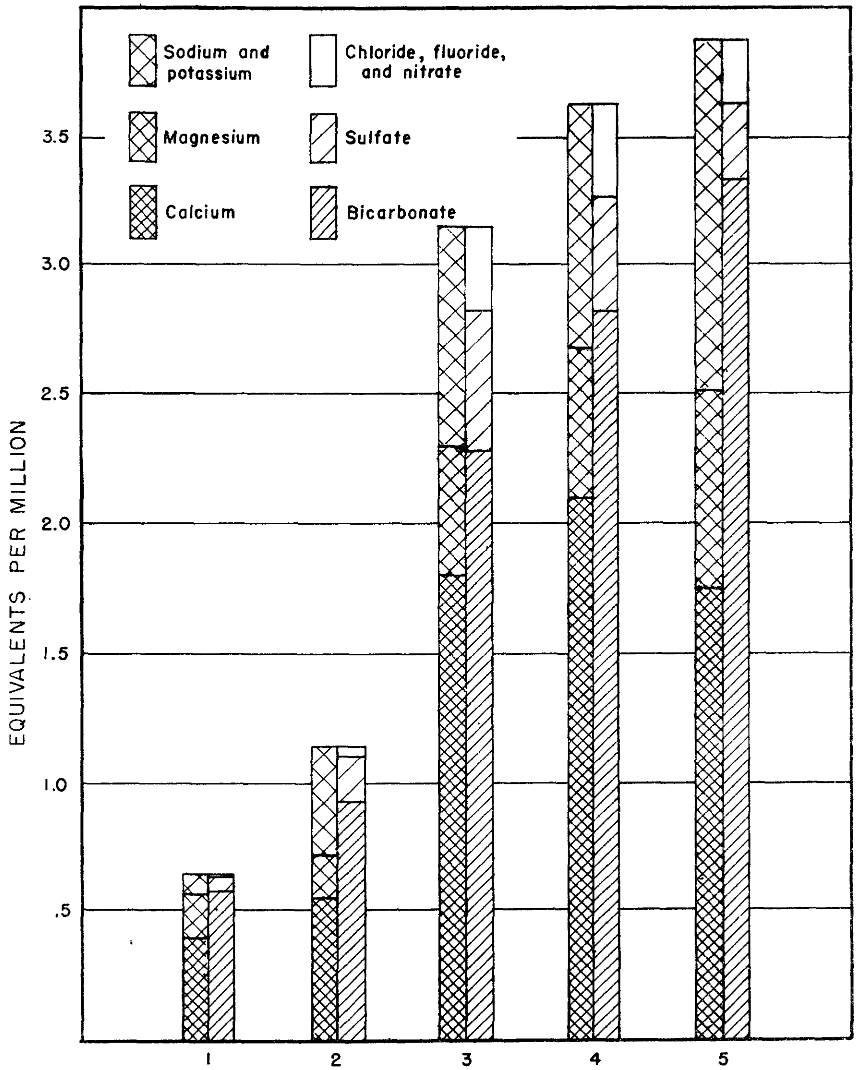


FIGURE 21.—Analyses of surface water. 1, Rio Grande canal in NE¼N¼, sec. 2, T. 40 N., R. 6 E.; 2, Farmers' Union canal in SE¼NE¼ sec. 28, T. 40 N., R. 10 E.; 3, open drain in SE¼SE¼ sec. 2, T. 39 N., R. 8 E.; 4, box drain in SE¼SE¼ sec. 5, T. 39 N., R. 8 E.; 5, west bank of Head Lake in SW¼SW¼ sec. 14, T. 40 N., R. 11 E.

DRAINS

Analyses of 119 samples of water collected from drains in the area of study are listed in table 8 and 1 is shown graphically in figure 21. Concentration of dissolved solids ranged from 47 ppm at a station 3.5 miles east of the Rio Grande canal to 358 ppm at a station 19.5 miles from the Rio Grande canal. The concentration of bicarbonate ranged from 43 to 206 ppm, and the percent sodium ranged from 2 to 53.

The drains were sampled periodically at 17 stations during the course of this investigation, and the analyses indicate that, in general, there were no large fluctuations in mineral content. The quality of the waters collected from a station in the NE¼NE¼ sec. 28, T. 40 N., R. 10 E., fluctuated more widely, however, in that the concentration of dissolved solids ranged from 97 to 358 ppm, the concentration of bicarbonate ranged from 101 to 206 ppm, and the percent sodium ranged from 13 to 53.

Surface water collected from drains and from other sources in the area of study generally is entirely acceptable for irrigation because it generally is of low sodium hazard and low to medium salinity hazard (pl. 12).

GROUND WATER

The quality of ground water in the area of study was determined by the analysis of 919 samples of water from 312 representative wells. All the analyses are listed in tables 7 and 9 and part of them are illustrated graphically in plate 13.

CONFINED WATER

Of the 919 samples of ground water collected for analysis, 64 were samples of confined, or artesian, water taken from 41 artesian wells. It was not feasible to determine the quality of water in any particular artesian aquifer because the aquifers are discontinuous and leaky and because many of the wells obtain water from more than one aquifer. The samples collected as a part of this investigation, for example, were taken from wells ranging in depth from 60 to 4,200 feet. Most of the deeper wells obtain water from many artesian aquifers.

Water from artesian aquifers generally is of better quality than water from the shallow aquifer, although it may contain higher concentrations of silica. The concentration of dissolved solids in samples of confined water ranged from 70 to 437 ppm, and the total hardness ranged from 8 to 224 ppm. The range in percent sodium was from 2 to 35. (See table 3.) The concentration of fluoride is discussed on page 93. The percentage of sodium appears to increase toward the east and reach a maximum in the sump area of the Closed Basin, indicating that the water dissolves sodium salts in its movement through the aquifers.

UNCONFINED WATER

The quality of ground water from the shallow unconfined aquifer ranges between wide limits, as indicated by the analyses of 855 samples of water listed in tables 7 and 9. The range is emphasized further by the data in plate 13, the discussion on pages 90 to 97, and the data in the following table.

Maximum and minimum concentrations of mineral constituents in unconfined ground water, in parts per million

Mineral constituent	Maximum	Minimum
Silica	66	2.5
Calcium	936	1.0
Magnesium	562	.24
Sodium[1] and potassium	3,100	.5
Bicarbonate	7,310	9.9
Sulfate	4,510	1
Chloride	4,510	.5
Fluoride	24	0
Nitrate (as NO_3)	120	0
Dissolved solids	13,800	52
Total hardness	5,060	10

[1] Percent sodium: maximum, 100; minimum, 1.

The unconfined water is of best quality on the western side of the valley, where the aquifer is recharged readily by the application of surface water of good quality for irrigation. The quantity of dissolved solids increases from the sides of the closed basin to the sump area, as indicated in plate 14. The analyses shown in plate 14 were chosen because the concentration of dissolved solids was approximately the same as the average for all the analyses in a particular range. It should be emphasized that the analyses are not representative of the average concentration of individual constituents, such as sodium, calcium, or sulfate. The illustration shows that the concentration of dissolved solids increases nominally from R. 6 E. to R. 8 E., and that it increases greatly from R. 8 to the sump area in R. 11 E. The effect of the westward movement of ground water of good quality from the alluvial fans on the east side of the valley is indicated by the abrupt improvement in the quality of water between R. 11 E. and R. 12 E.

It is common knowledge that the shallow ground water is of poorest quality in the sump area of the closed basin, but there has been some speculation as to the cause. It has been suggested that the shallow ground water dissolves almost all the mineral matter it contains during its movement toward the sump, but it has also been suggested that the poor quality of water in the sump area may be the result of leakage and discharge of artesian water into the shallow aquifer. The analyses show that water from the shallow aquifer is of much poorer quality than water from the artesian aquifers and, hence, could not have been contaminated by the leakage or discharge of artesian water into the shallow aquifer. The increase in mineral concentration toward the sump area of the closed basin appears to be largely a factor of solution in transit and concentration by evapotranspiration. As the shallow ground water moves eastward toward the sump its content of dissolved solids increases appreciably but its hardness shows an overall decrease, presumably as a result of base exchange. The shallow ground water on the west side of the valley is largely calcium and magnesium bicarbonate water, but as the water moves eastward the calcium and magnesium apparently are replaced by sodium. The percent sodium in the water in R. 11 E., in the vicinity of the sump, is locally as much as 100 and averages about 70. The rate of increase in percent sodium, specific conductance, and concentration of dissolved solids is indicated by the data in the following table.

Average percent sodium and conductivity of unconfined ground water in the closed basin, by land-survey ranges

Range	Percent sodium		Conductivity		Average concentration of dissolved solids (estimated)[1]
	Number of samples	Average percent sodium	Number of samples	Average specific conductance	
6 E.	8	17	10	192	134
7 E.	39	28	59	232	197
8 E.	47	36	84	352	246
9 E.	131	56	212	799	559
10 E.	94	61	159	923	646
11 E.	106	70	246	3,867	2,707
12 E.	33	60	66	1,417	992

[1] Determined by multiplying the specific conductance by 0.7.

On the west side of the closed basin, unconfined ground water is entirely satisfactory for irrigation, whereas in the sump area of the closed basin it is of such poor quality that it will not meet the requirements of the Rio Grande compact. As the Rio Grande compact requires that the percent sodium should not exceed 45 in water having a concentration of dissolved solids in excess of 350 ppm, it appears that most of the unconfined ground water in Rs. 6, 7, and 8 E. is of sufficiently good quality to meet compact requirements and that the water in Rs. 10, 11, and 12 E. will not meet compact requirements. The water in R. 9 E. had an average percent sodium of 56 and an average concentration of dissolved solids of more than 500 ppm. It appears, therefore, that the eastern limit of shallow ground water of a quality suitable to meet compact requirements lies in R. 9 E.

The quality of unconfined ground water, either within or outside the closed basin, ranges widely but generally is satisfactory for irrigation. Of the 267 samples of unconfined ground water for which determinations of both sodium-adsorption ratio and conductivity are available, 202 have low to medium sodium hazard and 137 have low to medium salinity hazard. Only 45 had a very high sodium hazard and only 29 had a very high salinity hazard.

QUANTITY AND QUALITY OF GROUND WATER AVAILABLE TO PROPOSED CLOSED BASIN DRAIN

A large part of the San Luis Valley lies in the closed basin, which is separated from the valley of the Rio Grande by a low divide. Most of the diversions from the Rio Grande are used for irrigation in the closed basin, and the excess water is collected by drains. A nominal amount of the water thus picked up by drains is reused for irrigation farther east, but most of the water not used by crops and other vegetation eventually drains to the sump area, where it is dissipated by evaporation and transpiration by native vegetation. A part of the water reaches the sump area by movement through the shallow ground-water reservoir and, in the western part of the irrigated area, a part probably percolates farther downward to recharge some of the underlying artesian aquifers. Of the water thus recharging the artesian aquifers, a part again reaches the surface through artesian wells, but a part percolates upward into the sump area and is discharged by evapotranspiration, and another part leaves the closed basin to emerge farther south in the valley of the Rio Grande (pl. 5). Similarly, much of the ground and surface water from the Sangre de Cristo Mountains, which border the closed basin on the east, reaches the eastern part of the sump area, where it is dissipated in a like manner.

The sump area, which comprises about 250 square miles and is about 35 miles long, north and south, and about 8 miles wide, is covered mainly by saltgrass, greasewood, and rabbitbrush, but it includes also several permanent lakes and many playas. Some of the larger lakes, such as Head and San Luis, contain fresh water, but the water in others is highly mineralized. The water table is within 5 feet of the surface in an area of about 120 square miles within the sump area.

Robinson and Waite (1938, p. 249) estimated that the annual amount of transpiration and evaporation from that part of the sump area within the 7,540-foot land-surface contour (250 square miles) was about 100,000 acre-feet of water and was about comparable with the amount of precipitation on the same area. On the basis of rather scanty data they estimated that the subsurface flow of unconfined ground water into this area (perimeter, 75 miles) amounted to only about 8,000 acre-feet a year. From this they concluded that the amount of unconfined ground water entering the sump area plus the discharge of flowing artesian wells in the sump area is only a small part of the ground water discharged there by transpiration and evaporation. Thus it appears that most of the recharge to the body of unconfined ground water in the sump area comes from precipitation and, during favorable years, from inflow of surface water. From computations based on data given in table 6 and plates 9 and 10, it appears that the subsurface movement of unconfined ground water into an even smaller part of the sump area (perimeter, 67 miles) amounts to about 9,100 acre-feet a year; however, this slight refinement in no way changes the validity of the conclusions of Robinson and Waite. Studies by the Bureau of Reclamation (W. H. Sweet, written communication, Dec. 10, 1953) indicate that direct evaporation from the permanent lakes in the sump area amounts to only about 2,000 acre-feet a year—a negligible amount compared with the transpiration from native vegetation and evaporation from soil. Thus it seems that most of the total water supply entering the sump area is stored temporarily in the shallow ground-water reservoir pending discharge by transpiration and evaporation.

It has long been proposed to construct a drain to intercept what ground and surface water can be salvaged in the sump area and to conduct the water through the low divide to the Rio Grande. Several proposed sites have been under consideration by the Bureau of Reclamation. The latest site to be considered, which is discussed in this report, is shown on plate 16. The proposed system comprises a main drain (*L–L'*) about 35 miles long, some 31 miles of which would be within the closed basin, and 8 lateral drains aggregating about 57 miles long.

QUANTITY OF GROUND WATER

METHOD OF INVESTIGATION

The method of investigation used to determine the quantity of ground water that the proposed closed basin drain may intercept was developed by C. V. Theis in 1940, while he was the Geological Survey member of the original Closed Basin Committee. He kindly made the method available for the present study in a letter of October 15, 1945. As this method has not been published, it will be desirable to quote extensively from the letter.

The invisible accretion to the drain must be salvaged from the native vegetation inasmuch as all the ground water is transpired at present. How much reduction in transpiration can be accomplished by lowering the water table depends on the types of vegetation, which in the sump area consists of greasewood, rabbitbrush, and saltgrass, and the amount of lowering. The lowering will be a maximum at the drain and decrease to zero at some distance back. It seems evident that the invisible accretion to the drain will increase with the unit amount salvaged from transpiration by a unit lowering of the water table, within limits; with the amount of lowering at the drain; and with the transmissibility of the aquifer, as the greater the transmissibility the flatter and more extensive will be the depression of the water table produced by the drain. The following discussion is offered as a preliminary attempt at rationalizing the problem and indicating a possible approach to it.

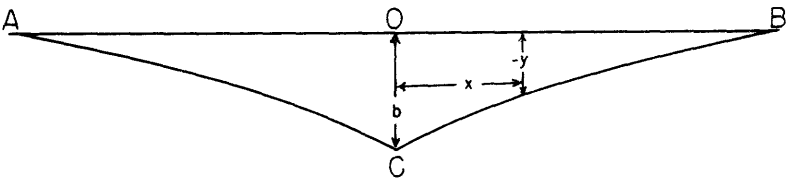


FIGURE 22.—Schematic cross section of water table normal to axis of drain, illustrating method of determining quantity of water that may be intercepted by proposed closed basin drain as suggested by C. V. Theis. Explanation is given in text.

The system at the drain can be simplified as follows: In figure [22] *AOB* is the original position of the water table and *ACB* is the position after the drain is operating. The lowering of the water table at the drain, *OC*, is equal to b. The drawdown, $-y$, at any point, x, must be such that the gradient is sufficient to move the water salvaged to the left of it. If there were no additions of water, the gradient would be a straight line, except possibly in the immediate vicinity of the drain. However, there are such additions of salvaged water and, hence, the line is curved. The curvature, which is the second derivation of the line *AC*, is sufficient to move the new accretions of salvaged water. Hence $T\frac{d^2y}{dx^2}$, where T is the coefficient of transmissibility, equals the accretion of water at the point x. [The factors are explained below and, in greater detail, in the following section, "Evaluation of factors."]

The amount of the unit accretion from salvage cannot be determined prior to an investigation and even the nature of a function that would express it is in doubt. There is some evidence that the use of water by native vegetation varies linearly with the depth to the water table and in this preliminary analysis such a variation may be assumed. If the salvage with the maximum drawdown, b, is assumed to be a, and the salvage varies linearly with the drawdown, the accretion at any point will be $\frac{ay}{b}$. Hence, equating the two expressions for the accretion:

$$-T\frac{d^2y}{dx^2}=\frac{ay}{b} \tag{1}$$

The minus sign is necessary as the curvature is negative.

This second-order differential equation leads to the following results:

$$\frac{dy}{dx} = -\sqrt{\frac{a}{Tb}}\, y \tag{2}$$

$$Y = be^{\sqrt{-\frac{a}{Tb}}\, x} \tag{3}$$

Inasmuch as the drawdown, b, is negative, the quantity under the radical is always positive. As x has been taken to the left of the origin, the index of e is negative.

The flow into the drain from one side is $T\frac{dy}{dx}$ and from both sides under the assumptions is $2T\frac{dy}{dx}$. At the drain $y=b$ and, hence, if $\frac{dQ}{dt}$ is the rate at which water flows into the drain per unit length,

$$\frac{dQ}{dt} = 2T\frac{dy}{dx} = 2\sqrt{\frac{-a}{Tb}}\,Ty \tag{4}$$

$$= 2\sqrt{-aTb}$$

If distances from the drain and drawdowns are always considered positive, some possible confusion in the above expression may be eliminated by writing them thus:

$$Y = be^{-\sqrt{a/Tb}\, x} \tag{5}$$

$$\frac{dQ}{dt} = 2\sqrt{aTb} \tag{6}$$

The general equation (6) leads to the following specific equation for units of measurement commonly used by the Geological Survey:

$$\frac{dQ}{dt} = 1.694\sqrt{aTb} \tag{7}$$

in which $\frac{dQ}{dt}$ is the pickup of the drain, in acre-feet per mile per year; a is the salvage from transpiration at full drawdown, b, in feet of water a year; T is the coefficient of transmissibility, in gpd/ft; and b is the drawdown at the drain, in feet.

EVALUATION OF FACTORS

SALVAGE FROM TRANSPIRATION AND EVAPORATION

The factor a in equation (7), above, is perhaps the most difficult to evaluate accurately. In 1930 Tipton and Hart (1931) conducted investigations in the sump area of the amounts of water evaporated and transpired from soil tanks planted to saltgrass. The results from 3 such tanks in which measurements were made during the period from May through October were as follows: water table 4 inches below surface, 2.26 feet; water table 9⅝ inches below surface, 1.75 feet; water table 23⅛ inches below surface, 1.57 feet.

During the period 1925–27 White (1932, p. 86) determined the discharge by plants and evaporation from soil on the basis of detailed studies of water-level fluctuations in wells in the Escalante Valley, Utah—a desert valley having only slightly lower altitude than the San Luis Valley and a very similar climate. From these studies, he estimated that about 1 foot of water per year is discharged by transpiration and evaporation from lands covered by saltgrass and beneath which the water table ranges from the surface to 3 feet in the spring and from 3 to 5 feet in the fall.

The value obtained by White compares favorably with the results obtained by Tipton and Hart when it is considered that the lower figure of White represents average natural conditions over a large area (2,600 acres) having a range in depth to water level as great as 5 feet, whereas the higher figures obtained by Tipton and Hart were from artificially controlled small tanks having a much shallower water table.

Inspection of column 7 in tables 4 and 5 reveals that most of the proposed main drain and its laterals would be in areas in which the water table lies between the surface and a depth of 5 feet, but small parts of the main drain and its laterals would extend into areas in which the water table lies 5 to 7 feet deep, and still smaller parts would extend into areas in which the water table lies somewhat deeper than 7 feet.

Practically all the area that would be affected by the proposed closed basin drain is covered to some extent by saltgrass. About one-fourth of the area is covered only by saltgrass, and about three-fourths of the area is covered by a varying mixture of saltgrass, greasewood, and rabbitbrush. Smaller parts of the area have bare soil or are occupied by perennial or playa lakes.

In order to determine the salvage factor a for each segment of the proposed drain, the three values obtained by Tipton and Hart were plotted against the depth to water level, and a straight line was drawn between the lone value at a depth of 23⅛ inches and the graphical average of the other two values, on the assumption that the rate of salvage varies linearly with depth (at least within the assumed limits). On this assumption, the rate of salvage was found to be 0.32 foot per foot per year and no salvage was indicated below a depth of 7 feet.

The final salvage factor (col. 8, tables 4 and 5) was obtained by multiplying 0.32 foot per foot per year by either of the following: by 7 minus the depth to water level if the depth was less than 7 feet; or by b (col. 9) if b was smaller than 7 minus the depth to water. The resulting dimensions of a are thus in feet per year. This procedure assumes no salvage of water if the initial depth to water level is 7 feet or more, and it assumes a maximum salvage of 2.2 feet per year at the surface. There may be a slight salvage even below 7 feet, but data for such depths were not available.

COEFFICIENT OF TRANSMISSIBILITY

The coefficient of transmissibility, *T*, of the shallow unconfined aquifer in the sump area was determined by pumping tests of temporary test wells located at convenient intervals along the line of the proposed main drain and lateral drains at the points shown on plate 16. (See pp. 75–80.) The results of these and other determinations are given in the last column of table 6. As originally planned, the main line of the proposed drain would end at point *A′* (test well 51), but after all the pumping tests had been completed the Bureau of Reclamation altered the site to extend from the vicinity of test well 41 to point *L′* (pl. 16).

For the extensions of the proposed main drain and lateral drain *B–B′*, values of the coefficient of transmissibility were extrapolated from the nearest points where determinations had been made. Except for these extrapolated values, the segments of the proposed drains for which computations of yield were made (tables 4 and 5) were taken between points where pumping tests had been made, and average values of the coefficient of transmissibility were used.

The character of material penetrated by the test holes along the site of the drain is shown on plate 11, which includes cross sections for only the original sites. After each test hole was drilled and logged it was partly filled with drilling mud so that the well screen could be installed above the shallowest reasonably persistent clay layer, in order that only the shallow unconfined aquifer could be tested. This aim probably was not accomplished for each test well, however, because of the general lack of homogeneity of the material and because it was not practicable to complete all test drilling and prepare the cross sections in advance of installing the screens and casing. However, use of paired shallow and deep observation wells at three distances on one side of the pumped well should have compensated in a large part for the lack of homogeneity of material and incomplete penetration by some of the test wells. The depths at which test wells were plugged and above which screens were set are given in table 6.

The cross sections (pl. 11) show that the underlying clay bed is not continuous, and that there probably would be some contribution of water from underlying artesian aquifers; indeed, there would be a slight leakage even if the clay beds were continuous. In analyzing this problem, C. E. Jacob (written communication, Nov. 10, 1945) found that if the clay layer is discontinuous it would seem desirable to make some allowance for the resulting convergence of the flow approaching the drain laterally and from below, and that the added drawdown due to this convergence would be given approximately by

$$\Delta s = \frac{q}{\pi K} \log_e \frac{m}{\pi r_0} \tag{8}$$

where Δs is the added drawdown; q is the pickup of water per unit length of drain; K is the transmission constant, or "permeability"; m is the thickness of the saturated bed; and πr_0 is approximately the wetted perimeter of the drain. In units convenient to the problem, equation (8) may be written

$$\Delta s = \frac{0.124q}{T} \log_{10} \frac{m}{\pi r_0} \tag{9}$$

where Δs, m, and πr_0 are in feet; q is in acre-feet per mile; and T is in gallons a day per foot.

Equation (9) was applied to selected segments of the drain, but it was found that the added drawdown (Δs) resulting from the leakage of water from underlying artesian aquifers is very small and, hence, may be disregarded.

DRAWDOWN AT THE DRAIN

The drawdown at the drain, b, in the above equation is the difference between the water level at any point in the proposed drain and the undisturbed position of the water table at the same point. The positions of the water table considered in computing the probable yield of the drain are those that prevailed during a low stage of the water table in the fall of 1946 (pl. 9) and a high stage of the water table in the spring of 1947 (pl. 10). The altitudes of the bottom of the proposed drain at all points were taken from detailed profiles of the proposed drain prepared by the Bureau of Reclamation. These profiles were drawn to a horizontal scale of 500 feet to the inch and a vertical scale of 5 feet to the inch. The positions of the water table at each observation well along the sites of the proposed drain were plotted on these profiles for the two periods selected, and the water table was assumed to have a uniform gradient between known points. The average drawdown, b, for each segment (tables 4 and 5, cols. 2 and 10) was determined as the average difference between the altitude of the bottom of the proposed drain and the altitude of the water table.

As the depth of water in the proposed drain could not be predicted accurately, 3 separate computations were made for each segment for each period considered, assuming depths of water of 2, 2.5, and 3 feet in deriving b' from b (tables 4 and 5, cols. 11, 12, and 13).

In the derivation of equation (7) Theis assumed "that the aquifer is sufficiently thick so that the reduction in transmissibility by lowering the water table can be neglected." In the present problem the aquifer was not considered sufficiently thick to warrant this assumption, and therefore, in accordance with a suggestion by C. E. Jacob (written communication, Nov. 10, 1945), all drawdowns were corrected as follows (Jacob, 1944):

$$b' = b - \frac{b^2}{2m} \qquad (10)$$

where b' is the corrected drawdown, in feet; b is the computed drawdown, in feet; and m (tables 4 and 5, col. 9) is the original saturated thickness, in feet.

The corrected drawdowns (b') finally used in equation (7) were obtained as follows:

$$b' = (b - d) - \frac{(b - d)^2}{2m} \qquad (11)$$

where b', b, and m are in the units given for equation (10), and (d) is the assumed depth of water (2, 2.5, or 3 ft) in the proposed drain.

RESULTS OF INVESTIGATION

The estimated yields of ground water of the proposed closed basin drain under conditions that prevailed during the fall of 1946 and the spring of 1947 are given in tables 4 and 5, respectively. Each table contains the results of separate computations (cols. 11, 12, and 13) for each segment (col. 2), for each of which the estimated yield per mile per year was multiplied by the length of the segment in miles (col. 5) to obtain the estimated yield per year.

An attempt has been made in the foregoing pages to evaluate the probable accuracy of the factors and assumptions involved in equation (7), each of which has an important bearing on the estimated yield of the drain under the conditions indicated. Because of several of the assumptions involved, the results given in tables 4 and 5 should be considered as approximate and as the probable maximum yields of ground water that could be expected from the proposed closed basin drain under the conditions indicated.

QUALITY OF GROUND WATER

The Rio Grande compact states:

> In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin, Colorado shall not be credited with the amount of such water delivered, unless the proportion of sodium ions shall be less than forty-five per cent of the total positive ions in that water when the total dissolved solids in such water exceeds three hundred fifty parts per million.

The wells and test wells in the sump area of the closed basin from which samples of ground water were obtained for analysis are shown on plates 1 and 16 and in figure 9, and the analyses are given in tables 7 and 9.

After careful consideration of the analyses of ground water from the sump area and the estimated yields of ground water given in tables 4 and 5, C. S. Howard, staff chemist, Geological Survey, submitted the following statement (written communication, Apr. 15, 1948):

> The records indicate that there are large quantities of soluble solids in the ground water and presumably in the materials of the aquifers, so that it is to be expected that drainage water from the sump area will be moderately high in concentration for a long period of time.
>
> The available analytical data are not sufficient to compute accurately the quality of the water that will be found in each segment of the drain and laterals, but an approximate estimate has been made for the main drain and for each of the proposed laterals. It is likely that there may be small seasonal changes in the quality of the shallow ground water and, therefore, in the water of the drain, but the data are not sufficient to show the extent of those changes. It is likewise impossible to compute the changes in quality for the different estimated depths of water in the drain. Computations have been made on the basis of the estimated concentrations of dissolved solids in water from the various segments of the main drain and the laterals. It appears that the water in the drain during the period of greatest yield (high water levels and minimum depth in drain) and during the period of lowest yield (low water levels and maximum depth in drain) will have an average concentration of 1.6 tons per acre-foot.

As a concentration of 1.6 tons of dissolved solids per acre-foot is equivalent to about 1,175 ppm and as the percent sodium in the shallow water in the vicinity of the proposed drain and laterals is about 75, the water does not fall within the limits acceptable for credit under the terms of the Rio Grande compact.

It has been suggested that the quality of the water discharged into the proposed drain may improve noticeably after the drain is in operation and may eventually be sufficiently good to meet the compact requirements with a minimum of dilution with surface water. It has been shown in the section on "Quality of water" that most of the dissolved mineral constituents in the shallow ground water probably are taken into solution as the water moves toward the sump area, where the mineral content is further increased by concentration. The proposed drain would tend to reduce the concentration by (1) conducting mineralized water out of the basin and (2) allowing water moving into the basin to be carried away with less concentration by evaporation and transpiration. The possible degree of improvement in quality and the length of time required for substantial "sweetening" of the water are not known.

Consideration was given to the fact that the water may be made acceptable by diluting it with a sufficient quantity of surface water that has a low concentration of dissolved minerals. But studies by the Bureau of Reclamation during the period of investigation indicated that sufficient surface water for this purpose was not available (W. H. Sweet, oral communication).

Consideration has been given also to the possibility of constructing drains or lines of drainage wells to the west of the sump area, where the water is of a quality that would be acceptable under the terms of the Rio Grande compact.

TABLE 4.—*Estimated yield of proposed closed basin drain during low stage of the water table in the fall of 1946, in acre-feet per year*

Segment	Location of segment: Between test wells (pl. 16), or USBR[1] stations	Location of segment: Between USBR[1] stations	Length of segment: Feet	Length of segment: Miles	Average coefficient of transmissibility (gallons per day per foot)[2]	Average depth to water level (feet)	Salvage factor (feet per year)[2]	Thickness of saturated water-bearing material (feet)[2]	Drawdown to bottom of proposed drain (feet)[2]	Estimated yield, from corrected drawdown (acre-feet per year)[2]: 2 feet[3]	2.5 feet[3]	3 feet[3]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
					Main drain *L–L′*							
1	1,848 ft below point opposite T7	650+00–681+52	3,152	0.60	1,000	5.3	0.54	29	14.3	74	73	71
2	T7–728+20	681+52–728+20	4,668	.88	2,800	3.8	1.0	27	11.9	234	219	215
3	728+20–T5	728+20–778+60	5,040	.95	4,400	2.7	1.4	24	10.8	331	323	315
4	T5–1 mile N. of T5	778+60–832+15	5,355	1.01	[4] 7,700	2.6	1.4	21	7.8	382	367	349
5	1 mile N. of T5–T3	832+15–885+70	5,355	1.01	12,800	5.2	.58	21	6.0	280	263	245
6	T3–943+80	885+70–943+80	5,810	1.10	11,800	9.2	0	20	4.5	0	0	0
7	943+80–T18	943+80–994+10	5,030	.95	4,600	9.1	0	19	3.5	0	0	0
8	T18–1050+15	994+10–1050+15	5,605	1.06	3,600	8.7	0	20	3.0	0	0	0
9	1050+15–T15	1050+15–1105+40	5,525	1.05	8,800	5.9	.35	33	3.1	103	76	31
10	T15–T13	1105+40–1174+00	6,860	1.30	7,900	5.7	.42	40	3.1	132	98	40
11	T13–T47	1174+00–1305+28	13,128	2.49	12,600	5.0	.64	40	5.0	655	602	542
12	T47–T12	1305+28–1341+20	3,592	.68	20,700	4.8	.70	43	5.6	257	240	220
13	T12–T45	1341+20–1424+30	8,310	1.57	36,800	4.8	.70	44	5.6	759	739	678
14	T45–T43	1424+30–1480+60	5,630	1.07	38,300	5.8	.38	31	6.4	441	417	391
15	T43–T41	1480+60–1605+60	12,500	2.37	23,500	5.7	.42	55	6.9	862	817	772
16	T41–T51	1605+60–1813+08	20,748	3.93	30,000	4.3	.86	49	7.9	2,560	2,450	2,340
17	T51–1900+00	1813+08–1900+00	8,692	1.65	[4] 36,000	4.5	.80	39	3.6	597	495	369
18	1900+00–2130+10	1900+00–2130+10	23,010	4.36	[4] 36,000	4.0	.67	39	2.1	365	0	0
19	2130+10–2150+10	2130+10–2150+10	2,000	.38	[4] 36,000	[5] 4.5	0	39	0	0	0	0
20	2150+10–2274+31	2150+10–2274+31	12,421	2.35	[4] 36,000	[5] 4.7	.61	39	1.9	0	0	0
	Subtotal			30.76						8,032	7,179	6,578
					Lateral drain *B–B′*							
21	0+00–T51	0+00–90+00	9,000	1.7	12,100	4.2	.90	39	4.4	457	407	351
22	T51–T52	90+00–245+00	15,500	2.9	43,300	4.7	.74	36	5.7	1,640	1,570	1,420
23	T52–1,100 ft W. of T52	245+00–256+00	1,100	.2	[4] 25,200	5.7	.42	36	7.8	80	78	74
	Subtotal			4.8						2,177	2,055	1,845

	Lateral drain *C–C′*											
24	T41–T42	4+00–99+00	10,300	1.9	48,600	4.8	.70	63	6.4	1,220	1,150	988
25	T42–1,000 ft E. of T39	99+00–204+00	10,500	1.9	[4] 44,900	4.9	.67	57	10.4	1,560	1,510	1,470
26	T41–T40	4+00–110+00	10,600	2.0	25,700	6.1	.29	58	5.6	550	508	466
27	T40–T35	110+00–215+00	10,500	1.9	22,100	5.7	.42	54	3.7	400	337	259
28	T35–323+50	215+00–323+50	10,850	2.05	19,100	8.7	0	40	2.3	0	0	0
	Subtotal			9.75						3,730	3,505	3,133
	Lateral drain *D–D*[1]											
29	00+00–T43	0+00–15+00	1,500	.28	11,600	5.8	.38	50	5.9	60	59	52
30	T43–T45	15+00–40+00	2,500	.47	38,200	6.3	.22	47	5.0	124	115	101
31	00+00–T44	0+00–164+00	16,400	3.1	21,200	5.8	.38	44	4.2	682	602	506
32	T44–T38	164+00–332+00	16,800	3.2	20,500	6.2	.26	35	4.1	500	493	412
33	T38–T37	332+00–429+00	9,700	1.8	30,200	5.7	.42	29	3.3	385	305	187
34	T37–5,500 ft W. of T37	429+00–484+00	5,500	1.0	[4] 14,400	5.7	.42	27	4.4	200	179	154
	Subtotal			9.85						2,017	1,753	1,412
	Lateral drain *E–E′*											
35	00+00–T47	0+00–30+00	3,000	.57	20,300	7.7	0	47	3.7	0	0	0
36	T47–T48	30+00–136+00	10,600	2.0	18,500	6.6	.13	44	3.5	201	165	117
37	T48–T19	136+00–246+00	11,000	2.08	14,400	5.4	.51	24	2.8	268	165	0
38	T19–5,400 ft E.	246+00–299+00	5,300	1.00	[4] 6,400	3.1	1.3	57	10.4	440	428	415
39	0+00–T12	0+00–72+00	7,200	1.4	20,300	4.7	.74	48	2.4	59	0	0
40	T12–T46	72+00–178+00	10,600	2.01	17,200	4.5	.80	41	4.1	570	500	417
41	T46–5,900 ft W. of T46	178+00–237+00	5,900	1.1	[4] 8,000	7.4	0	33	9.8	0	0	0
	Subtotal			10.16						1,538	1,258	949
	Lateral drain *F–F′*											
42	0+00–T20	0+00–84+00	8,400	1.59	6,200	6.3	.23	36	3.4	120	0	64
43	T20–7,500 ft E.	84+00–159+00	7,500	1.4	[4] 4,000	[5] 5.0	.64	34	7.4	267	256	243
44	00+00–T14	0+00–97+50	9,750	1.8	9,400	5.4	.51	39	3.9	286	246	199
45	T14–6,200 ft W.	97+50–159+50	6,200	1.17	[4] 7,300	7.7	0	40	4.6	0	0	0
	Subtotal			5.96						673	502	506

See footnotes at end of table.

TABLE 4.—*Estimated yield of proposed closed basin drain during low stage of the water table in the fall of 1946, in acre-feet per year*—Continued

Segment	Location of segment		Length of segment		Average coefficient of transmissibility (gallons per day per foot)[3]	Average depth to water level (feet)	Salvage factor (feet per year)[3]	Thickness of saturated water-bearing material (feet)[3]	Drawdown to bottom of proposed drain (feet)[3]	Estimated yield, from corrected drawdown (acre-feet per year)[2]		
	Between test wells (pl. 16), or USBR[1] stations	Between USBR[1] stations	Feet	Miles						2 feet[3]	2.5 feet[3]	3 feet[3]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
					Lateral drain *G–G′*							
46	0+00–T21	0+00–165+00	16,500	3.13	10,000	4.9	0.67	24	4.1	616	539	533
47	T21–2,900 ft E.	165+00–194+00	2,900	.55	[4] 3,800	6.9	.03	56	15.0	68	67	65
48	0+00–T16	0+00–198+00	19,800	3.75	13,700	6.8	.06	17	2.4	121	0	0
49	T16–10,800 ft W. of T16	198+00–306+00	10,800	2.05	[4] 8,000	7.8	0	26	1.5	0	0	0
	Subtotal			9.48						805	606	598
					Lateral drain *H–H′*							
50	0+00–7,200 ft E.	0+00–72+00	7,200	1.36	[4] 500	8.7	0	25	3.5	0	0	0
51	0+00–T17	0+00–103+00	10,300	1.95	500	9.0	0	16	2.3	0	0	0
	Subtotal			3.31						0	0	0
					Lateral drain *I–I′*							
52	0+00–T4	0+00–103+60	10,360	1.96	8,200	8.7	0	13	4.0	0	0	0
53	T4–T2	103+60–209+10	10,550	1.99	750	6.8	.06	21	4.0	31	27	22
	Subtotal			3.95						31	27	22
	Total			88.02						19,003	16,885	15,043

[1] U. S. Bureau of Reclamation.
[2] Slight apparent discrepancies in yields, subtotals, and totals are due to rounding of figures.
[3] Assumed depth of water in drain.
[4] Obtained by extrapolation from nearest point where a determination was made.
[5] Estimated.

TABLE 5.—*Estimated yield of proposed closed basin drain during high stage of the water table in the spring of 1947, in acre-feet per year*

Segment	Location of segment: Between test wells (pl. 16), or USBR[1] stations	Location of segment: Between USBR[1] stations	Length of segment: Feet	Length of segment: Miles	Average coefficient of transmissibility (gallons per day per foot)[2]	Average depth to water level (feet)	Salvage factor (feet per year)[2]	Thickness of saturated water-bearing material (feet)[2]	Drawdown to bottom of proposed drain (feet)[2]	Estimated yield, from corrected drawdown (acre-feet per year)[2]: 2 feet[3]	2.5 feet[3]	3 feet[3]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Main drain *L–L′*											
1	1,848 ft below point opposite T7	650+00–681+52	3,152	0.60	1,000	4.2	0.90	30	15.4	102	97	95
2	T7–728+20	681+52–728+20	4,668	.88	2,800	1.9	1.6	29	13.8	306	301	296
3	728+20–T5	728+20–778+60	5,040	.95	4,400	2.3	1.5	24	11.2	357	349	297
4	T5–1 mile N. of T5	778+60–832+15	5,355	1.01	[4] 7,700	1.5	1.8	22	8.9	483	470	455
5	1 mile N. of T5–T3	832+15–885+70	5,355	1.01	12,800	4.5	.80	22	6.7	353	336	319
6	T3–943+80	885+70–943+80	5,810	1.10	11,800	8.8	0	20	4.9	0	0	0
7	943+80–T18	943+80–994+10	5,030	.95	4,600	9.1	0	19	3.5	0	0	0
8	T18–1050+15	994+10–1050+15	5,605	1.06	3,600	8.1	0	20	3.6	0	0	0
9	1050+15–T15	1050+15–1105+40	5,525	1.05	8,800	5.7	.42	33	3.3	122	97	59
10	T15–T13	1105+40–1174+00	6,860	1.30	7,900	5.0	.64	41	3.8	208	177	139
11	T13–T47	1174+00–1305+28	13,128	2.49	12,600	4.7	.74	40	5.3	726	671	609
12	T47–T12	1305+28–1341+20	3,592	.68	20,700	3.7	1.1	44	6.7	367	347	327
13	T12–T45	1341+20–1424+30	8,310	1.57	36,800	3.7	1.1	45	6.7	1,130	1,070	1,010
14	T45–T43	1424+30–1480+60	5,630	1.07	38,300	5.4	.51	31	6.8	533	506	478
15	T43–T41	1480+60–1605+60	12,500	2.37	23,500	4.4	.83	56	8.2	1,360	1,300	1,250
16	T41–T51	1605+60–1813+08	20,748	3.93	30,000	1.8	1.7	52	10.4	4,300	4,070	3,850
17	T51–1900+00	1813+08–1900+00	8,692	1.65	[4] 36,000	2.2	1.5	41	5.9	1,330	1,250	1,160
18	1900+00–2130+10	1900+00–2130+10	23,010	4.36	[4] 36,000	3.0	1.3	40	3.1	1,660	1,240	506
19	2130+10–2150+10	2130+10–2150+10	2,000	.38	[4] 36,000	[5] 2.5	1.4	41	0	0	0	0
20	2150+10–2274+31	2150+10–2274+31	12,421	2.35	[4] 36,000	[5] 3.7	1.1	40	2.9	750	500	0
	Subtotal			30.76						14,090	12,780	10,850
	Lateral drain *B–B′*											
21	00+00–T51	00+00–90+00	9,000	1.7	12,100	3.4	1.2	39	5.2	608	561	508
22	T51–T52	90+00–245+00	15,500	2.9	43,300	3.9	1.0	37	6.2	2,100	1,890	1,860
23	T52–1,100 ft W. of T52	245+00–256+00	1,100	.2	[4] 25,200	4.6	.77	37	8.95	119	115	111
	Subtotal			4.8						2,827	2,666	2.479

See footnotes at end of table.

TABLE 5.—*Estimated yield of proposed closed basin drain during high stage of the water table in the spring of 1947, in acre-feet per year*—Continued

Segment	Location of segment: Between test wells (pl. 16), or USBR[1] stations	Location of segment: Between USBR[1] stations	Length of segment: Feet	Length of segment: Miles	Average coefficient of transmissibility (gallons per day per foot)[2]	Average depth to water level (feet)	Salvage factor (feet per year)[2]	Thickness of saturated water-bearing material (feet)[2]	Drawdown to bottom of proposed drain (feet)[2]	Estimated yield, from corrected drawdown (acre-feet per year)[2]: 2 feet[3]	2.5 feet[3]	3 feet[3]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Lateral drain *C–C′*											
24	T41–T42	4+00–99+00	10,300	1.9	48,600	2.4	1.5	65	8.8	2,210	2,130	2,050
25	T42–1,000 ft E. of T39	99+00–204+00	10,500	1.9	[4] 44,900	2.0	1.6	50	13.3	2,170	2,130	2,080
26	T41–T40	4+00–110+00	10,600	2.0	25,700	5.0	.64	59	6.7	923	875	823
27	T40–T35	110+00–215+00	10,500	1.9	22,100	2.9	1.3	57	6.5	1,130	1,070	1,000
28	T35–323+50	215+00–323+50	10,850	2.05	19,100	6.7	.10	42	4.3	227	201	172
	Subtotal			9.75						6,660	6,406	6,125
	Lateral drain *D–D′*											
29	00+00–T43	00+00–15+00	1,500	.28	11,600	4.6	.77	51	7.1	58	55	53
30	T43–T45	15+00–40+00	2,500	.47	38,200	5.6	.45	48	5.7	195	182	168
31	00+00–T44	00+00–164+00	16,400	3.1	21,200	5.0	.64	45	5.0	1,040	953	764
32	T44–T38	164+00–332+00	16,800	3.2	20,500	5.8	.38	35	4.5	742	666	580
33	T38–T37	332+00–429+00	9,700	1.8	30,200	3.4	1.2	31	5.6	1,050	980	900
34	T37–5,500 ft W. of T37	429+00–484+00	5,500	1.0	[4] 14,400	1.3	1.8	31	8.8	669	647	624
	Subtotal			9.85						3,754	3,483	3,089
	Lateral drain *E–E′*											
35	00+00–T47	00+00–30+00	3,000	.57	20,300	.4	.90	50	7.2	291	278	263
36	T47–T48	30+00–136+00	10,600	2.0	18,500	6.3	.22	44	3.8	287	245	192
37	T48–T19	136+00–246+00	11,000	2.08	[4] 14,400	5.0	.64	24	3.2	366	281	151
38	T19–5,400 ft E.	246+00–299+00	5,300	1.00	6,400	2.8	1.3	57	10.7	439	425	414
39	0+00–T12	0+00–72+00	7,200	1.4	20,300	3.1	1.3	50	4.0	539	468	383
40	T12–T46	72+00–178+00	10,600	2.01	17,200	4.1	.93	41	4.5	667	598	520
41	T46–5,900 ft W. of T46	178+00–237+00	5,900	1.1	[4] 8,000	4.9	.67	35	12.3	404	395	387
	Subtotal			10.16						2,993	2,690	2,310

					Lateral drain *F–F'*								
42	0+00–T20	00+00–84+00	8,400	1.59	6,200	6.2	.26	36	3.5	131	108	76
43	T20–7,500 ft E.	84+00–159+00	7,500	1.4	[4] 4,000	[5] 4.1	.93	35	8.3	346	338	320
44	00+00–T14	00+00–97+50	9,750	1.8	9,400	4.3	.86	40	5.0	467	427	383
45	T14–6,200 ft W.	97+50–159+50	6,200	1.17	[4] 7,300	1.5	1.8	46	10.8	635	619	602
	Subtotal			5.96						1,579	1,487	1,381
					Lateral drain *G–G'*							
46	0+00–T21	0+00–165+00	16,500	3.13	10,000	3.5	1.1	25	5.5	1,002	933	856
47	T21–2,900 ft E.	165+00–194+00	2,900	.55	[4] 3,800	1.9	1.6	61	20.0	283	279	275
48	0+00–T16	0+00–198+00	19,800	3.75	13,700	6.7	.10	17	2.5	165	0	0
49	T16–10,800 ft W. of T16	198+00–306+00	10,800	2.05	[4] 8,000	7.6	0	26	1.7	0	0	0
	Subtotal			9.48						1,450	1,212	1,131
					Lateral drain *H–H'*							
50	0+00–7,200 ft E.	0+00–72+00	7,200	1.36	[4] 500	8.5	0	25	3.7	0	0	0
51	0+00–T17	0+00–103+00	10,300	1.95	500	8.8	0	16	2.5	0	0	0
	Subtotal			3.31						0	0	0
					Lateral drain *I–I'*							
52	0+00–T4	0+00–103+60	10,360	1.96	8,200	8.6	0	18	4.1	0	0	0
53	T4–T2	103+60–209+10	10,550	1.99	750	6.6	.18	21	4.2	48	42	36
	Subtotal			3.95						48	42	36
	Total			88.04						33,401	30,766	27,401

[1] U. S. Bureau of Reclamation.
[2] Slight apparent discrepancies in yields, subtotals, and totals due to rounding of figures.
[3] Assumed depth of water in drain.
[4] Obtained by extrapolation from nearest point where a determination was made.
[5] Estimated.

INFLOW AND OUTFLOW OF WATER IN SELECTED IRRIGATED AREA

The heavily irrigated area north of Monte Vista was chosen for special study during this investigation in order to determine the inflow and outflow of water and the amount of water used. The study was made principally by the Bureau of Reclamation, but data on ground water were obtained by the Geological Survey as a part of this investigation. The report on the study was prepared by personnel of the Bureau of Reclamation and constitutes a supplement to this report.

Ground-water data include the discharge of water from artesian wells, the ground-water outflow, and the change in ground-water storage.

The discharge of artesian wells in the so-called inflow-outflow area is estimated (on the basis of measurements from 311 wells) to have been 12,000 acre-feet in 1949. Between 1949 and 1952 the annual discharge is estimated to have increased to 15,000 acre-feet, and it is assumed that the rate of increase was uniform —that is, 1,000 acre-feet each year.

The changes in ground-water storage, based on records of approximately 100 observation wells within the area of study, were computed by means of the Thiessen mean method (Thiessen, 1911), whereby a polygon was constructed around each observation well and the assumption was made that the change in water level throughout the area of the polygon was the same as the change in the well within the polygon. Data for the 4 years of study are illustrated in plate 15. Change in water level for any one year, as shown in plate 15, represents the change between January of that year and January of the following year. Change in storage is computed by multiplying the change in water level in each well by the specific yield of the aquifer and by the area of each polygon as determined by use of the planimeter. The changes in storage in the area shown in plate 15 are tabulated below.

Change in ground-water storage in the inflow-outflow area[1]

Year	Number of observation wells used in the determinations	Average net rise (+) or decline (—) in water level (feet)	Net gain (+) or loss (—) in storage (acre-feet)
1949	103	+0.18	+10,330
1950	102	−.99	−55,180
1951	105	−1.65	−92,120
1952	101	+2.41	+134,920

[1] Area used in determinations: 291.02 square miles. (See pl. 15.)

The area of inflow-outflow study in the report of the Bureau of Reclamation, page 120, differs slightly from the area shown in plate 15 of this report, because it was necessary for the Bureau of Reclamation to make some adjustment of the south boundary on the basis of the position of gaging stations. The changes in storage shown in the above table concern an area of 291.02 square miles, whereas the changes tabulated in the appendix refer to an area of 281.6 square miles.

The area chosen for the inflow-outflow study was one having boundaries that were believed to be reasonably well suited for the determination of the total inflow and outflow of water and the changes in ground-water storage. Investigation revealed, however, that not all the boundaries are firm, that the ground-water hydrology is complicated, and that the existing developments of ground water have a complex pattern in that many irrigation wells tap both the shallow unconfined aquifer and the deeper artesian aquifers.

The ground-water divide between the closed basin and the Rio Grande is not a fixed divide but probably moves a considerable distance with the large changes in ground-water storage. During the period of low water levels in 1951, the water table was below the level of the Rio Grande at many places in the closed basin north of Monte Vista, and it is likely that, at least locally, the divide may have been temporarily shifted southward toward the Rio Grande.

Investigation revealed also that the estimates of inflow and outflow of ground water may be in error. As the layers of clay that separate the artesian and nonartesian aquifers are lenticular and perhaps also leaky, ground water in large but unmeasurable amounts must have escaped from the area by way of the artesian aquifers.

The method of development of the shallow unconfined ground water may also affect the computations. It was assumed that the pumping of shallow ground water did not affect the total inflow or outflow; however, as many of the wells penetrate one or more layers of clay, it is believed that a large amount of artesian water was brought into the area by means of the so-called shallow irrigation wells.

INFLOW-OUTFLOW STUDY

By Philip B. Mutz
U. S. Bureau of Reclamation

INTRODUCTION TO INFLOW-OUTFLOW STUDY

At the request of the Colorado Water Conservation Board, members of the Closed Basin Committee met on August 12, 1947, and discussed the need for an investigation of ground-water conditions in the area irrigated by waters of the Rio Grande where large quantities of shallow ground water were being withdrawn by pumping. The members of the committee concluded that a detailed investigation should be made. The major purpose of the investigation was to determine the following points: (1) whether the use of ground-water storage can be correlated with the operation of the proposed Wagon Wheel Gap Reservoir in such a way as to make the most effective use of water and minimize irrigation shortages; (2) the effect of pumping water from the ground-water reservoir on the present practice of subirrigation of crops by maintaining the water table at a proper depth to supply the root zone; (3) the effect of the use of deep artesian wells on the availability of shallow unconfined ground water and shallow artesian water, and the suitability of deep artesian water for irrigation; and (4) the amount of water that may be developed by necessary drains and that can be brought to the Rio Grande by way of the proposed closed basin drain.

In order to obtain answers to the above and other related problems, the committee recommended 14 itemized procedures. This report deals mainly with procedure 9, which states: "During the two irrigation seasons, measure the quantity of water entering the area in irrigation ditches and the quantity leaving the area in irrigation and drainage ditches."

LOCATION

The area of study, the intensively cultivated land north of Monte Vista, is irrigated with water diverted from the Rio Grande. It lies within the closed basin of the San Luis Valley in the south-central part of Colorado. Center is the only town within the area.

Situated on an alluvial fan which has an average altitude of about 7,700 feet above sea level, the area is bounded on the south by the closed basin ground-water divide, on the east by the range line common to Rs. 9 and 10 E. (New Mexico principal meridian), on the north by the township line common to Tps. 41 and 42 N., and on the west by the Rio Grande canal. An additional small

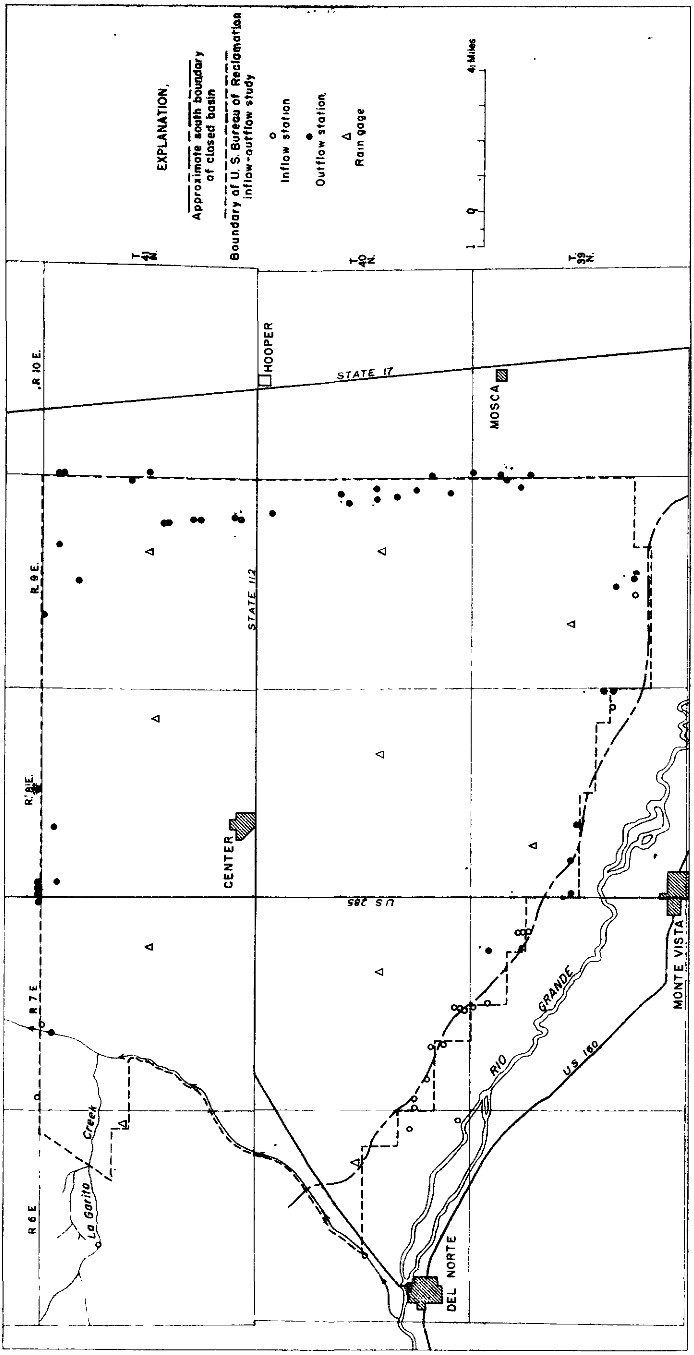


FIGURE 23.—Boundaries of area of inflow-outflow study.

area along La Garita Creek, west of the Rio Grande canal, was included to facilitate measurement of inflow. The total area of the study comprises 281.6 square miles, or 180,250 acres, of which about 115,000 acres is cultivated. The remainder consists of pasture land, brush land, abandoned tracts, roads, farmsteads, and the one town. Boundaries of the area of study as used in this report are shown in figure 23.

PERIOD OF STUDY

The inflow-outflow study was begun in March 1948. During that year, only basic information was obtained in order to establish rating curves for the gages and check on the adequacy of the installations. The study was to have covered the calendar years 1949 and 1950, but owing to unusual climatic conditions the study was continued through 1952. This report, therefore, covers the period from January 1, 1949, to December 31, 1952, and includes two wet and two dry years.

Data were collected by personnel of the San Luis Valley project office of the Bureau of Reclamation in cooperation with technicians of the local canal companies, the U. S. Geological Survey, and the Colorado Water Conservation Board.

CLIMATE

The climate of the area is typical of an arid region of high altitude. Precipitation is light, averaging about 7 inches per year, and most of it occurs as thunderstorms during the growing season. Humidity generally is low and evaporation averages about 57 inches per year. Temperatures range from a minimum of 40°F below zero to a maximum of 90°F; the mean temperature is approximately 42°F. The length of the growing season ranges from as little as 94 days to as much as 140 days. Owing to the deficiency of rainfall, irrigation with water from the Rio Grande is necessary to supply an adequate amount of water for crops.

SOILS

Soils of the irrigated lands generally are rather coarse in texture and contain varying amounts of gravel. The permeability in most places is very high. Near the west side of the area the soils are coarse and contain gravel in such large amounts that some of the land is not irrigated because of low productive capacity. The amount of gravel decreases eastward and the soil texture becomes finer, but the texture is in no place finer than that of a sandy loam. Productivity of the soil also increases eastward. The soil, which ranges in thickness from 6 to 24 inches, overlies a layer of gravel or cobbles. The shallow depth of soil and the coarseness of the underlying materials have a pronounced effect on irrigation practices.

The soils contain varying amounts of soluble salts and alkali which increase in concentration toward the east. Many places have concentrations sufficient to reduce crop production materially. Soils in the nonirrigated areas in the eastern part contain very little gravel and are relatively fine textured. They contain sufficient soluble salts and alkali to make them nonproductive under normal irrigation practices.

GENERAL CROPPING PRACTICES

The area includes much of the potato-producing land of the San Luis Valley and the farming practices are built around this crop. Although there are exceptions, the practices are about the same throughout the area. Of two basic farm patterns, one is based on sweet clover and the other on alfalfa.

In the sweet-clover pattern, one or two crops of potatoes are raised. This is followed by a nurse crop of small grain planted with sweet clover. The sweet clover, being a biennial, is left for the following year, when it is used as pasture for livestock and later is plowed under. Sufficient livestock is raised to use the pasture furnished by the clover. A part of most farms is in sweet clover every year.

In the alfalfa pattern, potatoes usually are grown for 2 years in succession, after which a nurse crop of small grain is planted with alfalfa. The alfalfa is raised from 4 to 6 consecutive years and the land is then replanted with potatoes. With this system, the land is planted to potatoes only about a fourth to a third of the time as compared with nearly half the time under the sweet-clover system. The alfalfa system permits the handling of a larger number of livestock and makes it easier to maintain productivity without the use of large quantities of commercial fertilizer. There are advantages in both systems, and livestock is an important factor in each.

Land holdings in the area range from large to small, but the average farm is between 160 and 200 acres. Smaller acreages have a higher overhead per acre and a greater fixed cost, whereas the larger acreages have almost reached the point of maximum efficiency.

Irrigation water generally is supplied from April through September, the amount depending on the flow of the Rio Grande and on the amount of upstream storage, which is usually small. During periods of low flow, the supply is augmented by water from approximately 650 large pumped wells and from flowing artesian wells.

METHODS OF IRRIGATION

Subirrigation, which is practiced in the western part of the area, is used because the soil is highly permeable and ordinary methods of surface spreading tend to remove the minerals from the soil. Both subirrigation and surface irrigation are practiced in the eastern part of the area where the soil is more dense and where subirrigation tends to increase the amount of alkali in the soil.

DRAINAGE

In the western part of the area, the ground slope is sufficient to permit draining excess water eastward into the sump area of the closed basin. The present drainage systems empty into both the Rio Grande and the sump area. The systems draining eastward into the sump tend to raise the ground-water level in that area because there is no surface outlet. The water draining into the sump is not reused but is dissipated by evapotranspiration.

METHOD OF STUDY

The method employed in this study consisted of an analysis of the inflow minus the outflow, corrected for changes in storage of shallow ground water. The inflow of shallow ground water was not considered because it is believed to be negligible. The outflow of artesian water could not be determined. It is included in the figures for "water used" (p. 128), but it is assumed to be negligible.

INFLOW

SURFACE-WATER INFLOW

The inflow of surface water to the area was determined by means of 11 automatic water-stage recorders installed on major canals, an automatic water-stage recorder on a natural stream, and 10 staff gages on small distribution ditches. All streamflow records were obtained and computed by accepted practices, and their accuracy is considered adequate for the type of drains and canals measured.

PRECIPITATION

Precipitation was measured by means of 10 standard 5-inch precipitation gages. Records were obtained after every observed storm, and the gages were also checked at periodic intervals. The precipitation records obtained were distributed over the area by the Thiessen mean method (Thiessen, 1911). The inflow by precipitation, computed on a monthly basis, was considered to be 100 percent effective. As most of the precipitation falls during the growing season, little error is introduced by using the total observed precipitation because it contributes to the ground-water storage and reduces the consumptive use of water by plants.

DISCHARGE OF ARTESIAN WELLS

The discharge of artesian water into the area of inflow-outflow study was determined by the Geological Survey. Discharges of more than 300 flowing wells were measured and the average discharge per well, as determined by the measurements, was assumed to be the average discharge of all flowing wells in the area.

OUTFLOW

SURFACE-WATER OUTFLOW

The outflow of surface water from the area was measured by means of 23 automatic water-stage recorders on major canals and drains and 20 staff gages on small distribution ditches. Records of the outflow gages are comparable in accuracy with the records of the inflow gages. All staff gages were read on 5 consecutive days each week, and linear variations of the gage heights were assumed for the days when the gages were not read. As some small ditches were abandoned and new ones were constructed during the period of study, the number of staff gages varied somewhat from year to year.

The approximate locations of all inflow, outflow, and precipitation stations are shown in figure 23, and the monthly rates are tabulated on page 126.

SHALLOW GROUND-WATER OUTFLOW

At the beginning of the period of study a network of 304 observation wells was established. Some wells were abandoned as the study progressed because they could not be measured or because they did not add materially to the study. As a result, the program was reduced to approximately 100 wells which were measured periodically throughout the period of study. The wells were measured monthly during the winter and semimonthly during the remainder of the year. Six of the wells were equipped with automatic water-stage recorders in order to obtain continuous records of water-level fluctuations.

Altitudes of the measuring points of all observation wells were determined and a water-table contour map was prepared by the Geological Survey in order to determine the position of the ground-water divide and the direction and rate of ground-water flow. A series of pumping tests of wells tapping the shallow

Surface-water inflow, surface-water outflow, and precipitation in the area of inflow-outflow study, in acre-feet

Year	Month												Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Surface-water inflow													
1949	215	234	3,564	27,924	84,887	86,112	75,500	57,571	18,786	9,300	1,672	673	366,438
1950	184	333	5,799	30,585	49,446	60,363	30,876	9,363	3,743	5,964	454	215	197,325
1951	68	111	3,818	10,071	32,141	39,656	6,162	4,064	1,776	793	6,783	122	105,565
1952	111	155	198	34,180	107,692	127,405	72,276	49,444	21,346	15,426	938	184	429,355
Surface-water outflow													
1949	1,105	1,072	3,527	11,590	31,210	42,858	32,243	16,030	8,436	5,308	4,127	3,101	160,607
1950	1,191	1,776	3,962	9,002	19,720	21,512	8,766	2,552	1,040	1,332	1,190	1,656	73,699
1951	1,264	1,809	3,236	2,697	10,089	10,965	1,643	1,330	588	318	516	195	34,650
1952	164	250	663	8,719	35,484	44,775	23,554	16,689	7,331	6,362	2,531	1,252	147,774
Precipitation													
1949	6,226	2,246	5,001	826	16,932	16,593	26,076	14,355	15,475	6,777	340	4,599	122,836
1950	990	1,140	1,203	1,645	1,761	14,443	15,172	16,631	11,362	1,840	0	264	66,751
1951	631	2,612	2,370	4,963	2,957	1,266	8,636	22,449	133	1,990	0	1,136	49,143
1952	16,423	259	2,092	21,256	9,659	2,033	16,686	18,833	13,423	0	7,297	1,715	109,676

ground-water aquifer were made in 1948 and 1950 in order to determine the coefficients of permeability and transmissibility of the aquifer. Several test holes also were drilled to obtain data on the thickness and character of the aquifer. Results of the pumping tests and logs of the test holes may be found in another part of this report. The water-table contour map (pl. 8) shows that the shallow ground water moves eastward and northward out of the area of inflow-outflow study. With the use of data obtained from the water-table contour map and from test-drilling and pumping tests, the ground-water outflow was determined by application of the equation for Darcy's law.

EVAPORATION

There are no large bodies of free water in the area. Canals, drains, and old gravel pits compose the area of free water surface that would be subject to evaporation, but the losses from these sources were not computed. It is realized that some evaporation does occur, but the amount is not considered to be sufficient to introduce a large error in the computations.

CHANGE IN GROUND-WATER STORAGE

Personnel of the Ground Water Branch of the Geological Survey computed the annual change in ground-water storage on the basis of records of water-level fluctuations in the observation wells and specific yield of the aquifer as determined by pumping tests and laboratory tests. The effective area of each well was determined by the Thiessen mean method (Thiessen, 1911), and the change in ground-water storage was then computed. (See p. 118.)

LAND USE

The total area of the inflow-outflow study as used in this report is about 180,250 acres, of which approximately 4,940 acres is in the La Garita Creek section west of the Rio Grande canal. An area of about 2,830 acres in the La Garita Creek section is under irrigation.

In 1949 a crop census of the area of study was taken and the irrigated acreage was obtained. In 1950 the amount of land irrigated was not determined in the field because it was a year of low surface-water supply—a reduction of 5 percent of the 1949 acreage of irrigated land was considered to be reasonable. In 1951, a year of abnormally small surface-water supplies, the idle land was measured in order to determine the irrigated acreage. Personnel of the Bureau of Reclamation completed a detailed land-classification study of the area in 1951, and the irrigated acreage determined by this study was used as the irrigated acreage for the year 1952. Irrigated acreages are shown in the following table:

Acreage of irrigated and nonirrigated land (total: 180,250)

Year	*Irrigated land*	*Nonirrigated land*
1949	114,162	66,088
1950	108,454	71,796
1951	93,653	86,597
1952	115,850	64,400

RESULTS OF STUDY

The annual amounts of the various types of inflow and outflow and the changes in ground-water storage are listed in the following table:

Annual inflow, outflow, and change in ground-water storage, in acre-feet

Year	Inflow			Outflow		Change in ground-water storage
	Surface water	Precipitation	Discharge from flowing artesian wells	Surface water	Ground water	
1949	366,400	122,800	12,000	160,600	20,800	+12,500
1950	197,300	66,800	13,000	73,700	20,500	−51,700
1951	105,600	49,100	14,000	34,700	19,800	−86,000
1952	429,400	109,700	15,000	147,800	19,800	+126,400

The amount of water that was used or lost in the area of study was determined by adding the surface-water inflow, the discharge of artesian wells, and the precipitation; then subtracting the surface-water outflow and the ground-water outflow; and then applying algebraically the change in ground-water storage. The results are shown in the following table:

Inflow, outflow, change in ground-water storage, and water used, in acre-feet

Year	Inflow	Outflow	Change in ground-water storage	Water used[1]
1949	501,200	181,400	+12,500	307,300
1950	277,100	94,200	−51,700	234,600
1951	168,700	54,500	−86,000	200,200
1952	554,100	167,600	+126,400	260,100

[1] Includes water used by transpiration and evaporation and ground-water outflow through underlying artesian aquifers (the last considered to be negligible).

The amounts of water used per acre of land in the area of study are listed in the following table:

Use of water in inflow-outflow area, in acre-feet

Year	Amount used per acre (all land)	Amount used per acre (irrigated land)	Water used
1949	1.70	2.6	307,300
1950	1.30	2.16	234,600
1951	1.11	2.14	200,200
1952	1.44	2.25	260,100

Of the 4 years of study, 1950 and 1952 are assumed to have been years in which there was sufficient water supply, and it is assumed that the average consumptive use during those years approximates the average for all years. The consumptive use in 1951 was very low because of an abnormally low water supply. There was an oversupply of water in 1949, and seemingly it was not used as efficiently as in 1951. The less efficient use of water and the greater precipitation in 1949 resulted in greater losses by evapotranspiration and a larger consumptive use. In order to make a comparison, the consumptive use of water for agriculture in the area was computed by the Lowry-Johnson effective heat method (Lowry and Johnson, 1942), using records of the weather station at Monte Vista. The results are summarized in the following table:

Consumptive use as determined by the Lowry-Johnson method

Year	Beginning of growing season	End of growing season	Effective heat (°F)	Consumptive use (acre-feet per acre)
1949	May 22	Oct. 7	6,178	1.80
1950	May 27	Sept. 12	4,980	1.62
1951	June 12	Sept. 10	4,352	1.53
1952	May 13	Sept. 13	5,401	1.69

RECORDS

SUMMARY OF METHOD OF PRESENTATION OF DATA

Records of the 39 wells that were test-pumped to determine the hydrologic properties of the shallow aquifer are listed in table 6, page 130.

Analyses of water from wells that were numbered under the Bureau of Land Management system of land subdivision are given in table 7, page 134.

Analyses of surface water are given in table 8, page 156.

Analyses of water from test wells 1 through 52 are given in table 9, page 162.

Records of selected wells are given in table 10, page 168. The locations of the 2,162 wells that were examined during this investigation are shown on plates 1 and 16 (in pocket) and in figure 9.

Logs of 290 wells and test holes, including 52 test holes and test wells that were drilled for the Geological Survey as a part of the investigation, are given on pages 238 through 280.

TABLE 6.—*Records of wells that were test-pumped*

Well: Wells 1 through 52 are shown on pl. 16. Wells 39–8–13ab through 41–9–23ca are shown on pls. 1 and 16. Chemical analyses of the water are given in tables 7 and 9 for all wells except those whose numbers are enclosed in parentheses.
Depth of well: Measured depths are given in feet and tenths of a foot; reported depths are given in feet.

Well	Location	Owner	Year drilled	Measured depth of drilled hole (feet)	Depth of well (feet)	Diameter of well (in.)	Character of principal water-bearing material	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Measured discharge (gpm)	Draw-down (feet)	Pumping time (hr)	Coefficient of transmissibility of aquifer (gpd per foot)
	T. 38 N., R. 10 E.															
1	NW¼NW¼ sec. 6	Alamosa County	1949	53.0	40.0	6	Sand, fine, to coarse gravel.	Top of casing	0.4	7,567.5	6.46	Nov. 3, 1949	96	------	28.1	25,200
	T. 38 N., R. 11 E.															
3	NE¼NE¼ sec. 14	do	1946	94.8	34.3	8	Sand, very fine, to coarse gravel.	do	1.3	7,522.2	11.09	July 24, 1946	52	------	24	15,300
5	NW¼NW¼ sec. 25	S. Crow	1946	63.4	25.3	8	do	do	1.3	7,516.0	3.67	July 29, 1946	22	------	11.9	5,200
7	SE¼SE¼ sec. 35	Alamosa County	1946	82.5	35.0	8	do	do	1.1	7,529.8	5.89	Aug. 6, 1946	17	------	7.7	2,000
	T. 39 N., R. 8 E.															
39–8–13ab	NW¼NE¼ sec. 13	Grant Oxley	------	------	50	18	Sand, fine, to medium gravel.	Top of pump base, east side.	.6	7,616.9	4.98	Sept. 9, 1948	1,474	17.0	32.1	157,000
	T. 39 N., R. 9 E.															
39–9–4cc	SW¼SW¼ sec. 4	R. F. McNitt	------	------	50	16	Sand, medium, to coarse gravel.	Top of casing	−2.0	7,596.3	4.21	Aug. 8, 1948	972	------	25.9	108,000
9	NE¼NE¼ sec. 24	Alamosa County	1949	48.0	40.0	6	Sand, very fine, to coarse gravel.	do	1.1	7,564.2	4.34	Oct. 27, 1949	93	11.33	25	47,100

	T. 39 N., R. 10 E.															
11	NW¼NW¼ sec. 7	do	1949	52.0	40.0	6	do	do	.1	7,572.6	6.09	Oct. 20, 1949	85	------	72	35,400
	T. 39 N., R. 11 E.															
12	NW¼NW¼ sec. 3	do	1946	147.6	54.0	8	do	do	2.3	7,525.0	5.74	Aug. 11, 1946	125	------	9.3	19,700
13	NW¼SW¼ sec. 13	do	1946	115.8	45.9	8	Sand, fine, to coarse gravel.	do	1.5	7,521.3	6.44	July 12, 1946	54	------	19.4	4,300
14	SE¼NE¼ sec. 16	do	1946	84.8	46.4	8	do	do	1.1	7,524.2	6.59	Sept. 19, 1946	88	18.74	10.3	14,500
15	SE¼SE¼ sec. 23	do	1946	93.9	46.6	8	Sand, very fine, to very coarse gravel.	do	1.3	7,519.2	5.78	July 18, 1946	85	22.67	24	11,400
16	NW¼NW¼ sec. 29	do	1946	63.4	35.4	8	Sand and gravel, medium to coarse.	do	1.3	7,532.1	9.30	Apr. 18, 1946	76	------	10.7	15,900
18	SE¼SE¼ sec. 35	do	1946	84.9	29.0	8	Sand and gravel, very fine to coarse.	do	.7	7,521.6	11.00	July 19, 1946	5	------	4	[1] 1,000
	T. 39 N., R. 12 E.															
19	NW¼NW¼ sec. 3	do	1946	132.8	61.8	8	do	do	1.3	7,587.3	5.24	Sept. 7, 1946	77	21.38	8	12,800
20	SE¼SW¼ sec. 7	do	1946	63.6	39.3	8	do	do	1.9	7,522.7	5.17	Aug. 12, 1946	34	------	9.7	8,000
21	SE¼SE¼ sec. 20	do	1946	85.3	47.7	8	do	do	1.6	7,533.4	5.59	Sept. 14, 1946	54	------	8.4	7,500
	T. 40 N., R. 8 E.															
40-8-1bc	SW¼NW¼ sec. 1	Roy Lofton	------	------	33.3	22	Sand and gravel, fine to coarse.	do	1.6	7,614.1	4.28	Oct. 29, 1947	1,264	------	30.6	243,000
	T. 40 N., R. 9 E.															
34	SE¼SE¼ sec. 25	Alamosa County	1949	52.0	50.0	6	Sand and gravel, very fine to coarse.	do	3.0	7,574.4	7.14	Oct. 12, 1949	39	------	120	14,900
	T. 40 N., R. 10 E.															
35	SW¼SW¼ sec. 2	E. G. Cooper	1946	211.0	83.2	8	Sand, very fine, to medium gravel.	do	.4	7,545.6	7.39	Apr. 11, 1946	32	------	24	25,000
36	SW¼SW¼ sec. 5	G. E. Stoeber	1946	112.0	39.3	8	Sand, very fine, to coarse gravel.	do	1.5	7,567.6	10.46	Oct. 8, 1946	70	17.77	9.5	43,500
37	SW¼NW¼ sec. 20	Chester Brobacker	1946	70.5	33.9	8	Sand, fine, to coarse gravel.	do	1.2	7,563.9	6.55	Oct. 14, 1946	100	------	9.2	38,700

See footnotes at end of table.

TABLE 6.—*Records of wells that were test-pumped*—Continued

Well	Location	Owner	Year drilled	Measured depth of drilled hole (feet)	Depth of well (feet)	Diameter of well (in.)	Character of principal water-bearing material	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Measured discharge (gpm)	Drawdown (feet)	Pumping time (hr)	Coefficient of transmissibility of aquifer (gpd per foot)
	T. 40 N., R. 10 E.—Continued															
38	SE¼NE¼ sec. 21	James Steffens	1946	84.1	39.2	8	Sand and gravel, fine to coarse.	do	0.9	7,553.0	7.71	Oct. 12, 1946	70	23.04	8	21,700
	T. 40 N., R. 11 E.															
39	NE¼SE¼ sec. 1	L. Linger	1946	103.4	51.3	8	Sand, fine to coarse; contains medium to coarse gravel.	do	1.6	7,554.7	5.77	June 2, 1946	53		10	16,200
40	SW¼SW¼ sec. 6	Alamosa County	1946	179.5	62.3	8	Sand and gravel, very fine to very coarse.	do	1.4	7,535.2	6.09	May 6, 1946	131	34.59	24.1	27,700
41	NW¼NW¼ sec. 9	do	1946	194.2	66.3	8	Sand, fine, to coarse gravel.	do	1.4	7,535.1	6.48	May 23, 1946	144	12.82	10.7	23,700
42	NE¼NE¼ sec. 10	do	1946	201.7	70.7	8	Sand, medium to very coarse.	do	.6	7,533.9	3.86	May 27, 1946	134	26.12	17	[2]73,500
43	SW¼SE¼ sec. 15	do	1946	123.5	54.9	8	Sand, very fine, to medium gravel.	do	1.3	7,530.0	7.13	June 24, 1946	78	31.73	21	23,200
44	SW¼NW¼ sec. 19	Alamosa County	1946	85.9	46.8	8	Sand and gravel, very fine to very coarse.	Top of casing	1.4	7,539.2	7.90	Oct. 4, 1946	90		8.7	19,300
45	SE¼SE¼ sec. 22	do	1946	100.3	50.5	8	Sand and gravel, fine to coarse.	do	1.1	7,527.1	6.24	Sept. 27, 1946	94	27.76	8	53,300
46	SW¼SW¼ sec. 32	J. Crow	1946	100.0	39.4	8	Sand, very fine, to coarse gravel.	do	2.0	7,534.6	5.91	Aug. 14, 1946	85		11	14,700
47	SE¼SE¼ sec. 35	Alamosa County	1946	95.5	47.4	8	do	do	1.2	7,524.5	5.36	June 29, 1946	102	16.21	24.5	21,000

	T. 40 N., R. 12 E.														
48	SW¼SW¼ sec. 32	do	1946	63.3	48.0	8	Sand, very fine to coarse	do	1.5	7,534.4	7.88	Aug. 30, 1946	92	22.32	10	16,000
	T. 41 N., R. 8 E.															
41-8-10cc	SW¼SW¼ sec. 10	Adolph Coors			80	16	Sand and gravel, fine to very coarse.	Hole in casing, north side.	.0	7,613.0	2.31	Aug. 7, 1948	1,400		28	319,000
	T. 41 N., R. 9 E.															
49	NE¼NE¼ sec. 1	J. Gariatakis	1949	62.0	50.0	6	Sand and gravel, very fine to coarse.	Top of casing	.9	7,549.5	3.81	Sept. 29, 1949	83	28.06	26.6	59,900
41-9-23ca	NE¼SW¼ sec. 23	Alice Fogal			32.0	14	Sand and gravel, fine to coarse.	Top of casing, east side.	−2.5		.29	Oct. 5, 1948	412		9.5	39,900
	T. 41 N., R. 10 E.															
50	SW¼SW¼ sec. 7	Saguache County	1949	62.0	50.0	6	Sand and gravel, very fine to coarse.	Top of casing	1.1	7,554.7	4.82	Oct. 4, 1949	94	7.66	70	33,800
(51)	SW¼NW¼ sec. 26	do	1946	95.8	46.4	8	do	do	1.8	7,542.0	7.24	Oct. 6, 1946	90		9	36,200
52	NW¼NW¼ sec. 29	do	1946	96.8	40.9	8	Sand and gravel, fine to coarse.	do	1.1	7,551.5	5.09	Oct. 10, 1946	107	12.45	9	50,400

1 Estimated on basis of specific capacity.
2 Determined by Theis recovery method.

TABLE 7.—*Analyses of water from typical wells*

Depth: Measured depths are given in feet and tenths of a foot; reported depths are given in feet.
SAR: Sodium-adsorption ratio.
Hardness as $CaCO_3$: Total hardness was calculated from calcium and magnesium where these constituents are reported; hardness was determined by the soap method where calcium and magnesium are not reported.
(Dissolved constituents are given in parts per million. One ppm is equal to 8.33 pounds of substance per million gallons of water.)

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
3 -8-2 dc	60	May 2, 1940	54		0.3		92	13		11	94		170	37		1.2		370	283		8
3 -9-1 ac	60	Apr. 21, 1948	54	241	1.0	65	28	3.2		21	106		33	5.0		0		207	83	0	35
6 bc	160	Apr. 8, 1949	53	244	.9	61	34	3.4		21	122		37	2.5		2.4		221	99	0	31
16 cc	642	Apr. 8, 1949	58	220	.6	60	30	2.8		12	78		42	2.5		2.0		190	86	22	23
7 cc	748	Apr. 8, 1949	61	236	.4	65	33	4.0		10	65		61	2.0		1.7		209	99	46	19
13 aa	10.4	Oct. 31, 1949	56	2,560	1.4					127	156		1,460	55					1,450	1,320	16
13 aa	10.4	Nov. 29, 1949		2,450																	
37-8-14 bb	10.5	Oct. 31, 1949	58	1,430	3.0	27				150	380		347	87					468	156	41
14 bb	10.5	Nov. 29, 1949		1,280							342										
35 cc	39	Oct. 31, 1949	52	401	.6					16	138		51	16					153	40	19
35 cc	39	Nov. 29, 1949	52	387	.9					25	127		51	16		30			150	46	26
37-9-1 aa	10.1	Aug. 30, 1949	63	1,410	7.8	56				244	364		359	30					185	0	74
15 dc	1,400	Aug. 21, 1949	82	181	1.6					24	104		5.6	2					41	0	56
17 aa	8.2	Aug. 31, 1949	62	8,270	31.	42				1,910	670		2,970	875					720	171	85
17 aa	8.2	Nov. 29, 1949		8,580							730										
32 ac2	500	Aug. 31, 1949	59	230	.6					12	108		22	3					90	2	22
32 dd	9.3	Aug. 31, 1949	62	791	.9					40	202		242	9					342	176	20
32 dd	9.3	Nov. 29, 1949		1,060	3.6					143	221		392	10		2.5			295	114	51
37-10-10 bb	760	June 24, 1936	72	244	4.2	108	9.2	1.3	52	2.3	113	19	7.7	2.1	1.3			259			80
10 bb	760	Sept. 25, 1936	73	240		89									.9				224		
11 cc	1,802	Apr. 9, 1951	98	265	2.8	117	5.4	6.8	42	8.8	116	13	15	3.5	3.2	.5	0.07		41		63
19 cc	8.7	Aug. 31, 1949	56	1,360	1.4					77	268		489	31					604	384	22
19 cc	8.7	Nov. 29, 1949		921	2.6					107	173		341	28		9.9			311	169	43
37-11-3 dd	9.2	Aug. 30, 1949	56	456	5.3					82	112		88	28					45	0	80
3 dd	9.2	Nov. 29, 1949		540							140										
37-12-6 bb	6.3	Aug. 28, 1946		980	13.0		11	7.6		227	338		147	80	2.3	3.8	.09	645	58	0	89
6 bb	6.3	Nov. 18, 1946	48	929							264		240	21	2.4		.11				

38-8-5 cb	40	Apr. 7, 1949	51	385	.8	47	46	5.7	22	187		20	5.0		5.6		243	138	0	25
38-11-1 cc	10.5	Aug. 27, 1946		23,000						620										
1 cc	10.5	Nov. 30, 1948	52	17,400						102		4,510	4,420							
1 cc	10.5	Jan. 20, 1949	47	17,400						453		4,210	4,320							
1 cc	10.5	Mar. 8, 1949	46	17,900						552										
1 cc	10.5	Apr. 14, 1949	45	18,000	20	20	936	562	3,100	505		4,440	4,510				13,800	4,650	4,230	59
1 cc	10.5	June 2, 1949	50	17,100						312		4,200	4,300							
1 cc	10.5	July 20, 1949	64	16,000						360										
1 cc	10.5	Nov. 28, 1949		17,300																
1 cc	10.5	Mar. 17, 1950	48	18,500	16	16			2,640	566		4,370	4,100					5,060	4,600	53
2 bb	9.1	Aug. 27, 1946		10,600	28		316	133	2,380	1,290		2,060	2,340	0		.55	7,860	1,340	278	79
2 bb	9.1	Nov. 18, 1946	54	10,600						1,350										
12 dd	16.2	Feb. 17, 1950	48	17,800	18	17			2,910	516		4,340	4,470					4,920	4,500	56
14 aa	30.2	July 26, 1946		1,810	8.5				291	502		200	163	.7		.09		219	0	74
14 aa	30.2	Aug. 8, 1946	55	1,910	17				424	1,050		50	87	2.4		.91		120	0	88
25 aa	7.8	Aug. 28, 1946		20,200						2,140	1,010									
25 aa	7.8	Nov. 25, 1946	46	10,400						1,430										
25 aa	7.8	Nov. 30, 1948	46	4,870						275	13									
25 aa	7.8	Jan. 20, 1949	40	4,700						390										
25 aa	7.8	Apr. 14, 1949	44	4,830	47		39	5.0	1,170	395		1,990	195		1.3		3,590	118	0	96
25 aa	7.8	June 2, 1949	57	5,020						372		2,010	210					322		
25 aa	7.8	July 20, 1949	67	5,320		18				490			230							
25 aa	7.8	Nov. 28, 1949		5,780																
25 aa	7.8	Feb. 7, 1950	42	6,130	43	19			1,480	675		2,430	255		2.1			220	0	94
25 aa	7.8	Mar. 17, 1950	44	5,590	40	24			1,320	630		2,180	215		.6			212	0	93
25 bb	23.3	Aug. 14, 1946		1,450	5.6	32	88	20	222	212		413	127	.6	.5	.36	1,010	302	128	62
26 bb	8.6	Nov. 25, 1946	54	388	1.5		38	7.2	38	197		27	11	1.0		.04	219	124	0	40
26 bb	8.6	Aug. 27, 1946		645	2.4		42	9.4	65	226		53	30	1.2	0	.09	312	144	0	50
34 dd	8.8	Aug. 28, 1946		1,120	7.4		47	9.8	215	284		334	28	2.2	0	.36	776	158	0	75
34 dd	8.8	Nov. 25, 1946	54	875	9.9	42	18	5.2	182	224		188	57	.7		.02	603	66	0	86
35 bb	11.0	Aug. 27, 1946		762	14		14	3.9	227	400		128	55	2.3	0	.18	627	51	0	91
36 bb	5.8	Nov. 30, 1948		386						108										
36 bb	5.8	June 2, 1949	58	440						88		60	47					75		
36 bb	5.8	July 20, 1949	70	477						108		67	47							
36 bb	5.8	Nov. 28, 1949		645						98		62								
36 bb	5.8	Feb. 17, 1950	40	612	7.8	19			118	126		112	56		0			43	0	86
36 bb	5.8	Mar. 17, 1950	46	697	9.4	26			137	145		126	62		0			40	0	88
38-12-1 cc	250	Oct. 29, 1936	55	93	.3	20	14	.8		53		3.4	.7		.6		70			21
1 cc	250	Apr. 21, 1948	45	92	.6	24	14	.5	8.7	58		5.3	1.8		.5		83	37	0	34
1 cc	250	Dec. 1, 1948	53	100						64										
2 bb	200	Apr. 21, 1948	54	121	.5	35	18	1.3	8.7	62	5.9	7.4	.8		0		108	50	0	27
2 cc	200	Apr. 21, 1948	55	95	.6	29	14	1.3	8.3	42		5.1	3.5		.4		90	40	0	31
2 cc	200	Dec. 1, 1948	56	97						62										

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
38-12-11 bb	200	Apr. 21, 1948	55	89	0.4	33	12	2.6		5.5	32	12	5.3	0.5		0.8		87	40	0	23
15 ad	200	Apr. 21, 1948	55	86	.7	28	11	1.3		9.9	32	12	6.4	1.2		.6		86	33	0	39
30 cc	7.0	Aug. 28, 1946		682	8.8					182	248	37	150	40			0.55		81	0	83
30 cc	7.0	Nov. 18, 1946	52	762	9.5					165	387		51	17	0.8				57	0	86
31 cb	6.3	Aug. 28, 1946		1,170	11		38	5.7		265	226		427	45	.6	0	.91	893	118	0	83
39-7-13 bb	40.5	Nov. 12, 1947	55	408	1.9	30				42	200		5	8.8					90		50
13 bb	40.5	Aug. 15, 1948	64	135	.8		16	2.7		13	80		10	2.0				83	51	0	35
39-8-17 bb	29.5	Nov. 12, 1947	53	369	1.6	41				36	188		16	6.0					100		44
17 bb	29.5	Mar. 12, 1948	44	343							172								153	12	
17 bb	29.5	Apr. 5, 1949	38	129		25					84		10	1.5							
17 bb	29.5	Aug. 4, 1949	48	330	.9	39				22	164		15	6	.4				112		30
17 bb	29.5	Aug. 25, 1949	50	313							159										
17 bb	29.5	Nov. 15, 1949	51	396							193										
18 ba	33.7	Nov. 12, 1947	55	349	.6	39				16	168		7	5.2					117		23
18 ba	33.7	Mar. 12, 1948	45	342							162										
18 ba	33.7	Aug. 4, 1948	58	329	1.4	36				31	158		20	6	.4				92		42
18 ba	33.7	Nov. 15, 1948	49	353							184										
18 ba	33.7	Apr. 5, 1949	48	330							174										
18 ba	33.7	Aug. 25, 1949	49	313							158										
18 ba	33.7	Nov. 15, 1949		316																	
39-9-1 aa	9.6	Aug. 2, 1948	63	331	.6	37				17	194		8	6	.4				140		21
1 aa	9.6	Nov. 15, 1948	50	283							170										
1 aa	9.6	Apr. 5, 1949	45	194							112		6.9	3.0							
1 aa	9.6	Aug. 25, 1949	61	221							136										
1 aa	9.6	Nov. 16, 1949		262																	
1 dd	9.4	Mar. 11, 1948	41	709	4.9	17				124	168		160	26					122		69
1 dd	9.4	Aug. 2, 1948	64	643	7.0	7.3				132	182		118	22	.7				68		81
1 dd	9.4	Nov. 15, 1948	53	678							220	12									
1 dd	9.4	Apr. 5, 1949	46	968	3.7	24	72	16		134	300		232	33		2.8		662	246	0	54
1 dd	9.4	Aug. 25, 1949	60	1,020							296										
1 dd	9.4	Nov. 6, 1949		1,230							264										
2 aa	9.3	Mar. 12, 1948	45	311	1.3		26	9.5		30	168		21	6	.4	.5		176	104	0	39

3 bb	9.6	Sept. 13, 1948	64	731	5.8	24	30	4.7	129	166		165	48				482	94	0	75
3 dd	9.9	Sept. 3, 1948	67	512	2.5	5.9			62	64		138	39					117		53
4 cc	30.0	Sept. 10, 1948		390	.5				15	162		35	11					152		18
4 cc	30.0	Sept. 14, 1948	59	254	.6				14	118		20	5.8					94		25
4 dd	9.7	Nov. 16, 1936	55	566	6.7		17	3.9	118	311		33	14		3.1		415			81
4 dd	9.7	Mar. 12, 1948	42	818	7.1	7.0			157	401	3.6	29	9	.6				92	0	79
4 dd	9.7	Aug. 4, 1948	62	871	14	23			197	506	9.8	20	8	.8				38		92
4 dd	9.7	Nov. 15, 1948	53	1,010	7.3	40	40	11	202	574	16	35	12		43		682	145	0	75
4 dd	9.7	Apr. 5, 1949	47	1,050						606		40	10		50					
4 dd	9.7	Aug. 25, 1949	62	788						496								32	0	
4 dd	9.7	Nov. 16, 1949		860																
10 cc	9.8	Mar. 12, 1948	40	455	5.5	6.3			90	138	37	50	14					51		79
10 cc	9.8	Sept. 3, 1948	68	369	1.5				36	150		49	13					114		41
10 dd	9.9	Sept. 3, 1948	68	427	3.6		20	4.4	68	104		95	22				261	68	0	68
11 aa	5.6	Nov. 12, 1947	48	647	8.3	18			133	384		9	10					48		86
11 aa	5.6	May 12, 1948		511	8.8	29	9.0	2.6	116	288		36	6	1.4	.4	.04	342	33	0	88
11 aa	5.6	Aug. 4, 1948	65	884	7.8				184	433		125	13	.9				106		79
11 aa	5.6	Nov. 15, 1948	50	905						502										
11 aa	5.6	Apr. 5, 1949	44	867	7.5	36	26	9.2	175	446		88	17		4.2		575	103	0	79
11 aa	5.6	Aug. 25, 1949	65	801	6.9	56			150	418		43	21					90	0	78
11 aa	5.6	Nov. 16, 1949		781																
11 dd	9.0	Sept. 3, 1948	67	659	3.4	17	44	8.6	94	198		143	28				432	146	0	58
12 dd	9.9	Mar. 12, 1948	40	771	4.9	17			135	254		179	28					141		68
12 dd	9.9	Aug. 2, 1948		1,040	6.0	8.9	44	14	179	260		258	53				685	168	0	70
12 dd	9.9	Nov. 15, 1948	51	1,790	5.4	32	124	34	262	441		497	99		.2		1,270	450	88	56
12 dd	9.9	Apr. 5, 1949	42	1,110						314		282	51							
12 dd	9.9	Aug. 30, 1949	65	997						362										
12 dd	9.9	Nov. 15, 1949		1,220						342										
13 dd	6.9	Mar. 12, 1948	38	1,030	5.1	12			163	170		313	56					190		65
20 aa	10.0	Sept. 13, 1948	64	786	1.3		92	18	54	152		220	48				507	304	179	28
20 bb	9.6	Sept. 13, 1948	65	488	2.2		34	9.9	58	114		113	28				299	126	32	50
22 aa	8.6	Sept. 3, 1948	67	1,800	11	35			373	516		454	87					207		80
22 cc	9.9	Mar. 12, 1948		349	.5		42	10	15	125		57	11	.2	.3		197	146	44	18
22 cc	9.9	Aug. 4, 1948	60	624	1.9	20			61	102		169	44	.3				190		41
22 cc	9.9	Nov. 15, 1948	51	347	1.2	15	31	7.9	28	99		62	18		.6		211	110	29	36
22 cc	9.9	Apr. 5, 1949	40	243						96		37	5.5							
23 cc	10.0	Sept. 3, 1948	62	1,240	3.4	27	102	22	147	104		421	100				870	345	260	48
23 cc	10.0	Aug. 30, 1949	58	1,370						170										
24 cc	9.9	Dec. 9, 1948	47	889						268										
24 dd	9.0	Mar. 12, 1948	39	733	3.4	19			97	302		70	31					153		58
26 cc	8.0	Sept. 3, 1948	62	1,610	4.0	14	136	30	198	56		585	170				1,160	463	417	48
26 dd	8.8	Sept. 3, 1948	60	806	5.4	19			134	282		114	42					118		71
30 ab	28.2	Nov. 18, 1948	51	782						538										

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
39-9-35 cc	8.0	Sept. 3, 1948	60	484	3.0		29	7.6		70	236		48	8				279	104	0	59
36 dd	8.4	Aug. 31, 1948	64	2,080	12	8.8				360	114		674	130					176		82
39-10-22 dd	9.6	Dec. 7, 1948	51	1,550							316	15									
25 aa	9.9	Nov. 15, 1946	54	1,590							352	30									
25 aa	9.9	Nov. 30, 1948	53	1,290							436										
25 aa	9.9	Jan. 20, 1949	50	1,320	22	32	10	2.6		307	412	18	268	37		4.2		882	36	0	95
25 aa	9.9	Mar. 8, 1949	46	1,340							422	43									
25 aa	9.9	Apr. 14, 1949	48	1,560							456										
25 aa	9.9	June 2, 1949	53	1,250							408		264	30					48		
25 aa	9.9	July 20, 1949	59	1,240							400										
25 aa	9.9	Nov. 23, 1949		1,240																	
25 aa	9.9	Feb. 13, 1950	44	1,310	20	49				289	431		258	33		1.1			41	0	94
32 dd	8.7	Dec. 7, 1948	52	1,370							292										
36 aa	10.0	Nov. 15, 1946	55	1,980							478	51									
39-11-1 bb	4.7	May 7, 1946	47	4,960							1,080	826			12	31	1.4				
1 dd	9.8	June 21, 1946	53	3,450	51	30	12	6.8		902	1,420	211	308	123	3.0	1.0	1.8	2,250	58	0	97
1 dd	9.8	May 12, 1948	58	2,440	49					681	1,795		9.9	25			1.4		36	0	98
1 dd	9.8	Dec. 1, 1948		1,380							770										
3 bb	48.9	Aug. 8, 1946	55	1,890	14					410	960	49	50	87	1.6		.91		156	0	85
4 cc	9.5	June 21, 1946	58	3,050	32	20	22	11		727	1,050		485	216	3.8	1.2	1.4	2,000	100	0	94
4 cc	9.5	Apr. 6, 1949	48	3,070							1,110										
6 aa	7.9	Mar. 28, 1946		1,270		34					710		20	39	1.6	1.0	.55				
6 aa	7.9	Apr. 16, 1946	43	1,270	9.4	32				259	704		27	68	2.0		.74		144	0	80
6 aa	7.9	Nov. 13, 1946	52	1,100							631										
6 dd	9.9	Dec. 1, 1948	53	895	3.3	39	60	23		118	442		105	21		.4		584	244	0	51
6 dd	9.9	Mar. 8, 1949	44	835	6.5	12	21	9.4		143	348	35	36	8		11		447	91	0	77
7 cc	10.0	Nov. 16, 1946	53	756							260		52	30							
7 cc	10.0	Nov. 30, 1948	51	308							175										
7 cc	10.0	Jan. 20, 1949	47	563	1.5	16	57	14		50	296		44	14		1.3		342	200	0	35
7 cc	10.0	Apr. 14, 1949	48	752	.7	22	84	28		30	379		55	14		3.9		424	324	14	17
7 cc	10.0	June 2, 1949	56	505							268		28	8					171		
7 cc	10.0	July 20, 1949	66	388							224		16	5.5							

7 cc	10.0	Nov. 23, 1949		302																
7 cc	10.0	Feb. 17, 1950	43	365	1.0	25			26	188		22	6		4.1			132	0	30
7 cc	10.0	Mar. 17, 1950	46	357	.6	26			18	192		20	6		.2			148	0	21
7 dd	9.9	Nov. 15, 1946	50	1,790						248	71	24	41							
9 aa	9.5	June 21, 1946	54	5,250	97	20	9.0	5.0	1,460	1,370	875	247	250	11	1.1	1.8	3,560	43	0	99
9 aa	9.5	Nov. 15, 1946	49	3,320						2,090										
9 cc	10.0	Nov. 15, 1946	55	2,080						1,070										
9 dd	9.4	Mar. 12, 1948	34	3,930	166	9.7			1,080	2,180	162	41	169	10		2		8	0	100
9 dd	9.4	May 13, 1948	51	3,180	89				867	1,850	84	38	134	7		1.2		18	0	99
10 aa	11.5	June 21, 1946	51	15,200						4,740	1,040			12		1.4				
11 bd	10.4	June 21, 1946	53	3,190	106				772	915	246	300	145	4.6		1.4		10	0	99
12 cc	7.8	Sept. 26, 1946		3,020	91				931	450	502	600	152			1.4		20	0	99
13 cc	10.0	Aug. 26, 1946		19,500						5,730	2,350									
13 cc	10.0	Nov. 13, 1946	55	22,500						7,310	325									
14 cc	8.0	July 17, 1946	58	10,020						3,710	305			8.0		1.8				
14 cc	8.0	Nov. 30, 1948	50	9,700						3,580	167									
14 cc	8.0	Jan. 20, 1949	47	9,820		21				3,620	167		200							
14 cc	8.0	Apr. 14, 1949	45	10,100	127	21	3.5	22	2,910	4,000	54	1,910	755		2.2		7,650	99	0	98
15 aa	10.0	Nov. 15, 1946	51	11,800						4,320	806									
15 cc	9.9	Nov. 15, 1946	54	4,820						2,480	334									
16 cc	10.0	Nov. 15, 1946	53	2,210						845	59									
18 cc	9.9	Nov. 15, 1946	53	401	5.3	8.8	10	5.2	83	220		37	5	.6			258	46	0	80
19 aa	9.5	Nov. 15, 1946	56	5,020						444			460							
19 aa	9.5	Mar. 11, 1948	45	4,740	18		138	45	934	199		1,700	444	.2	.4		3,360	530	366	79
19 aa	9.5	Sept. 22, 1948	60	4,760						108										
21 cc	9.9	Nov. 15, 1946	54	1,480						448	112									
23 cc	8.3	Nov. 11, 1936		13,100	194	10	12	10	3,750	4,830	580	1,840	976	10	.6	5.7	9,570			99
23 cc	8.3	July 17, 1946	57	13,800						4,640	787			12		1.8				
25 cc	9.4	Nov. 18, 1946	54	25,600						7,120										
25 cc	9.4	Aug. 27, 1946		24,000						6,300	1,110									
25 dd	9.8	Nov. 30, 1948	54	1,390						680										
25 dd	9.8	Jan. 20, 1949	51	1,370	22	28	10	4.4	327	722		65	64		4.4		858	43	0	94
25 dd	9.8	Apr. 14, 1949	48	1,320						670										
25 dd	9.8	June 2, 1949	55	1,380						656		108	58					22		
32 bb	17.7	Nov. 15, 1946	54	2,910						1,500	197									
39-12-2 bb	4.2	May 13, 1946	50	824	2.4	50	69	27	93	504		51	12	.8	0		551	283	0	42
2 bb	4.2	Nov. 13, 1946	47	917	3.4	39	64	23	126	564		28	25	.8	0	.04	634	254	0	52
6 dd	8.5	Nov. 13, 1946	54	1,040						458										
6 dd	8.5	June 21, 1946	58	882	4.3	31	56	9.4	132	400		101	22	.4	0	0	549	178	0	62
18 bb	9.8	June 21, 1946	53	1,380	11	32	28	11	279	428		242	84	.3	.1	.36	887	115	0	84
18 bb	9.8	Nov. 13, 1946	56	1,390						236		200	142							
19 ad	9.5	June 21, 1946	57	1,030	7.6	41	35	9.6	196	458		128	31	.7	0	.36	667	127	0	77
19 ad	9.5	Nov. 13, 1946	54	1,020						380										

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
39-12-19 bb	8.7	June 21, 1946	56	6,220	103				1,570		2,180		700	450	2.5		0.91		44	0	99
19 bb	8.7	Nov. 13, 1946	54	4,460							1,780	64									
19 bb	8.7	Nov. 30, 1948	52	1,930							772										
19 bb	8.7	Jan. 20, 1949	45	3,410	34						1,310	39		225							
19 bb	8.7	Mar. 8, 1949	42	3,320							1,850	65									
19 bb	8.7	Apr. 14, 1949	45	4,080	160	34	1.0	1.5	1,070		1,590	63	500	292		5.5		2,750	8	0	100
19 bb	8.7	June 2, 1949	55	4,790							1,780	89		345							
19 bb	8.7	July 21, 1949	60	4,060							1,520	63		305							
19 bb	8.7	Nov. 25, 1949		2,090							880										
19 bb	8.7	Feb. 17, 1950	42	2,590	65	34				668	1,010	69	275	172		.7			20	0	99
19 bb	8.7	Mar. 17, 1950	46	2,190	67	33				600	1,030		240	160		.3			15	0	99
29 bd	8.8	Aug. 26, 1947		928	4.2		58	12		133	350		132	42	0	0	.09	549	194	0	60
31 cc	13.3	Aug. 27, 1946		7,780							2,350	393	1,000	665							
32 ca	9.3	Aug. 26, 1946		5,840							2,070	393	1,000	172							
40-6-2 dd	27.3	Nov. 4, 1947	55	174	.3	24	25	3.4		6.0	98		7	1.0				115	76	0	15
2 dd	27.3	Sept. 15, 1948	62	161							96		9	1.2							
2 dd	27.3	Nov. 16, 1948	53	252	.3	24	40	6.9		9.0	162		11	2.5		.7		174	128	0	13
2 dd	27.3	Apr. 4, 1949	42	177							97										
14 cc	106.9	Nov. 4, 1947	53	167	.1	29				2.5	90		3	2.2					74		7
16 cc	22.4	Nov. 4, 1947	54	219	.5	32				12	128		9	2.0					92		22
16 cc	22.4	Sept. 15, 1948	57	154							92		10	1.0							
16 cc	22.4	Nov. 16, 1948	53	201							122										
16 cc	22.4	Apr. 4, 1949	50	208							129										
16 cc	22.4	Aug. 26, 1949	55	169							94										
16 cc	22.4	Nov. 22, 1949		203																	
40-7-1 cc	104	Nov. 4, 1947	55	237	.1					1.6	136		18	4.0					132		3
1 cc	104	Mar. 11, 1948	47	252	.2					4.6	140		18	2.0					126		7
1 cc	104	Aug. 16, 1948		179	.8	28	20	4.0		15	108		6	2	.8			129	66	0	33
1 cc	104	Nov. 16, 1948	53	325	.7	34	43	8.2		19	201		12	2.5		1.6		219	141	0	23
1 cc	104	Apr. 4, 1949	43	291		29					144										
1 cc	104	Aug. 26, 1949	65	235	.6	33	28	6.3		14	152		1.6	.5		.4		159	96	0	24
1 cc	104	Nov. 22, 1949		268																	

6 cd	20	Nov. 4, 1947	53	166	.9	8.6			18	112		12	2.0	0				69		36
6 cd	20	Mar. 10, 1948	49	209	.6				12	126		7	1.5					87		23
6 cd	20	Aug. 16, 1948		349	1.6				36	213		2	1.0					99		44
6 cd	20	Nov. 16, 1948	50	231						142										
6 cd	20	Apr. 4, 1949	52	246	1.1	16	30	3.4	24	154		10	2.5		.7		162	89	0	37
6 cd	20	Aug. 26, 1949	55	237						138										
9 aa	27.2	Nov. 4, 1947	55	308	.9	39			21	158		8	3.0					96		32
9 aa	27.2	Mar. 10, 1948	46	297	.4				11	160		18	2.5					129		16
9 aa	27.2	Aug. 16, 1948		328	.8				21	193		3	1.5					117		28
9 aa	27.2	Aug. 29, 1949	66	322						186										
9 aa	27.2	Nov. 22, 1949		295																
13 dd	20.3	Nov. 4, 1947	57	340	1.7	39			36	166		20	7.2					88		47
13 dd	20.3	Mar. 11, 1948	43	324	.2	33			5.1	156		20	7.0					148		7
13 dd	20.3	Aug. 2, 1948	54	569	1.3	37			35	168		40	30	.6				147		34
13 dd	20.3	Nov. 16, 1948	53	351						165										
13 dd	20.3	Apr. 4, 1949	48	266	.8	32	34	4.9	18	152		13	1.0		6.9		185	105	0	28
13 dd	20.3	Aug. 29, 1949	59	599	1.3	36	60	12	43	222		42	37		18		357	199	17	32
13 dd	20.3	Nov. 17, 1949		375																
14 cc	72	Nov. 4, 1947	53	232	.6	33			13	118		12	2.0					84		25
14 cc	72	Mar. 11, 1948	48	295	.8				19	152		20	2.8					108		28
14 cc	72	Aug. 2, 1948	62	132	.6	30	16	2.4	9.4	76		4	2	.4			102	50	0	29
14 cc	72	Nov. 16, 1948	51	309						152										
14 cc	72	Apr. 5, 1949	47	254	1.9	30	34	3.4	44	152		55	3.0		9.7		254	99	0	49
14 cc	72	Aug. 26, 1949	62	121						61										
18 dc	21.5	Nov. 4, 1947	50	234	1.1	14			22	134		6	2.0					72		39
21 aa	17.2	Nov. 4, 1947	52	198	.5	36	24	3.2	9.4	100		3	2.0	.2	6.4	0	134	73	0	22
25 ab	24	Nov. 5, 1947	52	328	1.1				29	174		32	6.5					123		34
25 ab	24	Aug. 15, 1948	63	325	1.0		37	7.1	26	160		35	7.2				191	122	0	32
25 ab	24	Apr. 4, 1949	42	321						162										
25 ab	24	Aug. 26, 1949	69	535	.7				24	243		42	17					214	15	20
25 ab	24	Nov. 22, 1949	51	345	.8	32			22	165		24	8		11			133	0	26
30 cb	88.7	Nov. 18, 1948	54	319						180										
40-8-1 bc[1]	33.3	Nov. 2, 1948		323						147										
16c[2]	33.3	Nov. 3, 1948		323						150										
3 cc	69.9	Nov. 4, 1947	57	254	.3	38			7.1	112		7	7.0					94		14
3 cc	69.9	Mar. 11, 1948	52	276	.1	37			3.0	136		20	6.5					135		5
3 cc	69.9	Aug. 16, 1948		94	.6		11	1.1	8.0	53		5	.8				52	32	0	35
3 cc	69.9	Nov. 16, 1948	57	153	.4	34	19	4.6	8.0	81		12	2.5		1.7		122	66	0	21
3 cc	69.9	Apr. 5, 1949	52	281	.9	31	32	5.2	21	127		25	5.5		11		193	102	0	31
3 cc	69.9	Aug. 29, 1949	64	123						64										
3 cc	69.9	Nov. 17, 1949		179						86										
4 bc	34.9	Nov. 4, 1947	57	175	.1	39			2.8	96		6	1.8					81		
4 bc	34.9	Mar. 11, 1948	48	181	.1				1.6	90		15	3.2					90		

See footnotes at end of table.

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$		Percent sodium
																			Total	Noncarbonate	
40-8-4 bc	34.9	Sept. 15, 1948	63	192							118		5	1.2							
4 bc	34.9	Nov. 16, 1948	55	157							89										
4 bc	34.9	Apr. 5, 1949	45	185							100										
4 bc	34.9	Aug. 26, 1949	60	211							135										
4 bc	34.9	Nov. 21, 1949		197																	
5 cc	28.1	Nov. 4, 1947	51	330	0.7					19	152		44	8.2					141		23
5 cc	28.1	Mar. 11, 1948	48	309	.2					4.8	146		25	6.5					144		7
5 cc	28.1	Sept. 22, 1948	59	291							144										
5 cc	28.1	Nov. 16, 1948	50	300							133										
5 cc	28.1	Apr. 5, 1949	51	296							142										
19 cb	31.2	May 1, 1940			.5		27	3.8		10	108		12	2		2.0		110	83		21
31 ac	83	May 1, 1940			.4		30	5.5		8.2	110		15	2		8.3		123	98		15
40-9-2 dd	10.0	Sept. 1, 1948	63	1,130	5.5	15	46	21		181	360		204	63				707	202	0	66
5 dc	34.6	Nov. 4, 1947	52	519	.4					14	218		44	20					222		12
5 dd	8.2	Mar. 11, 1948	39	668	5.9	31				126	236		105	41					87		76
5 dd	8.2	Aug. 4, 1948	68	756	5.5	63				136	366		78	19	0.6				114		72
5 dd	8.2	Nov. 15, 1948	59	579	2.2	6.7	42	18		67	293		57	17		.7		353	179	0	45
5 dd	8.2	Aug. 25, 1949	64	511	2.7	21				69	246		45	16					120	0	56
5 dd	8.2	Nov. 17, 1949		640																	
6 dc	29.5	Nov. 4, 1947	56	343	1.0	45				24	174		6	6.5					106		33
6 dd	9.9	Mar. 11, 1948	41	341	1.3	7.4				32	150	9.8	30	10					116		37
6 dd	9.9	Aug. 4, 1948	65	214	.6		26	5.2		12	130		2	2.0				111	86	0	22
6 dd	9.9	Nov. 15, 1948	54	216							133		6.0	3.0					87		27
6 dd	9.9	Mar. 5, 1949	44	628							324		51	16							
6 dd	9.9	Apr. 5, 1949	48	276	.6	8.7	34	8.3		15	170		8.6	20		.6		161	119	0	22
6 dd	9.9	Aug. 25, 1949	63	238							148										
6 dd	9.9	Nov. 17, 1949		286							176										
11 bc		May 13, 1948	60	215	3.5					40	96	7.9	17	2			0		24	0	79
11 bc		May 13, 1948	71	158	2.5					28	85		14	2			.05		24	0	72
11 bc	600	Nov. 4, 1947	72	154	2.4	77				29	58	14	14	2.2	.4		.01		27		70
11 bc	600	Dec. 9, 1948	72	152							89										
11 cc	8.9	Sept. 13, 1948	66	360	2.4					51	224		9	4.0					87		56

11 dd1	8.0	Sept. 1, 1948	62	531	.9		62	14	29	144		104	34				314	212	94	23
12 dd2	9.9	Mar. 12, 1948	42	2,080	15				428	381		543	143					148	0	86
12 dd2	9.9	Aug. 2, 1948	64	514	2.2	8.1			59	118		116	32	.7				136		49
12 dd2	9.9	Nov. 15, 1948	53	2,750	8.5	36	132	49	451	236		947	235		1.0		1,970	531	338	65
12 dd2	9.9	Apr. 6, 1949	40	2,340	10	33	94	29	450	226		837	195		.7		1,750	354	168	73
12 dd2	9.9	Aug. 29, 1949	54	1,160						544		169	34							
12 dd2	9.9	Nov. 17, 1949		2,260																
14 cc	10.0	Sept. 13, 1948	63	530	1.2		62	11	38	126		113	44				330	200	96	29
14 dd	9.8	Sept. 3, 1948	63	3,710	6.7	28	323	76	515	112		1,330	540				2,870	1,120	1,030	50
17 cc	73.8	Aug. 24, 1936	59.5	318	1.0	37	33	7.0	25 | 5.8	67.5		35	12		0		222			36
17 dd	9.3	Mar. 13, 1948	41	567	6.1				106	227	29	33	13					58	0	80
18 cc	40	Nov. 4, 1947	55	353	1.8	41			40	170	18	6	4.0					93		49
19 dd	9.9	Sept. 14, 1948	59	984	4.7	38			153	356		174	41					198		63
20 dd	9.6	Sept. 13, 1948	59	491	1.5		50	9.8	45	174		76	30				296	166	23	37
21 dd	9.9	Mar. 13, 1948	41	986	1.5		114	20	67	186		236	79	.5	.5		609	366	214	28
21 dd	9.9	Sept. 22, 1948	62	241						145										
25 dd	9.9	Aug. 31, 1948	66	440	2.2		29	12	56	276		14	3				250	122	0	50
26 bb	9.2	Sept. 3, 1948	67	891	4.8	13	50	8.0	138	134		246	66				587	158	48	66
26 dd	9.6	Sept. 3, 1948	63	1,520	3.9	19	126	27	185	152		475	148				1,050	426	301	49
26 dd	9.6	Nov. 16, 1949		2,090	3.6				218	179		682	217		.7			688	542	41
27 cc	8.8	Mar. 15, 1948	45	752	3.7		52	11	113	135		226	50	.3	2.5		521	174	64	58
27 cc	8.8	Aug. 4, 1948	56	788						138										
27 cc	8.8	Nov. 15, 1948	49	887						136										
27 cc	8.8	Apr. 5, 1949	41	1,010	3.6	10	74	13	130	132		266	96		.9		655	238	130	54
27 cc	8.8	Aug. 25, 1949	57	785	1.9				69	130		184	70					246	140	38
27 cc	8.8	Nov. 16, 1949		879																
32 bb	9.9	Sept. 14, 1948	59	458	2.9	26	30	7.8	68	228		48	13				305	107	0	58
32 cc	44.7	Sept. 14, 1948	60	428	.7		57	9.7	22	176		60	17				252	182	38	21
35 cc3	9.3	Sept. 3, 1948	65	634	2.3	32	56	10	70	170		137	36				425	180	41	46
35 cc3	9.3	May 12, 1948	49	542	1.4	21	57	9.4	44	130		117	33	0	1.3	0	347	180	74	35
35 cc3	9.3	Nov. 15, 1948	54	617						157										
35 cc3	9.3	Apr. 5, 1949	46	642						152		145	37							
35 cc3	9.3	Aug. 25, 1949	62	572						142										
35 cc3	9.3	Nov. 16, 1949		556																
40-10-1 gg	6.5	Feb. 21, 1941		1,390	28	43	9.2	.7	328	404	20	284	45		.6		930	26		
1 bb	6.5	Nov. 14, 1946	53	2,660						1,610			80							
1 cd	8.4	Apr. 4, 1941		1,090	15		9.6	3.3	211								792			92
1 cd	8.4	Apr. 3, 1946	43	1,830	23		14	4.4	384	82		548	178				1,170	53	0	94
1 cd	8.4	Nov. 19, 1946	54	2,060						276		500	140							
1 dc	5.7	Feb. 21, 1941		1,040	14	45	10	4.9	219 | 9.4	382	13	284	45		.2		819			
1 dc	5.7	Nov. 6, 1941		1,270	10		31	11	260								900			82
1 dc	5.7	July 3, 1941		860	4.1		45	17	127											60
1 dc	5.7	Apr. 3, 1946	42	891	6.9		31	3.3	152	127		107	146				502	91	0	78

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na), Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
40-10-1 dd	6.8	Apr. 3, 1946	42	1,160	27	6.4			286	582	65	7	29	2.0	4.1	0.55		22	0	97
1 dd	6.8			831	16		7.6	1.3	184								544			94
1 dd	6.8	Nov. 19, 1946	54	1,400						580	138	22	25							
2 bb	7.9	Nov. 14, 1936		1,270	7.9		39	16	231	316		307	62		0		811			75
2 bb	7.9	Nov. 14, 1946	53	1,120						374		230	55							
3 cc	8.3	Apr. 4, 1946		1,770	7.1	21			293	384		316	225	1.5		.04		327	12	66
3 cc	8.3	Nov. 17, 1946		420						213		48	18							
6 aa	11.6	Nov. 14, 1946	53	1,010						356			40							
6 aa	11.6	Mar. 11, 1948	42	683	.8				27	202		66	33					222		21
6 aa	11.6	Aug. 2, 1948	57	930	5.6	50			164	336		168	45	.7				160		69
6 cc	9.6	Mar. 12, 1948	42	1,450	15	22			334	748		147	34	3.5		.1		98	0	88
6 cc	9.6	Aug. 2, 1948	71	667	6.5	8.8			134	336		65	18	1.0				80		78
6 cc	9.6	Nov. 15, 1948		940						590										
6 cc	9.6	Apr. 4, 1949	40	818						474										
6 cc	9.6	Aug. 25, 1949	64	755		19				410	18	24	10	4						
6 cc	9.6	Nov. 17, 1949		1,520						760										
9 cc	9.8	Nov. 18, 1946		543	3.7				84	303		24	6					99	0	65
9 cc	9.8	Mar. 11, 1948	42	510	2.4	24			62	262		18	18					123		52
9 cc	9.8	Aug. 2, 1948	65	292	.9	54			21	174		6	3.0					106		30
9 cc	9.8	Nov. 15, 1948	56	276						153										
9 cc	9.8	Apr. 4, 1949	46	394		42				242										
9 cc	9.8	Aug. 29, 1949	62	1,320						512										
9 cc	9.8	Nov. 17, 1949		1,610						604										
10 aa	7.2	Nov. 17, 1946	52	1,310						464										
11 aa	7.7	Apr. 4, 1946	42	789	7.5	18			141	331		44	36	2.0		.18		66	0	82
13 bb	8.8	Apr. 9, 1946	42	2,160	7.3	17			372	350		759	155			.18		486	199	62
13 bb	8.8	Nov. 17, 1946	54	1,920						182			111							
13 dd	8.0	Apr. 16, 1946	47	270	1.7				34	147		5	16					75	0	49
14 bb	6.1	Apr. 4, 1946	42	3,490	27	36			645	1,520		68	122	8.9		.91		110	0	93
14 bb	6.1	Nov. 17, 1946	53	426						279		40	3							
14 bb	6.1	Mar. 12, 1948	38	466	65				94	275		2.9	11					40		84
14 bb	6.1	Aug. 2, 1948	58	524	11	77			120	320		2	12	1.6				24		92

14 dd	10.0	Apr. 16, 1946	45	799	6.7	16	21	11	152	266		162	28	.3	.6		522	98	0	77
14 dd	10.0	Nov. 17, 1946	54	2,120						460	43		145							
15 bb	9.8	Apr. 4, 1946	44	432	1.4	44			39	226		2	21	2.0	0	0		138	0	38
15 bb	9.8	Nov. 19, 1946	50	340						207										
16 cc	10.1	Nov. 18, 1946		879	7.4				161	376	413	60	28					90	0	80
19 bb	9.0	Nov. 14, 1946	49	525	2.7	17	34	10	70	234		67	12	.1			325	126	0	55
19 bb	9.0	Mar. 11, 1948	39	447	.4				14	208		40	10					195		14
19 bb	9.0	Aug. 2, 1948	63	382	3.1	47			57	166		30	12	.4				62		66
19 bb	9.0	Nov. 15, 1948	52	499						218										
19 bb	9.0	Apr. 4, 1949	41	485		45				168										
19 bb	9.0	Aug. 29, 1949	62	1,630						620										
19 bb	9.0	Nov. 17, 1949		887						183										
22 dd	7.1	Apr. 9, 1946	41	467	1.5	11			43	133		86	36	.9	0	.18		159	50	37
22 dd	7.1	Nov. 16, 1946	50	346						170										
23 bb	6.8	May 13, 1946	47	1,270	3.8				148	212		350	49					285	112	53
23 dd	9.6	Apr. 16, 1946	45	717	2.2	28	73	20	83	419		78	7	.8	8.9		505	264	0	40
26 dd	8.3	Nov. 19, 1946	52	597	1.1	17	62	22	40	239		107	17	.3			383	245	49	26
27 bb	10	Nov. 16, 1946	56	456	.6	50	56	15	20	180		71	16	.1			317	201	54	18
28 bb	9.9	Nov. 18, 1946		471	1.0	44	52	16	32	191		78	19	.4			336	196	39	26
29 bb	9.9	Nov. 16, 1946	53	648	3.5				93	211		120	24					130	0	61
29 bb	9.9	Nov. 18, 1946		616						151		60	34							
29 bb	9.9	Mar. 11, 1948	41	485	2.5	11	29	7.9	60	46		131	43				305	105	68	55
29 bb	9.9	Aug. 2, 1948	58	489	2.5	7.8	29	8.0	60	109		110	22	.3			291	106	16	55
29 bb	9.9	Apr. 6, 1949	40	556	3.2	15	33	8.8	79	104		130	50		.4		367	118	34	59
29 bb	9.9	Aug. 30, 1949	63	568	1.0				33	148		109	38					216	94	25
29 bb	9.9	Nov. 16, 1949		571																
30 bb	7.8	Nov. 18, 1946	54	595	4.5	16	22	10	101	241		89	16	.8			374	96	0	70
30 bb	7.8	Aug. 31, 1948	66	477	7.1	47	11	2.3	99	190		71	16				340	37	0	85
	9.9	Apr. 16, 1946	45	1,750	10				340	226		522	155	.7		.18		210	25	78
36 aa																				
36 dd	8.2	May 13, 1946	51	301						160		15	3							
36 dd	8.2	Nov. 13, 1946	57	327	1.4	18	26	8.8	33	176		16	8	.4		.04	197	101	0	42
40-11-2 cc	6.4	Apr. 4, 1946	41	636	4.1				96	176		130	24		.5	.18		105	0	67
2 dc	6.7	Apr. 4, 1946	36	256	.3				8.7	134		15	16					129	19	13
3 ad	7.0	Apr. 4, 1946	42	1,020	9.1				209	520		73	37					99	0	82
4 dd	8.3	Apr. 4, 1946	41	220	1.0	35	18	10	21	116		15	15				171	86	0	35
5 aa	5.0	Apr. 3, 1946	42	434	4.5				78	29	80	31	26		0			57	0	75
5 ab	5.4	Apr. 3, 1946	41	1,370	8.8	36			245	526		44	131	3.0	14	0		148	0	78
5 cc	5.8	Nov. 19, 1946	52	3,300						645										
6 bd	8.1	Apr. 4, 1946	39	1,430	28				356	404	175	70	68	3.9	2.2	.18		30	0	96
7 aa	9.4	Apr. 3, 1946	44	2,830	38				715	935	79	441	178	4.8	1.1	.55		66	0	96
7 cc	10.0	Mar. 5, 1941		482	4.3	32	19	5.2	83 | 14	267		28	5.3		.4		319	68		
7 cc	10.0	Apr. 4, 1946	47	574	5.6	11			111	337		22	11	1.0		.18		75	0	76
7 cc	10.0	Nov. 17, 1946	55	619	5.2	13	24	8.1	115	381		21	6				375	94	0	73

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) + Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
40-11-8 dc	8.8	Apr. 15, 1946	43	1,330	11	17			252	616		25	75	1.0		0.36		92	0	86
14 aa	5.7	Apr. 4, 1946	40	555	2.0	32			62	343		2	21	3.0		0		186	0	42
14 aa	5.7	Nov. 13, 1946	51	497						305		24	6							
14 bb	6.6	Apr. 4, 1946	39	189	1.7	45	16	2.4	28	109		2	13				156	50	0	55
14 bb	6.6	Nov. 13, 1946	50	339						189		2	5							
14 dc	6.0	Apr. 15, 1946	43	476						318		12	5							
14 dd	5.1	Apr. 15, 1946	39	465	1.4		56	9.0	44	261		26	20	1.0		0	285	176	0	35
15 bb	7.6	June 10, 1946	50	264	1.1	39			23	142		4	6	.6	0.1	.02		80	0	39
15 dd	7.8	Apr. 15, 1946	43	1,000	3.6	19			131	426		88	64	.9		.18		249	0	53
17 bb	8.4	Apr. 9, 1946	44	1,030	14	21			233	458		113	44	2.9	0	.36		56	0	90
17 cc	7.0	Apr. 16, 1946	46	973	15		8.5	5.2	226	435		105	48			.36	607	42	0	92
17 dd	6.0	Apr. 15, 1946	42	1,490	18				365	728		125	90	4.9		.55		74	0	91
18 bd	9.0	Apr. 22, 1941		451	6.9		5.0	6.7	101								372			85
18 bd	9.0	July 3, 1941		496	16		3.8	.24	118								350			
18 bd	9.0	Nov. 6, 1941		511	13		5.6	.73	119								382			94
18 bd	9.0	Apr. 8, 1946	44	379	8.4	18			88	233		3	10	1.0	2.2	.18		21	0	90
18 bd	9.0	Nov. 17, 1946	51	417						272			4							
19 dd	6.1	Apr. 9, 1946	43	1,250	8.3	45			255	514	79	100	47	2.9	0	.18		177	0	76
19 dd	6.1	Nov. 19, 1946	52	563	2.2	38	46	10	62	190		100	22				372	156	10	46
20 dd	9.7	Apr. 16, 1946	44	1,380	4.2				176	615	31	50	69					323	0	54
20 dd	9.7	Nov. 19, 1946	50	963						485										
22 bc	6.0	Apr. 15, 1946	41	5,260	62	22			1,340	1,930		885	340	4.5		.36		87	0	97
25 ba	9.8	June 11, 1946	49	1,270		44				692		150	22	3.1	.4	0				
25 ba	9.8	Nov, 13, 1946	49	1,250						720		200	27							
26 ab	4.7	June 11, 1946	56	3,050		40				1,780				14		1.5				
26 ab	4.7	Nov. 13, 1946	52	1,340						840										
26 bb	7.3	Nov. 14, 1936		3,420	31	58	2.3	30	820	2,150	20	58	31	24.0	0	.97	2,120			91
26 bb	7.3	June 11, 1946	54	1,830	9.5	25	68	19	345	1,080		5.8	73	.4	2.4	.18	1,070	248	0	75
26 db	7.7	Nov. 13, 1946	50	2,090						834	246									
27 aa	6.7	June 11, 1946	49	9,570	118	8.8	11	19	2,790	4,200	570	948	550	7.5	6.6	1.1	6,980	106	0	98
27 aa	6.7	June 11, 1946	49	2,650		33				39		1,660		4		.74				
27 cb	7.9	June 11, 1946	49	816	15	19			182	400		56	22	2.0	.3	.37		27	0	94

29 dd	6.4	May 13, 1946	50	2,010	39	14	--	--	419	582	85	200	72	1.5	--	.91	--	22	0	98
29 dd	6.4	Nov. 19, 1946	51	1,910	--	--	--	--	--	690	--	--	--	--	--	--	--	--	--	--
30 bb	10.0	Apr. 16, 1946	43	653	--	--	--	--	--	255	--	36	18	--	--	--	--	--	--	--
30 dd	6.2	May 13, 1946	46	1,620	5.9	31	--	--	203	322	--	250	97	1.5	--	.37	--	225	0	66
30 dd	6.2	Nov. 19, 1946	48	1,810	--	--	--	--	--	256	--	--	--	--	--	--	--	--	--	--
33 cc	6.0	Nov. 13, 1936	--	15,600	229	18	4.0	16	4,600	6,250	570	2,260	996	20	2.5	2.40	11,700	--	--	98
33 cc	6.0	Apr. 16, 1946	43	2,310	52	21	--	--	535	999	32	180	84	1.9	--	.74	--	20	0	98
33 cc	6.0	Nov. 30, 1948	48	9,080	--	--	--	--	--	3,620	634	--	--	--	--	--	--	--	--	--
33 cc	6.0	Jan. 20, 1949	40	5,550	--	18	--	--	--	2,020	349	--	250	--	--	--	--	--	--	--
33 cc	6.0	Apr. 14, 1949	44	6,190	187	25	4.0	1.6	1,750	2,640	118	968	312	--	7.9	--	4,490	16	0	100
33 cc	6.0	June 2, 1949	52	4,250	--	--	--	--	--	1,700	49	--	202	--	--	--	--	--	--	--
33 cc	6.0	July 20, 1949	65	2,900	--	--	--	--	--	1,200	--	--	130	--	--	--	--	--	--	--
33 cc	6.0	Nov. 23, 1949	--	3,660	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
33 cc	6.0	Feb. 17, 1950	40	4,170	56	37	--	--	1,110	1,860	--	635	208	--	2.3	--	--	75	0	97
33 cc	6.0	Mar. 17, 1950	40	4,700	54	42	--	--	1,210	1,990	--	720	242	--	.4	--	--	96	0	96
33 cd	6.6	May 13, 1946	50	2,880	34	19	--	--	639	1,430	--	100	124	2.7	--	.91	--	68	0	95
33 dd	5.2	May 7, 1946	47	1,830	22	24	--	--	409	926	--	64	86	2.8	--	1.8	--	66	0	93
34 dd	6.5	May 13, 1946	46	1,530	14	24	--	--	293	756	--	40	38	2.0	--	.91	--	84	0	88
40-12-7 dd	6.8	Nov. 14, 1936	--	1,250	4.7	64	118	62	253	845	--	67	31	1.8	5.6	--	1,020	--	--	67
7 dd	6.8	June 14, 1946	50	155	1.6	43	--	--	24	96	--	15	1	.6	.2	0	--	44	0	55
7 dd	6.8	Nov. 13, 1946	48	360	--	--	--	--	--	211	--	18	6	--	--	--	--	--	--	--
17 ac	5.4	June 3, 1936	60	703	--	--	--	--	--	380	--	--	16	--	--	--	--	--	--	--
17 ac	5.4	June 14, 1946	51	218	1.7	43	--	--	29	128	--	2	5	.3	1.1	0	--	54	0	53
17 ac	5.4	Nov. 13, 1946	49	215	--	--	--	--	--	111	--	--	--	--	--	--	--	--	--	--
18 bb	6.9	June 14, 1946	53	200	2.7	26	--	--	39	125	--	10	5	.7	1.1	0	--	39	0	68
20 ba	8.2	June 21, 1946	58	1,790	14	21	--	--	397	576	--	300	89	2.2	120	.06	--	150	0	85
20 ba	8.2	Nov. 13, 1946	48	2,030	--	--	--	--	--	1,180	--	--	--	--	--	--	--	--	--	--
29 dc	5.8	May 13, 1946	48	967	8.4	43	22	10	190	300	18	149	53	.7	.6	--	634	96	0	81
29 dc	5.8	Nov. 13, 1946	47	1,460	9.5	26	44	9.4	267	304	--	347	84	.2	0	0	927	148	0	80
30 aa	6.4	June 14, 1946	57	550	5.0	22	--	--	98	290	--	27	13	.8	2.1	.02	--	74	0	74
30 aa	6.4	Nov. 13, 1946	50	487	5.2	38	19	2.5	91	248	--	34	11	.8	0	.02	318	58	0	77
31 ab	6.5	May 13, 1946	52	1,460	17	32	--	--	340	530	--	280	61	.6	--	.11	--	75	0	91
31 ab	6.5	Nov. 13, 1946	52	1,140	--	--	--	--	--	376	--	--	--	--	--	--	--	--	--	--
31 cc	9.5	May 10, 1946	48	6,220	--	66	--	--	--	3,040	--			4	--	.36	--	--	--	--
31 cc	9.5	Nov. 13, 1946	52	1,710	--	--	--	--	--	1,090	--	--	--	--	--	--	--	--	--	--
31 dd	7.4	May 7, 1946	49	2,780	56	18	--	--	707	1,190	181	200	55	1.9	--	1.4	--	30	0	98
33 cc	9.3	May 13, 1946	50	592	2.2	16	--	--	60	266	--	30	17	.8	--	.27	--	144	0	48
41-7-3 bb	25.9	Nov. 3, 1947	54	105	.5	31	12	2.6	8.0	54	--	12	1.2	--	0	--	93	40	0	30
3 bb	25.9	Mar. 10, 1948	47	112	.2	--	13	2.7	3.4	52	--	6	1.8	--	--	--	52	44	1	15
3 bb	25.9	Sept. 15, 1948	60	153	.6	--	20	2.9	11	90	--	10	.8	--	--	--	89	62	0	27
3 bb	25.9	Nov. 18, 1948	51	124	--	--	--	--	--	75	--	--	--	--	--	--	--	--	--	--
3 bb	25.9	Apr. 5, 1949	46	128	--	--	--	--	--	66	--	--	--	--	--	--	--	--	--	--
3 bb	25.9	Aug. 26, 1949	58	138	--	--	--	--	--	80	--	--	--	--	--	--	--	--	--	--

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
41-7-3 bb	25.9	Nov. 22, 1949		127																	
26 dc	22.7	Nov. 4, 1947	53	319	0.9	34				20	132		14	10					94		31
26 dc	22.7	Mar. 10, 1948	41	316	.5					14	154		17	7.2					124		19
26 dc	22.7	Aug. 16, 1948		118	.2					3.2	76		1	.5					57		11
26 dc	22.7	Nov. 17, 1948	50	389	.6	32	50	9.8		17	162		33	18		11		251	166	33	18
26 dc	22.7	Apr. 4, 1949	46	471	.7	30	62	10		23	191		40	23		18		300	196	39	20
26 dc	22.7	Nov. 22, 1949		304																	
27 cc	42.2	Nov. 4, 1947	51	297	.8	30				19	144		18	6.8					105		28
27 cc	42.2	Mar. 10, 1948	46	347	.5					15	192		22	4.8					154		18
27 cc	42.2	Aug. 16, 1948		170	.2		25	4.0		3.2	103		1	.5				84	79	0	8
27 cc	42.2	Nov. 17, 1948	51	382	.5	33	54	9.4		14	203		18	10		6.9		245	173	7	15
27 cc	42.2	Apr. 4, 1949	47	370		30					184										
27 cc	42.2	Nov. 22, 1949		460							237										
28 cc	159	Nov. 4, 1947	54	182	.7	27				13	104		10	1.0					69		29
28 cc	159	Mar. 11, 1948	41	274	.7					17	168		9	1.0					111		25
28 cc	159	Nov. 17, 1948	57	274							155	9.8									
32 bb	16.8	Nov. 4, 1947	56	197	.2	40				3.2	100		3	2.2	0		0		81		8
32 bb	16.8	Sept. 15, 1948	62	196	.4		27	3.7		9.2	118		5	.8				104	82	0	20
32 bb	16.8	Nov. 17, 1948	50	197							114										
32 bb	16.8	Aug. 26, 1949	51	204							120										
32 bb	16.8	Nov. 22, 1949		265							138										
41-8-1 bb	9.9	Mar. 10, 1948	39	358	3.7	11				63	204		15	7.0					56		71
1 bb	9.9	Aug. 4, 1948	64	623	5.4					106	338		6	15	.4				74		76
1 bb	9.9	Sept. 13, 1948	61	443	5.3	3.8				84	146	22	50	16					48		79
1 bb	9.9	Nov. 17, 1948	51	335							197										
1 bb	9.9	Apr. 4, 1949	39	563							243		53	26							
1 bb	9.9	Aug. 29, 1949	66	495							296										
1 bb	9.9	Nov. 21, 1949		699																	
3 aa	10.0	Mar. 10, 1948	43	420	.6	22				18	188		50	16					190		17
3 aa	10.0	Aug. 3, 1948		375	.7					18	166		10	15	.4				130		23
3 aa	10.0	Nov. 17, 1948	47	564	1.8	24	50	15		58	233		79	28		1.3		370	186	0	41
3 aa	10 0	Apr. 4, 1949	35	597							192		93	42							

3 aa	10.0	Aug. 29, 1949	62	436	--	--	--	--	--	192	--	--	--	--	--	--	--	--	--	--
3 aa	10.0	Nov. 21, 1949	--	495	--	--	--	--	--	241	--	--	--	--	--	--	--	--	--	--
3 bb	8.6	Nov. 3, 1947	51	425	1.7	--	38	10	45	250	--	18	7.0	--	0	--	241	136	0	42
3 bb	8.6	Sept. 13, 1948	67	534	2.4	--	--	--	66	248	--	45	30	--	--	--	--	148	--	49
3 bb	8.6	Nov. 17, 1948	45	398	2.1	26	25	11	49	208	--	26	10	--	1.7	--	251	108	0	50
3 bb	8.6	Aug. 29, 1949	67	663	--	--	--	--	--	344	--	66	14	--	--	--	--	--	--	--
4 bb	10.0	Apr. 4, 1949	41	214	.9	2.5	21	5.1	17	50	--	45	16	--	.6	--	132	74	32	34
4 bb	10.0	Aug. 29, 1949	65	136	.1	4.7	--	--	2.1	50	--	8.8	6	--	0	--	--	54	13	8
4 bb	10.0	Nov. 22, 1949	--	131	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6 cc1	--	June 14, 1936	--	191	.4	--	23	5.2	9.2, .8	104	--	9.1	3.2	--	0	--	102	--	--	21
6 cc2	6.2	Apr. 4, 1949	48	292	--	--	--	--	--	132	--	29	7.5	--	--	--	--	--	--	--
6 cc2	6.2	Aug. 29, 1949	63	320	--	--	--	--	--	174	--	--	--	--	--	--	--	--	--	--
10 cc [3]	80	Aug. 10, 1948	--	234	.5	46	28	6.7	12	113	--	19	6	--	1.9	--	175	98	5	20
10 cc [4]	80	Aug. 12, 1948	--	273	.5	49	35	8.0	12	133	--	20	8	--	2.2	--	200	120	12	17
13 aa	9.7	Mar. 13, 1948	--	665	10	--	--	--	144	305	--	68	21	--	--	--	--	38	0	89
13 aa	9.7	Sept. 3, 1948	68	840	20	67	5.0	1.4	200	446	--	57	20	--	--	--	570	18	0	96
13 bb	9.8	Sept. 13, 1948	64	375	1.0	--	40	8.7	27	174	--	35	11	--	--	--	207	136	0	30
24 aa	9.9	Sept. 13, 1948	69	653	6.7	8.4	19	4.4	125	234	--	96	32	--	--	--	400	66	0	81
28 dc	33.1	Nov. 4, 1947	60	182	.5	36	20	3.6	9.2	96	--	2	2.8	.2	--	0	121	65	0	24
28 dc	33.1	Mar. 10, 1948	48	278	.7	--	--	--	17	132	--	23	5.8	--	--	--	--	102	--	27
28 dc	33.1	Aug. 16, 1948	--	111	--	--	--	--	--	62	--	--	--	--	--	--	--	--	--	--
28 dc	33.1	Nov. 17, 1948	54	158	.3	27	21	5.6	6.7	89	--	13	2.0	--	.6	--	120	76	2	16
28 dc	33.1	Apr. 5, 1949	49	283	--	28	--	--	--	142	--	--	--	--	--	--	--	--	--	--
28 dc	33.1	Aug. 26, 1949	66	95	--	--			--	50		--	--		--					--
28 dc	33.1	Nov. 21, 1949	--	150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29 cc2	71.8	Nov. 4, 1947	58	232	1.0	34	--	--	20	124	--	14	2.5	--	--	--	--	76	--	36
29 cc2	71.8	Mar. 10, 1948	50	298	.2	--	--	--	4.6	146	--	22	5.2	--	--	--	--	140	--	7
29 cc2	71.8	Aug. 16, 1948	--	139	.9	--	15	1.4	13	83	--	4	.5	--	--	--	75	44	0	40
29 cc2	71.8	Nov. 17, 1948	54	173	.2	30	25	5.6	4.6	102	--	8.6	2.0	--	.3	--	126	86	2	10
29 cc2	71.8	Apr. 5, 1949	50	308	--	--	--	--	--	154	--	--	--	--	--	--	--	--	--	--
36 bb	--	Nov. 4, 1947	54	158	.7	79	19	2.4	13	96	--	4	2.2	--	0	--	167	58	0	33
36 bc	34.2	Nov. 4, 1947	52	286	.7	--	--	--	17	138	--	36	7.5	--	--	--	--	123	--	24
36 bc	34.2	Mar. 10, 1948	47	328	.3	--	--	--	8.7	154	--	25	7.8	--	--	--	--	144	--	12
36 bc	34.2	Sept. 15, 1948	59	203	.8	--	26	4.0	16	116	--	15	3.5	--	--	--	122	82	0	29
36 bc	34.2	Nov. 17, 1948	51	273	.6	35	34	7.5	14	135	--	23	6.0	--	4.5	--	190	116	6	21
36 bc	34.2	Apr. 5, 1949	51	322	--	--	--	--	--	157	--	--	--	--	--	--	--	--	--	--
36 bc	34.2	Aug. 26, 1949	67	110	.4	28	14	2.4	6.0	62	--	3.7	2.0	--	0	--	87	45	0	22
41-8-36 bc	34.2	Nov. 21, 1949	--	282	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
41-9-1 aa	10.0	Mar. 10, 1948	40	616	5.1	29	--	--	106	150	28	99	28	--	--	--	--	81	--	74
1 aa	10.0	Aug. 3, 1948	61	651	5.3	36	--	--	116	257	--	92	25	.3	--	--	--	90	--	74
1 aa	10.0	Nov. 17, 1948	52	812	1.9	48	82	21	75	319	12	122	31	--	1.9	--	550	291	10	36
1 aa	10.0	Apr. 4, 1949	41	804	--	--	--	--	--	354	--	--	--	--	--	--	--	--	--	--
1 aa	10.0	Aug. 29, 1949	63	545	1.8	--	--	--	53	254	--	48	14	--	--	--	--	162	0	42

See footnotes at end of table.

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) Potassium (K)	Bicarbonate (HCO3)	Carbonate (CO3)	Sulfate (SO4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO3)	Boron (B)	Dissolved solids (sum)	Hardness as CaCO3 Total	Hardness as CaCO3 Noncarbonate	Percent sodium
41-9-1 aa	10.0	Nov. 21, 1949		694																
1 ac	110	Oct. 26, 1948		452	1.2	53	48	9.9	34	145		78	24		0.6		319	160	42	32
2 bb	9.8	Aug. 4, 1948	68	505	11	5.8	6.0	1.0	112	234		43	19				302	19	0	93
2 bb	9.8	Nov. 17, 1948	48	564						249										
2 bb	9.8	Aug. 29, 1949	67	369						174										
2 bb	9.8	Nov. 21, 1949		630						333										
3 bb	10.0	Sept. 13, 1948	71	751	8.4	28	3.5	.5	182	354		85	20				493	10	0	97
3 bb	10.0	Nov. 21, 1949		758																
5 dd	301.4	Nov. 3, 1947	55	161	.3	96			6.7	92		8	1.8					72		17
6 aa	10.0	Mar. 10, 1948	37	521	2.1	19			58	222		60	23					150		46
6 aa	10.0	Aug. 4, 1948		198	.2				5.1	116		5	2.0					92		11
6 aa	10.0	Nov. 17, 1948	50	238						151										
6 aa	10.0	Apr. 4, 1949	38	357						168		38	10							
6 aa	10.0	Aug. 29, 1949	62	154						86										
6 aa	10.0	Nov. 21, 1949		203																
6 bb	9.8	Mar. 10, 1948	39	881	5.4	41			139	348		70	47					123		71
6 bb	9.8	July 3, 1948	63	189	1.4				23	122		2	2.0					54		49
6 bb	9.8	Nov. 17, 1948	50	412	4.2	21	19	3.9	77	234		24	9		2.1		271	64	0	72
6 bb	9.8	Apr. 4, 1949	38	680						296		86	26							
6 bb	9.8	Aug. 29, 1949	62	173						100										
6 bb	9.8	Nov. 21, 1949		273						171										
6 cd	200	Nov. 3, 1947	54	154	1.0	56	16	1.8	16	88		6	2.8		0		142	48	0	42
10 bb	8.4	Aug. 3, 1948	66	640	2.8	46			85	278		86	27	0.4				171		52
11 dc	431	Nov. 3, 1947	59	349	12	75			84	134	39	8	2.0			0.02		9		95
12 aa	9.9	Mar. 10, 1948	40	2,390	21	24			548	292		761	201					124		91
12 aa	9.9	Aug. 3, 1948	61	2,260	16	32			493	328		696	180	.3				176		86
12 aa	9.9	Nov. 17, 1948	50	2,560						388		802								
12 aa	9.9	Apr. 4, 1949	42	2,640		30				404		825	200							
12 aa	9.9	Aug. 29, 1949	63	2,960						228										
12 aa	9.9	Nov. 21, 1949		2,780						451										
13 cc	9.9	Sept. 1, 1948	66	378	5.2	13			74	210		18	6.0					39		80
13 dd2	5.8	Mar. 12, 1948	42	459	.2				7.8	289		3.7	5					231	0	7

13 dd2	5.8	Aug. 31, 1948	64	390	.4				13	232		20	7.0					192		13
14 bb	10	Sept. 1, 1948	71	367	.9				24	160		40	13					138		28
18 aa	7.8	Sept. 13, 1948	69	818	13	14	12	1.6	178	188		197	45				540	36	0	91
19 cc3	9.9	Mar. 10, 1948	41	408	2.4	23			57	222		35	9.0					108		53
19 cc3	9.9	Aug. 4, 1948	65	300	1.7	39			34	177		2	2.0					75		50
19 cc3	9.9	Nov. 18, 1948	54	407						203		26								
19 cc3	9.9	Apr. 4, 1949	42	431						224										
19 cc3	9.9	Aug. 29, 1949	64	226						120										
19 cc3	9.9	Nov. 21, 1949		350						166										
20 cc	9.9	Mar. 10, 1948	37	334	2.1	4.0			40	80		30	16					69		56
20 dd2	10.0	Mar. 10, 1948	37	1,540	13	33			339	566		281	77					129		85
20 dd2	10.0	Aug. 4, 1948	63	1,740	17	31			401	540		372	107	.4				110		89
20 dd2	10.0	Nov. 18, 1948	54	1,520						316	42									
20 dd2	10.0	Apr. 4, 1949	41	1,650						446										
20 dd2	10.0	Aug. 29, 1949	64	770	11				171	398		64	18					46	0	89
20 dd2	10.0	Nov. 21, 1949		1,110						437										
22 cd	525	Nov. 3, 1947	61	195	1.1	61			19	108		3	2.8	.6		.02		56		42
22 cd	525	Dec. 9, 1948	61	187						101										
22 dd	9.9	Mar. 10, 1948	40	1,270	10	21			267	206	14	347	108					126		82
22 dd	9.9	Aug. 3, 1948	65	873	8.7	48			176	152	28	214	47					78		83
22 dd	9.9	Nov. 18, 1948	48	1,010	1.4	33	124	29	69	280		251	53		15		712	428	199	26
22 dd	9.9	Apr. 4, 1949	39	844						292		178	30							
22 dd	9.9	Aug. 29, 1949	64	875						284										
22 dd	9.9	Nov. 21, 1949		689						363	26									
23 bb	10.0	Sept. 1, 1948	66	591	3.0		36	10	80	292		40	17				327	131	0	57
23 ca	29.6	Oct. 11, 1948	53	463	1.3	47	52	10	39	196	14	52	11		2.9		324	170	0	33
23 ca	29.6	Dec. 9, 1948	64	628						375	35									
25 aa	6.3	Nov. 14, 1946	53	1,020						318		200	42							
25 aa	6.3	Mar. 12, 1948	40	899						253								70	0	
25 aa	6.3	Sept. 19, 1948	64	718	4.4	31			114	246		127	30					129		66
25 aa	6.3	Aug. 31, 1948	67	719	5.3	26			125	232		134	33					105		72
25 bb	9.4	Nov. 14, 1946	53	871	2.1	19	76	26	83	266		190	43	.3			568	296	78	38
25 cc	9.7	Sept. 1, 1948	68	705	2.6		50	15	81	170		162	39				431	186	47	49
27 cc1	9.6	Mar. 21, 1948	37	1,100	3.6	47			149	736		21	17	.8		.1		328	0	50
27 cc2	195	Aug. 3, 1948	64	284	3.1	55	15	2.2	49	176		4	2	1.0			215	46	0	70
27 cc2	195	Apr. 4, 1948	40	668	3.5	34	49	9.1	102	400		29	16		.7		437	160	0	58
27 cc2	195	Aug. 26, 1949	67	237	2.7	54			40	140		8	2	.7				42	0	67
27 cc2	195	Nov. 21, 1949		563						383										
28 aa	4.3	Sept. 13, 1948	69	4,360	67	50			1,130	648	181	1,170	325					54		98
28 dc	233.3	Nov. 4, 1947	56	142	.1	59			1.8	78		6	2.0					69		5
29 cc	9.9	Mar. 10, 1948	41	386	2.3	6.8			52	138	26	30	15					96	26	54
29 cc	9.9	Aug. 3, 1948	65	408	6.3	47			153	250		15	4	.4				111		51
29 cc	9.9	Apr. 4, 1949	42	424						227										

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
41–9–29 cc	9.9	Aug. 26, 1949	65	355	0.4	32				13	223		8	3.0					166	0	15
29 cc	9.9	Nov. 21, 1949		320																	
32 bb	91.0	Nov. 4, 1947	52	159	1.0	61	17	1.9		17	94		6	2.5		0		152	50	0	42
32 dd	9.9	Mar. 13, 1948	40	479	.4		51	10		15	185		64	22	0.2	.5		254	168	66	13
32 dd	9.9	Aug. 4, 1948	64	617	2.0		60	10		63	190		109	41				377	190	35	42
32 dd	9.9	Nov. 18, 1948	52	471	1.5	18	46	11		45	217		46	16		11		300	160	0	38
32 dd	9.9	Apr. 4, 1949	39	488							149		84	31							
32 dd	9.9	Aug. 26, 1949	65	475							172										
32 dd	9.9	Nov. 17, 1949		515																	
34 ab	266.2	Nov. 4, 1947	57	157	.9	69				16	86		18	2.0					57		38
35 dd	9.8	Mar. 12, 1948	43	699	6.6					134	345		69	11					78	0	79
35 dd	9.8	Aug. 3, 1948	64	1,270	13	34				283	644		130	34					96		86
35 dd	9.8	Nov. 18, 1948	54	1,280							390	30									
35 dd	9.8	Apr. 4, 1949	43	1,050							420		171	37							
35 dd	9.8	Aug. 26, 1949	66	1,180							520										
35 dd	9.8	Nov. 17, 1949		1,330																	
36 aa	8.0	Nov. 14, 1946	51	847	1.5	35	84	33		66	247		207	50	.3			597	345	142	30
36 aa	8.0	Mar. 11, 1948	39	661	2.2					70	154		143	51					195		44
36 aa	8.0	Aug. 2, 1948	56	844	14	22				194	178		212	66	.3				39		92
36 aa	8.0	Aug. 31, 1948	64	939	2.0		90	22		83	194		222	74				587	315	156	36
41–10–13 aa	6.9	Nov. 14, 1946	49	759	10	18	10	3.9		153	173		123	68	3.1		0.06	464	41	0	89
13 dd	7.3	Nov. 14, 1946	50	641	9.6	18	10	2.2		129	171		63	73	2.0		.11	381	34	0	89
15 cc	8.3	Feb. 21, 1941		988	4.3	43	56	13	136	14	242		227	48		1.9		658			
15 cc	8.3	July 2, 1941		899														656			49
15 cc	8.3	Nov. 6, 1941		904	2.8		77	16		103								636			46
15 dd	6.7	Apr. 4, 1941		1,610	18		18	3.9		322											
16 dc	7.	Apr. 4, 1941		815	7.3		23	6.0		153								540			80
18 bb	5.5	Mar. 13, 1948	41	1,730	10	28				314	707		19	178	1.2		.1		170	0	80
18 bb	5.5	Aug. 31, 1948	65	3,800	47	48				1,140	1,240		1,120	295					110		96
18 cc	625	Nov. 3, 1947	64	637	26	69				170	342	39	3	16	2.8		.02		8		98
18 cc	625	May 13, 1948	64	636	22					174	440		5.3	11	3		.30		12	0	97
20 dd	8.4	Nov. 14, 1946	54	709	4.0	11	32	17		112	272		125	28	.5			460	150	0	62

20 dd	8.4	Mar. 12, 1948	42	469	3.4				91	281		68	24					138	0	59
20 dd	8.4	Aug. 2, 1948	64	681	5.0	23			121	292		98	22	.3				110		71
26 dd	9.7	Nov. 14, 1946	52	1,350						480		260	65							
27 aa	4,200	June 15, 1936	116	373						166		65	9.9							
27 aa	4,200	July 3, 1941	116	379	12		3.8	.24	87								348			95
27 aa	4,200	Mar. 27, 1946	116	397	11	120	3.2	1.0	91	132	24	24	8.1	9.5			346	12	0	95
27 aa	4,200	May 12, 1948	116	394	7.9				77	188		27	3			.80		18	0	90
27 dd	11.4	Mar. 11, 1948	41	1,310	18	5.7			281	398	49	138	76					48	49	93
27 dd	11.4	Aug. 2, 1948	55	1,080	10	9.2			219	376		152	68	.5				88		84
27 dd	11.4	Nov. 18, 1948	43	939	4.9	9.7	40	19	151	355		126	60		.7		581	178	0	65
27 dd	11.4	Apr. 4, 1949	43	800	5.4	4.9	24	15	138	250		135	54		1.4		496	122	0	71
27 dd	11.4	Aug. 30, 1949		2,180		8.8				620	79	243	160	.3						
27 dd	11.4	Nov. 23, 1949		1,650																
28 aa	9.9	Nov. 14, 1946	55	805	13				181	291		141	30	.7				36	0	92
28 aa	9.9	Mar. 11, 1948	41	1,210	9.8	18			233	282		274	69					106		83
28 aa	9.9	Aug. 2, 1948	67	364	4.8	31			66	172		20	10	1.4				36		80
28 aa	9.9	Nov. 18, 1948	54	371						196										
28 aa	9.9	Apr. 4, 1949	47	384						232										
28 aa	9.9	Aug. 30, 1949	70	284		36				148		28		.4						
28 aa	9.9	Nov. 23, 1949		662	17				153	278		84	22		3.3			16	0	95
28 dd	9.9	Nov. 14, 1946	55	1,610						342	30	500	115							
29 bb	8.4	Nov. 14, 1946		563	2.5	16	36	17	72	330		26	13				343	160	0	49
29 cc2	8.6	Nov. 14, 1946	54	823	2.1	26	50	41	84	368	31	86	22	1.0			523	294	0	38
32 aa	7.2	Nov. 14, 1946	53	108						318		240	56							
32 dd	9.2	Apr. 23, 1941		711	3.5		37	11	95								476			60
32 dd	9.2	July 1, 1941		616													482			57
32 dd	9.2	Nov. 12, 1941		663	2.9		42	12	84								292			55
32 dd	9.2	Apr. 3, 1946	44	9,350	17	20	476	180	1,760	585		2,650	1,770	3.7		.02	7,150	1,930	1,450	66
33 dd	6.5	Nov. 14, 1946	53	1,260						504		200	53							
35 dc	8.8	Apr. 4, 1941		1,010	5.3		43	17	162								654			66
35 dc	8.8	Apr. 28, 1946		1,080	6.6	39			189	302		232	53	.7	2.5	.06		156	0	73
35 dc	8.8	Nov. 14, 1946	54	1,090						408		240	56							
35 dc	8.8	Mar. 11, 1948	42	1,170	27	15			324	490	39	193	45					27		96
36 dc	9.9	Apr. 4, 1941		1,560	14		28	5.0	313								1,052			88
36 dc	9.9	Mar. 28, 1946		1,300	4.5	29			192	450		279	72	.2	1.0	.02		345	0	55
36 dc	9.9	Nov. 14, 1946		1,380						481			75							
36 dc	9.9	Aug. 2, 1948	61	1,310	12	22			285	458		234	78	.9				112		85
41-11-31 cd	5.5	Apr. 15, 1946	37	3,280	38	9.3			796	715	138	642	225	3.7	0	.55		81	0	96
42-7-2 ad	91.4	June 21, 1948	53	194	.4	68	25	5.0	8.7	109		9.4	1.5		.8		172	83	0	19
25 aa	4.0	Mar. 10, 1948	34	474	2.7	35			66	258		30	12					117		55
42-8-7 bb		May 1, 1940	59		.3		21	4.2	6.4	92		5	2		.25		84	70		17
31 dd	360	Nov. 3, 1947	55	174	.4	60			8.0	100		16	2.2	0				84		17
34 cc	196.5	Nov. 3, 1947	53	146	.7	58	19	1.4	11	84		6	1.5		0		138	54	0	31

TABLE 7.—*Analyses of water from typical wells*—Continued

Well	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
42-9-32 dd	10.0	Mar. 10, 1948	37	779	6.4	21			155		318		138	31					111		75
32 dd	10.0	Aug. 5, 1948	65	773	9.7	18			170		390		68	24	1.0				58		86
32 dd	10.0	Nov. 17, 1948	51	653	4.8	11	32	5.9	113		207		128	34		0.4		426	104	0	70
32 dd	10.0	Apr. 4, 1949	42	782							338										
32 dd	10.0	Nov. 23, 1949		322	8.8				76		179		23	6.0		1.1			14	0	92
36 cc	9.9	Mar. 10, 1948	40	337	1.2	12			29		148		35	13					114		35
36 cc	9.9	Aug. 3, 1948	65	354	3.2	10			52		161	4.9	6	11	.4				50		69
36 cc	9.9	Nov. 18, 1948	52	471	2.4	18	30	11	60		215		44	19		1.8		290	120	0	52
36 cc	9.9	Apr. 4, 1949	42	429							188										
36 cc	9.9	Aug. 29, 1949	62	332																	
36 cc	9.9	Nov. 21, 1949		417																	
43-7-26 da	102.1	June 19, 1948	51	223	.8	66	29	3.2	16		122		14	4.0		1.0		193	86	0	29
36 cc	100.1	June 19, 1948	55	216	.5	74	31	3.1	11		112		13	5.5		1.4		194	90	0	21
43-8-4 cc	3.5	Aug. 13, 1948	63	1,830	16	39			408		676		242	149		.3			130		87
10 aa	5.0	Aug. 13, 1948	60	1,100	8.4	66			219		552		98	36		.3			129		79
15 cc	180	June 19, 1948	53	560	6.5	63	18	4.4	118		376		4.3	2.5	1.8	.1		397	63	0	80
20 bb	120	Nov. 3, 1947	48	179	.4	64			8.5		84		36	3.5					93		17
31 bc1	185	Dec. 9, 1948	56	182							98										
31 bc2	290	Nov. 3, 1947	58	170	.8	81			14		92		6	2.8	0				54		37
31 bc2	290	Apr. 7, 1949	57	175		68					94										--
33 dd	7.4	Aug. 13, 1948	62	848	18	44			211		440		72	34		2.0			27		94
43-9-21 ab	233.7	June 30, 1948	56	337	5.0	61	12	1.7	70		214		4.1	3.0	1.8	.2		259	37	0	80

[1] Sample taken 2 hours after pumping started.
[2] Sample taken 31 hours after pumping started.
[3] Sample taken 29 minutes after pumping started.
[4] Sample taken 27 hours after pumping started.

In addition to the large number of samples of ground water collected for analysis during this investigation, about 160 samples of surface water were collected during the study for use in determining the quality of the surface water that may be available for mixing with the ground water that would be salvaged by the proposed closed basin drain. These data will be useful in estimating the ultimate quality of the mixed ground and surface waters that would be discharged into the Rio Grande by the proposed drain. The samples were collected primarily from canals, ditches, laterals, and drains, but some were collected from lakes, such as San Luis, Head, and Soda Lakes, and from streams, such as Sand Creek and the Rio Grande.

The results of these analyses are given in the following table (table 8).

TABLE 8.—*Analyses of surface water*

SAR: Sodium-adsorption ratio.
Hardness as $CaCO_3$: Total hardness was calculated from calcium and magnesium where these constituents are reported; hardness was determined by the soap method where calcium and magnesium are not reported.
(Dissolved constituents are given in parts per million. One ppm is equal to 8.33 pounds of substance per million gallons of water.)

Location	Description	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (sum)	Hardness as $CaCO_3$		Percent sodium
																		Total	Noncarbonate	
T. 37 N., R. 8 E.:																				
SW¼SW¼ sec. 15	Sump reservoir	May 2, 1940	60		1.6		73	14	56		214		144	26		0.50	419	240		
T. 37 N., R. 10 E.:																				
sec. 29	Waverly drain	June 16, 1936		1,110					120		428		48							
sec. 32	Carmel drain	June 16, 1936		855							72		371	24						
T. 38 N., R. 9 E.:																				
sec. 26	Bowen drain at highway.	June 27, 1936		981							86.7			14						
T. 39 N., R. 7 E.:																				
NW¼ sec. 9	Prairie ditch	Nov. 5, 1947	46	120	.4	27	12	3.6	6.0		58		7	2.0	0		86	45	0	
NW¼SW¼ sec. 12	Open ditch	Apr. 22, 1948	58	80	.6	21	9.0	2.5	8.5		44		9.9	3.2		.6	76	33	0	36
NE¼SE¼ sec. 12	Open irrigation canal.	June 2, 1948	55	65	.0		10	2.2	0		36		4	.2			34	34	4	0
sec. 12	Open ditch	July 14, 1948	66	144	.5		18	2.8	8.7		80		8	1.0			78	56	0	25
NE¼NE¼ sec. 12	Travelers canal	June 2, 1949	49	71							36		6.6					27		
Do	do	July 20, 1949	59	84							44									
T. 39 N., R. 8 E.:																				
SE¼SE¼ sec. 2	Box drain	Nov. 5, 1947	52	320	.2				7.1		152		40	6.2				159		
Do	Open drain	Apr. 22, 1948	48	332	.6	40	40	8.4	17		152		28	10		4.9	223	134	10	22
Do	do	May 12, 1948	49	300	.8	40	36	5.9	20		140		26	6	.1	8.1	211	114	0	27
Do	do	July 14, 1948	58	323	.8				19		146		30	6.5	.2			118		26
Do	do	Apr. 7, 1949	47	313		36					145		29	6.0						
Do	do	Aug. 25, 1949	55	310	.6				15		150		23	5				122	0	
SE¼SE¼ sec. 5	Box drain	May 12, 1948		346	.8	39	42	7.1	22		172		21	4	.2	15	235	134	0	26
NW¼NW¼ sec. 34	do	Nov. 5, 1947	51	333	.5				14		140		40	6.0				135		18
Do	do	Mar. 11, 1948	45	207	.7		17	4.3	12		84		6	7.8			88	60	0	30
Do	do	Nov. 15, 1948	49	342							170									
Do	do	Apr. 5, 1949	48	178							94									
Do	do	Nov. 16, 1949		359							199									
T. 39 N., R. 9 E.:																				
NW¼NW¼ sec. 6	Open drain	Apr. 7, 1949	47	315		36					148		27	6.0						

SW¼SE¼ sec. 34	Rio Grande drain	June 18, 1936		394	1.3	43	36	8.0	34	4.7	163		48	14			268	269		39
T. 39 N., R. 10 E.:																				
SE¼NE¼ sec. 9	Open drain	Apr. 22, 1948	54	342	.7	26	38	10	20		152		37	12		.6	218	136	12	25
Do	do	June 2, 1948	60	94	.2		14	3.1	3.2		56		7	.8			56	48	2	13
Do	do	July 14, 1948	70	209	.7				15		96		30	3.5				82		28
Do	do	Dec. 3, 1948	34	431	1.0	49	54	9.5	29		201		43	10		15	308	174	9	26
Do	do	June 2, 1949	54	130	.5	24	16	2.1	8.7		63		12	1		2.5	97	48	0	24
Do	do	July 20, 1949	67	284							136		23	5.5						
SE¼SE¼ sec. 9	Prairie ditch	Aug. 30, 1948	76	305	1.2		35	5.8	30		154		40	6.8			194	112	0	37
NE¼SE¼ sec. 34	Open ditch	June 2, 1948	68	119	.5		13	2.7	7.8		63		7	1.0				44	0	11
Do	do	July 14, 1948	83	207	.3				6.2		114		20	2.2				104		11
Do	do	June 2, 1949	57	130			15	1.9			62							46	0	
Do	do	July 20, 1949	74	236							108		21	5.2						
T. 40 N., R. 6 E.:																				
NE¼NE¼ sec. 2	Rio Grande canal	June 2, 1948	49	58	.1		8.0	1.9	1.8		35		3	.2			32	28	0	12
Do	do	July 14, 1948	65	60	.7		9.4	2.9	10		37		4				34	36	5	
Do	do	Aug. 30, 1948	61	95	.6		12	1.0	8.7		50		10	1.2			58	34	0	36
Do	do	Oct. 20, 1948	48	124							70		12	.5						
Do	do	Apr. 4, 1949	35	135							69									
Do	do	Apr. 14, 1949	40	109							56		9.9	1.0						
Do	do	June 2, 1949	47		.1		8.5		1.1		31		5.0					26	0	
Do	do	July 20, 1949	57	75							36									
Do	do	July 26, 1949	64	79							42									
Do	do	Mar. 17, 1950	36	128		27			7.4		66		10	2		.6	52		0	
NW¼NW¼ sec. 30	Rio Grande headgate, Del Norte, Colo.	May 1, 1940									41		5	2				28		
T. 40 N., R. 8 E.:																				
SE¼SE¼ sec. 2	Open drain	Oct. 28, 1948	56	312							149									
SE¼SE¼ sec. 10	do	Nov. 5, 1947	47	324	1.2				29		162		40	4.5				117		35
Do	do	Apr. 7, 1949	56	344							160		32	8.0						
Do	do	Nov. 17, 1949		307							146									
SW¼SW¼ sec. 13	do	Aug. 30, 1948	62	273					5.5		140		35	4.8			146			8
NE¼NE¼ sec. 14	Box drain	Aug. 30, 1948	58	281	1.0		32	5.1	24		144		30	3.5			166	101	0	34
NE¼NE¼ sec. 15	Open drain	Mar. 13, 1948	42	343	.4				11		156		30	9.0				147	19	14
Do	Box drain	July 14, 1948	54	341	1.2				30		173		30	4.5	0.3			116		36
Do	Open drain	Aug. 30, 1948	61	257	.9		30	4.8	20		128		25	5.0			148	94	0	32
Do	do	Aug. 25, 1949	64	241	.7				14		116		17	5				88	0	26
NE¼NW¼ sec. 15	Box drain	Aug. 30, 1948	56	272	1.3		32	4.4	29		140		40	4.0			178	98	0	39
Do	do	Apr. 7, 1949	47	332		31					167		26	5.0						
NW¼NW¼ sec. 15	Ditch, 50 yards west of box drain.	Nov. 5, 1947	48	121	.6	46	14	2.6	9.9		72		6	1.5		0		46	0	32
Do	Box drain	Nov. 5, 1947		344	1.3	38			28		168		6	5.0				90		40
Do	do	Aug. 25, 1949	61	246	.6				14		118		17	5				91	0	25

TABLE 8.—*Analyses of surface water*—Continued

Location	Description	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
T. 40 N., R. 8 E.—Con.																				
NW¼NW¼ sec. 15	Box drain	Nov. 19, 1949		314							157									
NE¼NE¼ sec. 16	do	Nov. 5, 1947	49	343	1.1				30		176		44	5.8				132		33
Do	do	Mar. 13, 1948	44	342	.7		42	6.9	18		164		21	7	0.2	7.8	184	134	0	23
Do	do	Mar. 23, 1948	47	345	.7	33	42	8.8	18		168		26	8		4.9	224	141	4	22
NE¼NW¼ sec. 20	do	Nov. 19, 1948	46	316							163									
SE¼SE¼ sec. 20	do	Aug. 30, 1948	55	333	1.0		40	6.7	26		166		40	5.0			200	128	0	31
NE¼NE¼ sec. 23	do	Nov. 5, 1947	51	331	.1				4.1		154		32	8.0				162		5
Do	do	Nov. 4, 1947	51	326	1.7				33		118	20	6	6.2				72		50
Do	do	July 14, 1948	54	303	.3				8.0		156		30	3.5	.2			147		11
Do	do	Oct. 20, 1948	52	339							169									
NW¼NE¼ sec. 23	Open drain	Oct. 20, 1948	54	323							142	7.9								
NE¼NW¼ sec. 23	Box drain	Nov. 4, 1947	52	368	2.0	39			42		178		22	6.2				86		52
Do	do	Mar. 13, 1948	45	353	.2				6.0		167		24	7.0				159	22	8
Do	do	Apr. 7, 1949	52	354		33					168		31	5.5						
Do	do	Nov. 17, 1949		301							152									
SE¼SE¼ sec. 25	do	Nov. 5, 1947	50	315	.5				13		158		32	5.0				141		17
Do	do	Aug. 30, 1948	52	306							150									
Do	do	Oct. 20, 1948	53	318							174									
Do	do	Apr. 7, 1949	42	328		38					159		26	6.5						
Do	do	Aug. 25, 1949	54	285	.6				14		140		19	5				112	0	21
Do	do	Nov. 16, 1949		315							150									
NE¼NE¼ sec. 28	Drain	Nov. 16, 1949		408							168		50							
SE¼SE¼ sec. 36	Box drain	Nov. 5, 1947	52	344	.1				2.1		170		32	6.0				177		2
Do	do	Apr. 22, 1948	46	327	.5	38	42	8.6	14		162		22	8		4.9	217	140	8	18
Do	do	July 14, 1948	55	258	.5		32	5.2	12		123		20	4.5			134	102	0	21
Do	do	Nov. 19, 1948	49	326							156									
T. 40 N., R. 9 E.:																				
NW¼NW¼ sec. 5	do	Nov. 9, 1943		289	.7		34	7.4	18								208			25
NW¼NW¼ sec. 11	Center drain	May 1, 1940			2.0		21	9.0	44		163		30	14		.25	199	89		52
NW¼NW¼ sec. 31	Box drain	Nov. 5, 1947		376	.8				23		182		36	7.0				147		25
Do	Open drain	Apr. 22, 1948		372	.7	39	46	7.9	19		176		27	8		6.2	240	148	4	22

Do	do	Aug. 30, 1948		361						172									
Do	do	Oct. 20, 1948	53	379						181									
Do	do	Nov. 19, 1948	50	377						186									
Do	do	Apr. 7, 1949	46	379		37				177		30	6.5						
Do	do	Apr. 25, 1949	57	339	.5				14	170		20	5				136	0	
Do	do	Nov. 16, 1949		370						176									
T. 40 N., R. 10 E.:																			
NE¼NE¼ sec. 28	do	June 15, 1936		538	1.1		56	13	36	156		118	25		0	325	350		31
Do	do	July 15, 1947		456	1.5	31	46	9.3	43	164		82	18	.2	.7	311	153	18	38
Do	do	Apr. 22, 1948	57	385	1.0	38	42	9.4	28	162		47	16		1.2	261	144	11	30
Do	do	June 2, 1948	68	321	.9				20	101	15	10	12	.3			93		32
Do	do	July 14, 1948	70	352	2.1				44	124	15	40	8.0	.3			84		53
Do	do	Oct. 20, 1948	55	429	1.1	47	49	9.2	31	167		59	17		5.8	300	160	24	29
Do	do	Nov. 19, 1948	34	524	1.2	44	60	11	40	206		76	21		5.0	358	194	26	31
Do	do	Mar. 8, 1949	36	345	1.2	37	38	6.2	31	152		42	12		4.1	245	120	0	36
Do	do	Apr. 14, 1949	48	392	1.1		44	7.8	30	164		48	13		4.4	228	142	7	31
Do	do	June 2, 1949	57	381	.9	38	43	8.8	26	153		53	12		2.2	258	144	18	28
Do	do	July 20, 1949	68	425						173		54	14						
Do	do	Nov. 16, 1949		392						167									
Do	do	Mar. 17, 1950	42	417	.8	40			24	174		48	13		4.6		163	20	24
SE¼NE¼ sec. 28	Farmers' Union canal.	June 2, 1948	68	96	.7		11	1.9	9.7	56		8	1.5			60	36	0	37
Do	do	July 14, 1948	71	89	.3														
Do	do	June 2, 1949	58	74			12	2.4	3.9	48		8	.5			50	40	0	18
Do	do	July 20, 1949	71	93			9.8	1.6		39		5.0					31	0	
NW¼NW¼ sec. 28	Open drain	Aug. 30, 1948		394	1.4					44									
									36	144	14	47	15				132		37
T. 40 N., R. 11 E.:																			
SE¼SE¼ sec. 14	Sand Creek gaging station.	Mar. 28, 1946		200						100		4	4	.5	1.5				
SW¼SW¼ sec. 14	West Bank of Head Lake.	July 15, 1947		351	1.2	26	35	9.3	31	203		14	6.0	1.0	.8	223	126	0	
NE¼NE¼ sec. 23	Head Lake	Oct. 9, 1943		19,030	112		24	78	5,010			3,340				17,134			97
Do	1,000 feet east of South Bay of Head Lake.	Oct. 9, 1943		243	.8		23	7.4	17							250			30
Do	Below Sand Creek gaging station.	Mar. 28, 1946		201						102		5	2	.4	2.5				
NE¼NW¼ sec. 25	Soda Lake	Nov. 13, 1946		1,300						630		160	43						
SE¼NE¼ sec. 26	North end, San Luis Lake.	Nov. 13, 1936		904	4.9	28	26	24	145	402		88	38	1.6	0	549	578		66
Do	North end, San Luis Lake at inlet.	May 1, 1940			4.9		22	30	149	443		83	38		.25	540	178		64
SE¼SE¼ sec. 35	San Luis Lake, from pier at gun club.	Mar. 27, 1946		966		8.5				397	20	99	38	3.2	1.0				

TABLE 8.—*Analyses of surface water*—Continued

Location	Description	Date of collection	Temperature (°F)	Specific conductance (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (sum)	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
T. 40 N., R. 11 E.—Con.																				
SE¼SE¼ sec. 35	San Luis Lake; pier at gun club.	July 15, 1947		1,070	6.9	5.5	20	26	199		420	43	100	48	0.9	0.5	650	157	0	73
NW¼SW¼ sec. 35	South end, San Luis Lake.	June 15, 1936		1,020	5.1		19	29	150	55	410		111	46		.6	613	165		71
Do	San Luis Lake, 8 feet below surface.	June 6, 1941		928	5.6		20	25	158								587			69
Do	San Luis Lake, at surface.	Oct. 12, 1943		939	5.1		13	25	137								620			69
T. 41 N., R. 8 E.:																				
NW¼NE¼ sec. 6	Open drain	Apr. 22, 1948	52	158	.4	27	20	7.2	7.4		92		15	3.0		.4	125	80	4	17
Do	do	June 2, 1948	59	87	.2		11	2.9	3.2		50		5	.2			47	40	0	15
NW¼NW¼ sec. 6	do	June 2, 1948	62	215	.5		27	6.3	11		112		20	3.5			123	94	2	21
Do	do	July 14, 1948	65	137	.5		17	2.9	9.0		81		6	1.2			76	54	0	26
Do	do	Aug. 30, 1948	67	127							72									
Do	do	Oct. 20, 1948	50	179							103									
Do	do	Nov. 19, 1948	33	348	.8	39	40	9.9	21		169		30	8.0		5.5	237	140	2	24
Do	do	Nov. 19, 1948	33	330							167									
Do	do	Jan. 20, 1949	34	226	.8	36	30	7.6	20		148		17	4.5		4.8	193	106	0	29
Do	do	Mar. 8, 1949	40	256	.8	35	29	7.9	19		146		17	4.5		3.1	187	105	0	28
Do	do	Apr. 4, 1949	47	284		31					146		20	6.5						
Do	do	Apr. 14, 1949	47	243	.7		28	6.8	16		128		16	4.5		5.7	140	98	0	
Do	do	June 2, 1949	55	175							91		9.0				43			
Do	do	July 20, 1949	63	205							110		12	3.0						
Do	do	Nov. 22, 1949		305							155									
Do	do	Mar. 17, 1950	40	290	.6	34			15		146		19	7		2.6		119	0	22
Do	do	Feb. 13, 1950	38	265		36			12		136		16	6		3.1	114		2	
sec. 12	Gibson drain	June 15, 1936		366	.9		43	8.4	25		166		36	13		2.5	210	225		28
NW¼SW¼ sec. 31	Farmers' Union canal.	June 2, 1948	53	63	.3		7.8	2.1	3.9		39		3	1.2			37	28	0	23
Do	do	July 14, 1948	55	63	.7		10	2.6	10		36		3	0			33	36	6	
Do	do	June 2, 1949	49	66			9.0	1.4			33		5.0					28	2	
Do	do	July 20, 1949	68	82							40									

T. 41 N., R. 9 E.:																			
NE¼NE¼ sec. 3	Gibson drain	Nov. 8, 1943	...	393	1 2	...	35	9.7	31	...	...	...	...	...	...	304	...	...	...
NW¼NW¼ sec. 32	Open drain	Nov. 4, 1947	...	357	.6	...	...	...	16	160	...	20	11	...	...	...	132	...	21
T. 41 N., R. 10 E.:																			
SW¼SW¼ sec. 23	Sylvester drain	May 5, 1941	...	422	11	...	5.0	.24	93	...	...	...	...	...	...	390	...	...	94
T. 42 N., R. 7 E.:																			
SE¼SE¼ sec. 36	Drain	Nov. 22, 1949	...	268	...	...	...	...	...	139	...	...	...	...	...	...	...	...	...
T. 42 N., R. 8 E.:																			
SW¼SW¼ sec. 31	Open drain	Apr. 22, 1948	52	148	.6	27	20	6.4	12	102	...	14	3.0	...	.4	133	76	0	25
Do	do	Dec. 4, 1948	34	306	...	...	...	...	...	151	...	...	...	...	...	...	...	...	...
Do	do	June 2, 1949	53	73	...	...	...	...	...	43	...	7.8	...	...	...	...	31	...	...
Do	do	July 20, 1949	64	102	...	...	...	...	...	55	...	...	...	...	...	...	...	...	...
SE¼SE¼ sec. 31	Rio Grande lateral.	Apr. 14, 1949	44	150	...	...	...	...	...	80	...	10	2.0	...	...	...	...	...	...
T. 43 N., R. 7 E.:																			
SW¼NW¼ sec. 24	Russell Springs	Dec. 9, 1948	38	242	.7	66	30	4.2	16	122	...	17	6.0	...	2.1	201	92	0	...

TABLE 9.—*Analyses of water from wells that were test-pumped*

Well: Numbers correspond to those given in table 6 and shown on plate 16. Letters following the numbers refer to samples from pilot wells used in test-pumping numbered wells.

SAR: Sodium-adsorption ratio.

Hardness as $CaCO_3$: Total hardness was calculated from calcium and magnesium where these constituents are reported; hardness was determined by the soap method where calcium and magnesium are not reported.

(Dissolved constituents are given in parts per million. One ppm is equal to 8.33 pounds of substance per million gallons of water.)

Well	Location	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance, (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
	T. 38 N., R. 10 E.:																				
1 [1]	NW¼NW¼ sec. 6	40.0	Nov. 1, 1949		802	1.7				66	196		203	42		1.7			290	130	33
1 [2]	do	40.0	Nov. 3, 1949	52	568	1.1				36	118		132	39		3.1			213	116	27
1 [3]	do	40.0	Nov. 4, 1949		574						120										
	T. 38 N., R. 11E.:																				
3	NE¼NE¼ sec. 14	46.0	July 19, 1946	51	2,720		49				496		300	338	1.0	1.7	0.09				
3a	do	25.0	July 26, 1946	53	2,000	7.8	7.5	77	33	325	322		416	236	1.4	.5	.36		328		
5a	NW¼NW¼ sec. 25	22.0	July. 25, 1946	59	1,440						198		200	130	1.5		0				
5b	do	15.0	Aug. 14, 1946		1,060	6.0	13	39	12	168	124		275	86	1.4	.1	.92	656	147	46	71
5c	do	20.0	Aug. 14, 1946		1,410	4.1				158	224		250	121	1.1		.18		273	90	56
7	SE¼SE¼ sec. 35	35.0	Aug. 5, 1946	53	230	2.3	41	16	2.3	37	135		17	1	.4	0		181	50		62
7a	do	35.0	Aug. 6, 1946	55	251	1.7				33	126		25	10			0		72	0	50
7b	do	15.0	Aug. 14, 1946		300	4.3				104	191		100	44	4.0				108	0	68
7c	do	30.0	Aug. 14, 1946		227	1.5				26	116		10	6	.8				60	0	48
	T. 39 N., R. 9 E.:																				
9	NE¼NE¼ sec. 24	40.0	Oct. 31, 1949	49	779	1.2				48	191		196	39		.2			312	156	25
	T. 39 N., R. 10 E.:																				
11	NW¼NW¼ sec. 7	40.0	Oct. 21, 1949	51	560	1.1				36	128		126	32		5.0			206	101	28
	T. 39 N., R. 11 E.																				
12	NW¼NW¼ sec. 3	54.0	Aug. 1, 1946	54	2,340	17				513	1,160		150	125	1.5		13.8		171	0	87

12a	do	45.0	Aug. 1, 1946	57	1,890						975		100	110							
12b	do	20.0	Aug. 7, 1946	54	8,510						2,460	718			5.6		1.8				
12c	do	35.0	Aug. 7, 1946		1,650	20				391	844	49	30	74	4.0		1.4		69	0	92
12d	do	40.0	Aug. 8, 1946		1,390	16				340	794	37	20	54	4.0		.55		81	0	
13	NW¼SW¼ sec. 13	45.0	July 10, 1946	67	16,500		38				7,030	315			4		3.7				
13a	do	35.0	July 22, 1946	59	16,000						6,030	934			3.6		1.8				
13b	do	15.0	July 22, 1946	59	8,510						2,700	536			5.6		13.8				
13c	do	35.0	July 22, 1946		16,300						6,440	708			3.6		13.8				
13d	do	26.0	July 22, 1946	59	14,500						5,660	511			5.6		13.8				
13e	do	20.0	July 22, 1946		7,530						2,850	605									
14	SE¼NE¼ sec. 16	46.4	Sept. 20, 1946	52	1,850	44	53	5.0	3.4	518	1,240		18	76	4	0	.55	1,290	26	0	98
14a	do	15.0	Sept. 17, 1946		2,630	91				724	1,450	123	40	107					12	0	99
14a	do	20.0	Sept. 17, 1946		3,460	59				909	1,260	433	60	145					45	0	98
14a	do	25.0	Sept. 17, 1946		3,260	61				880	1,700	187	50	138					39	0	98
14b	do	30.0	Sept. 19, 1946		2,620	36				643	1,120	211	26	115					60	0	96
14b	do	40.0	Sept. 19, 1946		1,560	28				416	760	123	26	65					42	0	96
14b	do	46.0	Sept. 19, 1946	53	1,190	32				365	905		26	35					24	0	97
15	SE¼SE¼ sec. 23	47.0	July 19, 1946	51	12,700		63				6,260				8		7.4				
15	do	70.0	July 15, 1946	63	12,000	47				2,840	2,540		2,000	1,550	.9		.91		705	0	90
15	do	34.0	July 23, 1946	57	9,850		29				4,720	138					7.4				
15	do	24.0	July 23, 1946	57	7,040		29				3,170						2.8				
15	do	47.0	July 23, 1946	54	14,200		35				6,500	197			4		7.4				
15	do	11.0	July 23, 1946	53	3,120	55				663	995	138	280	85	4.2		1.8		27	0	98
15	do	16.0	July 23, 1946	53	2,220						838	181	250	94	3.9		.91				
16a	NW¼NW¼ sec. 29	23.0	Sept. 16, 1946	53	1,900	13	42	48	14	391	590		338	134	1.4	0	.91	1,260	178	0	83
16b	do	27.0	Sept. 16, 1946	53	1,590	8.4				262	464		200	118					186	0	75
16b	do	32.0	Sept. 16, 1946	53	1,290	15				282	425		200	86					66	0	90
16b	do	50.0	Sept. 16, 1946	53	1,130	20	21	7.5	4.6	280	706		18	33	1.2	0	.91		38	0	94
16b	do	35.0	Sept. 16, 1946	53	1,250	13	36	20	8.6	267	420		192	85	.7		.29	816	86	0	87
18	SE¼SE¼ sec. 35	29	July 26, 1946		25,800						1,170				4.0		1.8				
	T. 39 N., R. 12 E.:																				
19	NW¼NW¼ sec. 3	61.1	Sept. 7, 1946		161						93										
19a	do	26.0	Aug. 21, 1946		179						105		0	5							
19a	do	30.0	Aug. 21, 1946		180	.0				.5	106		0	5					93	6	1
19a	do	35.0	Aug. 21, 1946		170						102										
19a	do	40.0	Aug. 21, 1946		163						93										

See footnotes at end of table.

TABLE 9.—*Analyses of water from wells that were test-pumped*—Continued

Well	Location	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance, (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
	T. 39 N., R. 12 E.—Con.																				
19a	NW¼NW¼ sec. 3	45.0	Aug. 21, 1946		170						98										
19a	do	50.0	Aug. 21, 1946		161						102										
20	SE¼SW¼ sec. 7	39.3	Sept. 12, 1946	53	302	.9	56	30	9.8	22	152		25	9.0	0.4	0	0	227	116	0	30
20a	do	22.0	Aug. 5, 1946		252	1.0				22	130		25	7.0					94	0	34
20a	do	39.0	Sept. 5, 1946		212	1.6	41	15	5.8	29	114		26	3	.4	0	0	176	62	0	51
20b	do	27.0	Sept. 5, 1946		217	.7				15	120		16	3					87	0	27
20b	do	34.0	Sept. 5, 1946		204						121		25	5							
21	SE¼SE¼ sec. 20	47.7	Sept. 14, 1946	52	153	1.5	58	14	3.7	24	108		7.8	3	.3	0	0	164	50	0	51
21a	do	30.0	Aug. 30, 1946		159	.7				14	92		20	2					69	0	31
21a	do	35.0	Aug. 30, 1946		160	1.0				18	90		26	2					64	0	38
21a	do	40.0	Aug. 30, 1946		175	1.2	49	13	4.5	19	99		7.8	1	.4	.2	0	144	51	0	44
	T. 40 N., R. 9 E.:																				
34 [4]	SE¼SE¼ sec. 25	50.0	Oct. 12, 1949	50	299						110										
34 [5]	do	50.0	Oct. 16, 1949	50	296						104										
	T. 40 N., R. 10 E.:																				
35	SW¼SW¼ sec. 2	32.0	Apr. 5, 1946	51	725	1.7	45			63	201		158	41	0	3.0	.05		252	88	35
35	do	60.0	Apr. 6, 1946	51	280	.3	64			4.8	45		5	14				232	51	14	17
35 [6]	do	83.4	Apr. 28, 1946	52	410						162		25	16							
35a	do	52.0	Apr. 12, 1946	53	506	2.7		35	8.5	69	158		99	28		2.1		319	122	0	55
35b	do	52.0	Apr. 13, 1946	51	520	.7	45			21	151		30	29				371	150	26	23
35c	do	154.8	Apr. 15, 1946	50	508	1.7	41	48	10	49	150		94	30	.9	1.8	.02	362	161	38	40
35d [7]	do	115.0	Apr. 16, 1946	54	579	3.6				89	176		121	29					118	0	62
35d [8]	do	115.0	Apr. 16, 1946		434	5.3	85	14	3.7	87	175		63	18	.9	1.6	.06	379	50	0	79
35e	do	117.1	Apr. 16, 1946	52	436	3.5				72	177		60	21		1.9			81	0	66

36	SW¼SW¼ sec. 5	32.0	Oct. 7, 1946	52	251						137										
36	do	32.0	Oct. 8, 1946	52	155	1.8	64	10	3.1	26	92		16	2				166	38	0	61
36a	do	22.0	Oct. 7, 1946	52	143	.4				7.4	87		12	1.5					70	0	19
36b	do	26.0	Oct. 7, 1946	50	144						82		12	2.2							
36c	do	38.0	Oct. 8, 1946	52	295	.9				22	140		28	8.5					108	0	31
37	SW¼NW¼ sec. 20	22.0	Oct. 15, 1946		587	2.3	36	52	10	69	197		121	24				409	170	9	47
37a	do	27.0	Oct. 15, 1946		928						190										
37a	do	32.0	Oct. 15, 1946		1,000	.7	34	150	26	36	189		321	50				710	482	326	14
38	SE¼NE¼ sec. 21	22.0	Oct. 9, 1946		329	1.2				31	137		60	12					124	12	34
38a	do	37.0	Oct. 9, 1946	54	354						133		60	17							
38b	do	50.0	Oct. 9, 1946		168						97		24	4.8							
38c	do	27.0	Oct. 9, 1946		391						144		120	16							
38d	do	32.0	Oct. 9, 1946		418	.8				24	147		70	18					156	36	29
	T. 40 N., R. 11 E.:																				
39a	NE¼SE¼ sec. 1	10.0	May 29, 1946	50	210	.2				3.4	100		5	2	2.0		.09		88	6	8
39a	do	20.0	May 29, 1946	50	172	.1				1.2	98		5	2	1.6				90	10	3
39a	do	25.0	May 29, 1946	50	153	.1				1.2	78		10	2	.4				76	12	3
39a	do	30.0	May 29, 1946	50	110	.1				2.1	54		5	2	4.0				58	14	7
39a	do	40.0	May 29, 1946	50	120	.2				3.7	69		10	2	.8				64	8	11
39a	do	52.0	May 29, 1946	50	97	.1				.9	50		10	1	1.2				54	13	4
40	SW¼SW¼ sec. 6	42.4	May 2, 1946	52	973						551		40	25							
40	do	60.9	May 7, 1946	53	538	3.4				85	310		30	11					116	0	61
40a	do	24.8	May 8, 1946	52	1,310	12	56	28	9.2	283	608		139	50	3.9	.1		869	108	0	85
40b	do	60.0	May 7, 1946	53	263						135	14	13	3							
40c	do	49.0	May 9, 1946	54	503	4.1				86	272		25	13	.4		.18		82	0	69
41	NW¼NW¼ sec. 9	76.0	May 9, 1946	52	265						138		18	9.0							
41a	do	47.0	May 17, 1946	50	154						90		12	1.0							
41b	do	43.0	May 17, 1946	51	182						100		11	2							
41b	do	53.0	May 17, 1946	50	137						87		4	1.0							
41b	do	57.0	May 17, 1946	51	140	.3	51	22	3.1	5.8	84		8.4	.5	.8	.1		133	68	0	16
41c	do	27.6	May 21, 1946	50	200						175		12	2.5							
42a	NE¼NE¼ sec. 10	38.0	May 23, 1946	50	219	.2				3.7	68		15	3	.8	0			69	14	10
42a	do	52.0	May 23, 1946	50	167	.2				3.7	78		15	1	.8	0			75	11	10
42a	do	59.0	May 23, 1946	51	135						77		8.0	1.2							
42a	do	61.0	May 24, 1946	50	146						85		10	1	.8						
42a	do	66.5	May 24, 1946	51	156						105		2	1	.8						

See footnotes at end of table.

TABLE 9.—*Analyses of water from wells that were test-pumped*—Continued

Well	Location	Depth (feet)	Date of collection	Temperature (°F)	Specific conductance, (micromhos at 25°C)	SAR	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (sum)	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
	T. 40 N., R. 11 E.—Con.																				
42b	NE¼NE¼ sec. 10	22.8	May 23, 1946	50	105						50		12		0.8						
43	SW¼SE¼ sec. 15	100.0	June 3, 1946	54	261	1.7	46	14	8.1	33	140		16	1	1.6	5.6	0	194	68	0	51
43a	do	22.0	June 4, 1946	49	1,380		36				802		30	50	1.6	.3	.18				
43b	do	35.0	June 6, 1946		642	1.8	43	60	17	63	381		22	13	.8	.5	0	407	220	0	38
43b	do	43.0	June 6, 1946	60	647		42				380		1	15	.8	.4	0				
43b	do	50.0	June 6, 1946		863		48				728		16	20	.4	.1	0				
43b	do	52.0	June 6, 1946		799	2.1	38	75	27	83	494		37	23	.4	1.2	.09	528	298	0	38
43b	do	57.0	June 29, 1946	52	592	.6	8.8	72	25	23	300		49	24	.2	.2	0	350	282	36	15
43c	do	26.0	June 5, 1946	51	1,070		43				628		42	37	.4	.3	0				
44	SW¼NW¼ sec. 19	46.0	Oct. 4, 1946	52	384	1.8		35	6.6	45	130		83	14				248	114	8	46
44a	do	32.0	Sept. 30, 1946		495						134			19							
44a	do	37.0	Sept. 30, 1946		451						144			15							
44a	do	42.0	Sept. 30, 1046		353						148			11							
44b	do	46.0	Oct. 20, 1946		361						144			11							
45a	SE¼SE¼ sec. 22	50.0	Sept. 26 ,1946		445	2.5	45	30	12	63	290		16	4	.8	0	0	314	124	0	52
45b	do	25.0	Sept. 25, 1946	60	1,320	3.8				174	865		26	34					405	0	48
45b	do	30.0	Sept. 25, 1946	55	1,430	3.4				172	974		20	36					495	0	43
45b	do	35.0	Sept. 26, 1946	57	909	1.8				80	592		20	20					360	0	33
45b	do	45.0	Sept. 26, 1946		696	2.6	35	59	18	90	476		7.0	11	1.4	0	0	456	221	0	47
46a	SW¼SW¼ sec. 32	15.0	Aug. 12, 1946		1,530	7.8				287	944		25	53	1.2		.36		254	0	71
46a	do	22.0	Aug. 12, 1946		1,550	2.8	49	161	42	156	922		61	65	0	2.5	.18	991	574	0	37
46a	do	29.0	Aug. 12, 1946		808	3.0				107	426		75	29	.4		0		237	0	49
46a	do	33.0	Aug. 12, 1946		490	1.4				50	245		10	15	.4				225	0	46
46a	do	39.0	Aug. 12, 1948		351	2.5				53	185		30	9	1.2		.09		82	0	59
47	SE¼SE¼ sec. 35	47.4	June 30, 1946	49	5,740		45				1,440	767			12		5.5				
47	do	57.0	June 25, 1946	51	7,740		57				1,850	1,030			12		3.7				
47a	do	20.0	July 11, 1946	53	3,790	89				1,060	830	570	300	282			1.4		27	0	99
47a	do	20.0	June 20, 1946		2,860		46				610	502			6		2.3				

47b	do	40.0	June 20, 1946		6,150		50				1,600	915			14		7.4				
47c	do	26.0	July 11, 1946	53	4,380						1,000	625			4		1.4				
47c	do	48.0	June 20, 1946	52	8,060		43				1,725	1,240			14		11.0				
	T. 40 N., R. 12 E.:																				
48	SW¼SW¼ sec. 32	20.0	Aug. 15, 1946		440						220		25	15							
48	do	25.0	Aug. 15, 1946		226	.1				1.8	117		15	4	.4				114	18	3
48	do	35.0	Aug. 15, 1946		156	.7				12	86		10	2	1.2				60	0	31
48	do	40.0	Aug. 15, 1946		227						101			0							
48	do	48.0	Aug. 15, 1946		191						129										
48	do	54.0	Aug. 15, 1946		184						117		0	2							
	T. 41 N., R. 9 E.:																				
49 [9]	NE¼NE¼ sec. 1	60.0	Sept. 9, 1949	53	1,220						276										
49 [10]	do	60.0	Sept. 9, 1949	53	1,260	1.6				83	280		353	67		11			521	292	26
	T. 41 N., R. 10 E.:																				
50 [11]	SW¼SW¼ sec. 7	50.0	Oct. 4, 1949	50	305						130										
50 [12]	do	50.0	Oct. 5, 1949	50	299	1.0				23	130		36	8.5		.5			107	0	32
50 [13]	do	50.0	Oct. 7, 1949	50	299						131										
52	NW¼NW¼ sec. 29	32.0	Oct. 10, 1946		403						158		2	12					142	12	
52a	do	20.0	Oct. 8, 1946		622	1.5				51	184		140	27					224	73	33
52b	do	32.2	Oct. 9, 1946		380						145		80	11							
52c	do	34.0	Oct. 8, 1946		343	1.0	42	45	9.0	28	147		74	9				279	150	29	29

[1] Sample taken before pumping started.
[2] Sample taken 30 minutes after pumping started.
[3] Sample taken 27 hours after pumping started.
[4] Sample taken 1½ hours after pumping started.
[5] Sample taken 64 hours after pumping started.
[6] Sample taken 24 hours after pumping started.
[7] Sample takeu 10 minutes after pumping started.
[8] Sample taken 30 minutes after pumping started.
[9] Sample taken 2½ hours after pumping started.
[10] Sample taken 26 hours after pumping started.
[11] Sample taken 15 minutes after pumping started.
[12] Sample taken 24 hours after pumping started.
[13] Sample taken 69 hours after pumping started.

TABLE 10.—*Records of wells in part of San Luis Valley*

Well: Well-numbering system is described on p. 9. Wells in secs. 5, 6, 7, and 8, T. 37 N., R. 8 E., and wells in secs. 27, 28, 29, 32, 33, and 34, T. 38 N., R. 8 E. are shown in fig. 9; other wells are shown in pl. 1.
Depth of well: Measured depths are given in feet and tenths of a foot; reported depths are given in feet.
Type of casing: B, boiler steel; GI, galvanized sheet iron; GP, galvanized iron pipe; I, iron pipe; OB, oil barrels: R, rock; T, tile; W, wood.
Method of lift: C, horizontal centrifugal pump; Cy, cylinder pump; F, natural artesian flow; N, none; P, pitcher pump; T, turbine pump. Type of power: B, butane or propane engine; E, electric motor; G, gasoline engine; H, hand operated; N, none; T, tractor.
Use of water: D, domestic; F, fish hatchery; I, irrigation; O, observation; P, public supply; S, stock; SW, swimming pool.
Distance to water level: Measured water levels are given in feet and tenths and hundredths of a foot; reported water levels are given in feet.
Discharge: E, estimated; M, measured; R, reported.
Drawdown: M, measured; R, reported.
Remarks: "Sample" indicates that sample of water was collected for chemical analysis, which is given in table 7. Wells are drilled unless otherwise indicated under "Remarks."

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of— Water level	Date of measurement of— Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
36-8-1aa	Sallie Blakey	9.2	3	GI	N	O	Top of pipe, east side	0.5	7,615.5	4.95	Apr. 20, 1949					Jetted well.
1bc	John Schroeder	105	14	GI	T, T	I										
1cc1	Annie West Wood	14	120	W	C, T	I	Top of wooden crib, south side.	0		6.03	Mar. 10, 1949					Dug well.
1cc2	do		14	GI	T, E	I	Top of casing, east side	1.5		4.02	Mar. 9, 1949		1,287, M			Obtains water from Santa Fe formation.
1db	do	65	16	GI	T, E	I										
2aa	C. B. West		2	I	F	S						June 17, 1949	1.5, M		52	
2cc	J. Spradlin	60	12	GI	T, E	I										
2dc1	C. B. West				T, E	I										
2dc2	do	60			T, E	I							437, M			Sample.
3ac1	W. H. Ticken	47.7	18	GI	C, N			−2.8		14.54	Mar. 14, 1949					Unused irrigation well.

3ac2	do	39.2	18	GI	T, N		Hole in pump base, south side.	1.1		18.20	Mar. 14, 1949					Do.
3ac3	do	44.6	20	GI	T, G		Top of wooden crib, east side.	0		17.24	Mar. 14, 1949					
3dd	J. Spradlin	29.1	18	GI	T, N		Topofcasing, northside	.4		16.82	Mar. 14, 1949					Do.
11ac	Alice T. West				T, E	I										
11db	D. and K. Ono	160	12	GI	T, E	I										
11dc	Clyde E. Helms				T, E	I										
12ac	Ralph L. Smith				T, E	I										
12bc	W. H. Zacheis				T, E	I							798, M			
12cc	Alice T. West	73		GI	T, E	I							946, M		50	
12dc	Ralph L. West	160	16	GI	T, E	I										
13aa	Alamosa County	9.5	3	GI			Top of pipe	.4	7,638.4	6.15	Apr. 20, 1949					Jetted well.
13ac	Clydeand Grace Helms	75	16	GI	T, E	I										
13bc	Clay E. McElhinney	88.8	16	GI	T, G	I	Top of casing, east side	—.4		15.38	Mar. 10, 1949					
13cc	W. Wayne O'Toole				T, E	I										
13dc1	Clyde E. Helms	55	16	GI	T, E	I										
13dc2	do	55	16	GI	T, E	I							900, E			
24ac	J. H. Kelly	75	16	GI	T, E	I							1,000, E			
24bb	Alice T. West	75	16	GI	T, E	I							1,000, E			
24bc	do	98	18, 16	GI	T, G	I										
24dc	J. E. Mott	68	16	GI	T, E	I										
25ac1	C. L. Ulstrom				T, E	I										
25ac2	do				T, E	I							681, M	18, M		
25db	Thomas H. Brown	59.7	20	GI	T, E	I	Top of casing, north side	0		8.79	Mar. 10, 1949		682, M	9, M		
36-9-1ac1	Marvin Gammon	60	6	I	F	I							20, E			Sample.
1ac2	do	620	6	I	F	I							30, E			Obtains water from Santa Fe formation.
3bc	D. L. and Louise Martin.	457	8	I	F	I							300, E		56	
3cd	Wayne Wilson		6	I	F	I							50, R			
4ac	Ray R. Cody	400	8	I	F	I							300, E		54	
4ba	Ruby Wilcox		4	I	F	I							38, M		50	
5bb1	Edward L. Bolt		6	I	F	D, I									51	
5bb2	do		6	I	F	I									55	
6bc	Frank Uyeda	160	16	GI	F, T, T	I							900, E			Sample.
6cc	Loraine M. Schroeder	642	12, 10	I	F, T, E	I							744, M		58	Obtains water from Santa Fe formation. Flow estimated at 100 gpm.
7cc	Beatrice Ryker	748	12, 10	I	F, T, E	I							2,289, M			Obtains water from Santa Fe formation. Flow estimated at 25 gpm. Sample.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of— Water level	Date of measurement of— Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
36-9-7dc	Milton O. Gura		16	GI	F, T, E	I							588, M			Flow estimated at 75 gpm.
8cc	Daniel Mascarenas	17.1	18	GI	C, N		Top of casing, west side	0.8		6.34	Mar. 11, 1949					Unused irrigation well.
9cc	Alamosa County	5.7	3	GI	N	O	Top of casing, south side	.5	7,600.1	3.19	Apr. 21, 1949					Jetted well.
10cc	A. R. Claunch		4	I	F	I							47, M		51	Plugged at 1 foot.
11dd	Juan Valdez		2	I	F	S							18, M		55	
12cc	Maurice T. Smith		4	I	F	I							1, E		56	
13aa	Alamosa County	10.4	3	GI	N	O	Top of pipe, south side	.5	7,558.6	1.92	Apr. 21, 1949				56	Jetted well. Sample.
15aa	do	10.0	3	GI	N	O	Top of pipe, north side	.6	7,577.7	4.68	Apr. 21, 1949					Jetted well.
17cc	Hazel M. Johnson	497	16, 12	I	F, T, E	I							1,490, M	35, R	59	Measured artesian flow, 408 gpm. Obtains water from Santa Fe formation.
17cb1	do		16	GI	T, T	I										
17cb2	do		3	I	F	S, I							2, E			Plugged at 6.5 feet.
18bc	Fred W. Pottberg	48.3	30, 16	GI	T, E	I	Edge of timber support, west side.	0		6.68	Mar. 11, 1949		753, M			
18cb	do				T, E	I										
18cc	Horace W. Kelley	24.0			T, E	I	Top of casing, east side	1.3		8.45	Mar. 11, 1949					Battery of 6 wells.
18dc	J. V. Edgmond	602	12, 10	I	F, T, E	I							1,096, M			Obtains water from Santa Fe formation.
19ac		603	18, 14	I	F, T, E	I							2,230, M	36, R		Do.
19bc1			18	I	T, T	I										
19bc2	Horace Kelly	30.4	14	GI	T, E	I	Top of casing, south side	0		6.08	Mar. 10, 1949		600, E			Battery of 4 wells.

19cc	Clifford Colman	73	16	GI	T, N											Unused irrigation well.
19dc	C. L. Ulstrom	527	18, 14	GI	T, E	I		.9		4.55	July 12, 1950		2,500, M	34, R		Obtains water from Santa Fe formation.
30bb		7.8	3	GI	N	O	Top of pipe	.4	7,656.8	4.84	May 12, 1949					Jetted well.
30bc	J. H. Kelly		16	GI	T, E	I										
30cc1		418	20	GP	T, G	I										
30cc2		39.3	18	GP	T, T	I	Top of casing, north side	0		4.53	July 7, 1949					
36-10-5bb	Leon S. Clark		3	I	F	D									68	
7bb1	Nellie Schecter	700	6	I	F	I							600, R		58	
7bb2	do	700	6	I	F	I							600, R			
7bb3	do		10	I	F	I							1,000, R			
9aa	Alamosa County	9.9	3	GI	N	O	Top of pipe, east side	.5	7,536.6	4.75	Apr. 29, 1949					Do.
37-7-1bb	G. M. Haigler		10	I	T, E	I										
12ad1	Lazy U Cattle Co		2	I	F	S, I						June 15, 1949	12, M		55	
12ad2	do		2	I	F	S, I						June 15, 1949	7, M		55	
12dd	do		2	I	F	I							25, M		59	
13bc	Ted Still		14	I	T, E	I										
37-8-1cc	Nick Lehners	480	2	I	F	S, I	Top of 2-inch pipe	1.2	7,600.5	+35.53	June 17, 1949		8, M		58	
1dd	Rio Grande Co	10.2	3	GI	N	O	Top of pipe, east side	.5	7,592.7	6.95	June 19, 1949					Do.
2cc	John Berry	119.8	3	I	F	S, I						June 17, 1949	25, M		58	
2dc1	John J. and Lucy Schaffer.	127.4	2	I	F	S, I						June 17, 1949	22, M		56	
2dc2	do		2	I	F	S, I						June 17, 1949	3, M		53	
3bb	John Berry		3	I	F	S, I						June 6, 1949	200, M		56	
3bc	do	342.6	6	I	F	S, I, O	Top of 4-inch valve	2.5	7,615.8	+28.93	Aug. 15, 1950		150, M		55	
3cc1	Joseph E. Long		2	I	F	S, I							1, E		51	
3cc2	do	409	6	I	F	S, I							10, E		54	
3dc1	John Berry	134.6	6	I	F	S, I						May 6, 1949	14, M		52	
3dc2			3	I	F	S, I						May 6, 1949	25, M		52	
4cd	E. Salazar	254.3	2	I	F	S, I						May 9, 1949	18, M		54	
4db	Peter Kessler		2	I	F	S, I						May 10, 1949	20, M		53	
4dc1	do		2	I	F	S, I						May 10, 1949	25, M		54	
4dc2	do	235.6	2	I	F	S, I						May 10, 1949	15, M		53	
4dd1	do		2	I	F	S, I						May 10, 1949	20, M		54	
4dd2	do		2	I	F	S, I						May 10, 1949	20, M		52	
5bc1	Frank Inc	138.3	2	I	F	S, I						May 9, 1949	57, M		51	
5bc2	do		2	I	F	S, I							1, E		49	
5bc3	do		2	I	F	S, I							5, E		50	
5bc4	do	75.4	2	I	F	S, I						May 9, 1949	50, M		50	
5bc5	do		2	I	F	S, I						May 9, 1949	19, M		50	
5cb1	do		2	I	F	S, I						May 9, 1949	15, M		50	
5cb2	do		2	I	F	S, I						May 9, 1949	30, M		50	
5cb3	do		2	I	F	S, I						May 9, 1949	50, M		50	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point			Distance to water level above (+) or below measuring point (feet)	Date of measurement of—		Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
							Description	Distance above or below (−) land surface (feet)	Height above sea level (feet)		Water level	Discharge				
37–8–5cc1	Frank Inc.	111.2	2	I	F	S, I						May 9, 1949	27, M		50	
5cc2	do	99.0	2	I	F	S, I						May 9, 1949	20, M		50	
5cc3	do		2	I	F	S, I						May 9, 1949	21, M		50	
5cc4	do		2	I	F	S, I						June 9, 1949	30, M		51	
5cc5	do		2	I	F	S, I						May 6, 1949	25, M		51	
5cc6	do		2	I	F	S, I						May 9, 1949	30, M		50	
5cd	do		2	I	F	S, I						May 9, 1949	24, M		51	
6bb	Frank L. and Edna Rodman.	168	20, 16	GI	T, F, E	I						Aug. 1, 1950	588, M		51	Estimated flow, 10 gpm.
6cb1	Frances Sheridan		2	I	F	S, I							2, E		50	
6cb2	do		2	I	F	S, I							1, E		50	
6cb3	do		2	I	F	S, I							1, E		50	
6cc1	do	85.3	2	I	F	S, I							1, E		50	
6cc2	do		3	I	F	S, I						May 9, 1949	27, M		50	
6dc1	Frank Inc.		2	I	F	I						May 9, 1949	8, M		50	
6dc2	do		2	I	F	S, I						May 9, 1949	15, M		49	
6dc3	do		2	I	F	S, I						May 9, 1949	41, M		50	
6dc4	do		2	I	F	S, I							2, E		49	
6dc5	do	200	2	I	F	S, I	Top of 2-inch valve	1.1	7,633.7	+19.33	July 28, 1949		68, M	15.5, M	51	
6dd1	do		2	I	F	S, I						May 9, 1949	45, M		51	
6dd2	do		2	I	F	S, I						May 9, 1949	64, M		51	
7aa1	do	107.8	2	I	F	S, I						May 6, 1949	10, M		50	
7aa2	do		2	I	F	S, I						May 6, 1949	38, M		51	
7aa3	do		2	I	F	S, I						May 5, 1949	29, M		50	
7aa4	do		2	I	F	S, I						May 5, 1949	30, M		50	
7aa5	do		2	I	F	S, I						May 5, 1949	25, M		50	
7aa6	do		2	I	F	S, I						May 6, 1949	20, M		50	
7aa7	do		2	I	F	S, I						May 5, 1949	43, M		50	

7ab1	do		2	I	F	S, I						May 6. 1949	27, M		49
7ab2	do		2	I	F	S, I							35, E		50
7ac	do		2	I	F	S, I						May 5, 1949	39, M		51
7ac2	do		2	I	F	S, I						May 5, 1949	10, M		50
7ac3	do		2	I	F	S, I						May 5, 1949	13, M		50
7ac4	do		2	I	F	S, I						May 5, 1949	27, M		51
7ad1	do		2	I	F	S, I						May 5, 1949	30, M		50
7ad2	do		2	I	F	S, I						May 5, 1949	29, M		50
7ad3	do		2	I	F	S, I						May 5, 1949	25, M		50
7ad4	do		2	I	F	S, I						May 5, 1949	30, M		51
7ad5	do	89.5	3	I	F	S, I						May 5, 1949	30, M		51
7ad6	do		2	I	F	S, I						May 5, 1949	28, M		51
7ad7	do		2	I	F	S, I						May 5, 1949	56, M		51
7ad8	do		2	I	F	S, I						May 5, 1949	27, M		51
7ad9	do		2	I	F	S, I						May 5, 1949	43, M		51
7ba1	do		2	I	F	S, I						May 6, 1949	18, M		49
7ba2	do		2	I	F	S, I						May 6, 1949	20, M		49
7ba3	do		2	I	F	S, I						May 6, 1949	18, M		49
7ba4	do		2	I	F	S, I						May 5, 1949	60, M		50
7bb1	do		4	I	F	S, I						May 6, 1949	83, M		51
7bb2	do		2	I	F	S, I						May 6, 1949	25, M		50
7bb3	do		2	I	F	S, I						May 6, 1949	27, M		50
7bc1	do		2	I	F	S, I						May 5, 1949	30, M		51
7bc2	do		2	I	F	S, I						May 6, 1949	15, M		52
7bc3	do		2	I	F	S, I						May 5, 1949	30, M		50
7bc4	do		3	I	F	S, I						May 5, 1949	25, M		54
7bc5	do	150	2	I	F	S, I	Top of 4-inch valve	.8	7,646.4	+5.64	July 28, 1949		17, M	4.5, M	52
7bc6	do		2	I	F	S, I						May 5, 1949	30, M		52
7bc7	do	98.5	2	I	F	S, I						May 5, 1949	21, M		51
7bd8	do		2	I	F	S, I						May 5, 1949	27, M		50
7bd1	do	84.2	2	I	F	S, I							1, E		50
7bd2	do		2	I	F	S, I						May 5, 1949	15, M		49
7bd3	do	98.3	2	I	F	S, I							25, E		51
7cc	R. G. and Pearl Betts	17.8	16	GI	T, E	I									
8ab	Frank Inc		2	I	F	S, I						May 4, 1949	24, M		52
8ac1	do		2	I	F	S, I						May 4, 1949	60, M		52
8ac2	do		2	I	F	S, I						May 4, 1949	45, M		52
8ac3	do		3	I	F	S, I						May 4, 1949	14, M		52
8ac4	do		2	I	F	S, I						May 4, 1949	43, M		52
8ac5	do		2	I	F	S, I						May 4, 1949	33, M		52
8ac6	do		2	I	F	S, I						May 4, 1949	38, M		52
8ec7	do		4	I	F	S, I							3, E		52
8ac8	do		2	I	F	S, I						May 4, 1949	37, M		52
8ad1	do		2	I	F	S, I						May 4, 1949	38, M		52
8ad2	do		2	I	F	S, I						May 4, 1959	38, M		52

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
37-8-8ad3	Frank Inc.		2	I	F	S, I						May 4, 1949	38, M		52	
8ad4	do.		2	I	F	S, I						May 4, 1949	27, M		52	
8ad5	do.		4	I	F	S, I							3, E		52	
8ad6	do.		2	I	F	S, I						May 4, 1949	38, M		52	
8ad7	do.		2	I	F	S, I							2, E		52	
8ad8	do.		2	I	F	S, I							5, E		51	
8ad9	do.		2	I	F	S, I						May 4, 1949	38, M		53	
8bb1	do.		2	I	F	S, I						May 5, 1949	15, M		50	
8bb2	do.	100.7	2	I	F	S, I						May 5, 1949	20, M		50	
8bc1	do.		2	I	F	S, I						May 5, 1949	17, M		50	
8bc2	do.		2	I	F	S, I						May 5, 1949	30, M		51	
8bc3	do.		2	I	F	S, I						May 5, 1949	15, M		51	
8bc4	do.		2	I	F	S, I						May 5, 1949	12, M		50	
8bc5	do.		2	I	F	S, I						May 5, 1949	25, M		51	
8bd1	do.		2	I	F	S, I						May 5, 1949	30, M		52	
8bd2	do.		2	I	F	S, I						May 5, 1949	30, M		52	
8bd3	do.		2	I	F	S, I						May 5, 1949	30, M		52	
8bd4	do.		2	I	F	S, I						May 5, 1949	36, M		52	
8bd5	do.		2	I	F	S, I							1, E		52	
8bd6	do.		2	I	F	S, I						May 5, 1949	43, M		52	
8cc1	Ralph L. DeBoer	99.9	2	I	F	S, I						May 3, 1949	3, M			
8cc2	do.	73.9	2	I	F	S, I						May 3, 1949	27, M			
8cd1	do.	103.9	2	I	F	S, I						May 3, 1949	14, M			
8cd2	do.	101.1	2	I	F	S, I						May 3, 1949	14, M			
8dc	Elvin E. and Berta Eaton.		2	I	F	S, I						May 3, 1949	23, M			
8dd	do.	116.9	2	I	F	S, I						May 3, 1949	15, M			

9ab	Rolla M. and Leo M. Woods and Ora W. Matzon.		2	I	F	D, S									54	
9bb	O. C. Byland		2	I	F	S, I									52	
9cb	Charles P. Goff	118.5	2	I	F	S, I						May 4, 1949	38, M		52	
9cc	do		2	I	F	D, S							5, M			
10bc	Rolla M. and Leo M. Woods and Ora W. Matzon.	125.9	6, 4	I	F	S									54	
11bb	Jessie R. and Grace A. Davison.		2	I	F	S						June 17, 1949	5.5, M		54	
13ab	W. M. and Winnie Van Iwarden.	520	4	I	F	I, O	Bottom of 4-inch elbow	3.1	7,606.1	+35.14	Aug. 16, 1949		162, M		59	
13bb	Nick and Amelia Lehners.		2	I	F	S, I						June 17, 1949	5, M		52	
13dc1	W. M. and Winnie Van Iwarden.	500	6	I	F	S, I	Bottom of 4-inch valve	1.5	7,609.4	+28.75	Aug. 16, 1949		150, M	18, M	59	
13dc2	do	500	4	I	F	I, O	Bottom of hole in 4-inch T.	1.3	7,608.9	+31.72	Aug. 11, 1949		184, M	12.7, M	59	
14bb	Rio Grande County	10.5	3	GP	N	O	Top of pipe, north side	.4	7,617.8	7.77	Apr. 19, 1949					Jetted well. Sample.
15cb	J. W. Widger		4	I	F	I									53	
16bb	Charles P. Mahl		2	I	F	S							5, E		49	
16cc	do				C, G	I										
17aa	Rio Grande County	9.7	3	GI	N	O	Top of pipe, east side	.3	7,639.3	4.10	Apr. 20, 1949					Jetted well.
17bb	Joseph Neil and William Maestos.		2	I	F	D, S						May 3, 1949	7, M			
17bc	do	206	18	GI	T, T	I	Top of casing, south side	.6		10.73	Aug. 30, 1950					
17cc	B. O. Austin				T, G	I										
18bb	Rio Grande County	8.2	1¼	I	N	O	Top of pipe, west side	.3	7,658.5	6.46	Apr. 29, 1949					Do.
18cc	Ada Welty		16	GI	T, G	I							700, E			
20cc	F. A. Calkins	86.9	20	GI	T, N		Top of pump base, east side.	.8		37.60	Mar. 4, 1949					Unused irrigation well.
20db	Charles P. Goff				C, G	I										
21bc	Phoebe Bogart				C, T	I							800, E			
21dc	do	29.8	14	GI	C, T	I	Top of casing, east side	−3.6		3.09	Mar. 14, 1949					Battery of 2 wells.
22cc	Paul Widger	37.0	14	GI	T, N		Top of casing, north side	0		3.22	Mar. 4, 1949					Unused irrigation well.
22dd	Rio Grande County	10.3	3	GP	N	O	Top of pipe, south side	.4	7,631.5	4.75	Apr. 19, 1949					Jetted well.
23cc	Arvy Daniel		2	I	F	S, I						Aug. 13, 1949	8, M		56	
23dd	Clifford and Leona Tildon.		2	I	F										58	Unused domestic well.
24aa	Rio Grande County	7.9	3	GI	N	O	Top of pipe, east side	.5	7,596.3	2.28	Apr. 19, 1949					Jetted well.
24dc	F. A. Calkins		6	I	F	I							200, E		60	
25bb	Harold and Marjorie Davis.		2	I	F							June 28, 1949	11, M		53	Unused domestic well.
25bc	do	157.0	4	I	F	S, I						June 27, 1949	21, M		54	
26bb	S. Dutton		2	I	F							June 17, 1949	3, M		53	Unused stock well.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
37-8-26cc	Gard Merriman		16	GI	T, T	I										
27aa	Fred N. Schneider		2	I	F	S							1, E		50	
27bc	C. A. White	45.0	16	GI	C, G	I	Top of casing, north side	0		6.90	Mar. 9, 1949		1,200, E			Battery of 3 wells
27dc	do	28.5	14	GI	T, T	I	Top of casing, west side	2.6		5.48	Aug. 13, 1949					Do.
28ac	do		14	GI	T, T	I										
28bb	Rio Grande County	4.5	3	GI	N	O	Top of pipe, east side	.7	7,677.5	3.15	May 12, 1949					Jetted well.
28dc	A. J. West	50.1	22	GI	T, T	I	Top of casing, east side	−.5		21.75	Mar. 9, 1949					
34ac	Vint and Ross Garrett	52.4	18	GI	T, E	I	Top of casing, north side	.0		9.90	Mar. 14, 1949		800, E			
34bc	P. D. and L. Camillo	25.4	48	W	C, N		Edge of cross-timber, north side.	.0		22.07	Mar. 14, 1949					Unused irrigation well.
34bd	do		14	GI	T, E	I										
34cb	T. and P. Camillo	48.4	24	GI	T, E	I	Top of casing, south side	1.5		21.58	Mar. 14, 1949		1,769, M	38, M		Battery of 3 wells.
35bc	G. and R. Horning	230	14	I	T, G	I							1,500, R			
35cb	Wilson D. Kelso	37.5	18	I	T, G	I										
35cc	Harold Holiday	39	24, 16	GI	T, E	I, O	Top of casing, east side	0		6.00	Mar. 9, 1949		618, M	17, M	52	Sample.
36bc1	C. W. Burd	128.1	2	I	F	S, I						June 27, 1949	6, M		51	
36bc2	do	110.5	2	I	F	S, I						Feb. 20, 1949	10, M		50	
36cc1	do		2	I	F	S, I						June 20, 1949	4, M			
36cc2	do	124.5	2	I	F	S, I						June 20, 1949	7, M		51	
36dc	do		2	I	F	S, I						June 20, 1949	15, M		51	
37-9-1aa	Alamosa County	10.1	3	GI	N	O	Top of pipe, east side	.2	7,567.3	8.55	Apr. 2, 1949					Jetted well. Sample.
11cc	do	7.9	3	GI	N	O	Top of pipe, west side	.4	7,561.2	5.65	May 12, 1949					Jetted well.
12dd	do	9.9	3	GI	N	O	Top of pipe, south side	.3	7,551.4	2.19	Apr. 22, 1949					Do.
15dc	Joe Ross	1,400	6½, 4	I	F	I, O	Bottom of discharge pipe.	3.5		+57.87	Nov. 23, 1950		372, M		83	Obtains water from Santa Fe formation. Sample.
15dd	do	400	6	I	F	I						Aug. 6, 1949	83, M		63	
17aa	Alamosa County	8.2	3	GI	N	O	Top of pipe, east side	.5	7,572.9	3.35	Apr. 22, 1949					Jetted well. Sample.

18bc1	H. E. Calkins	450	6	I	F	I										
18bc2	do		4	I	F	S, I							50, E			
18bc3	do	600	4	I	F	S, I							100, E			
19bb	F. A. and H. Calkins	472.6	8	I	F	I							250, E		60	
19cb	R. E. Marsh	248.9	4	I	F	I						Aug. 13, 1949	79, M		60	
19cc	do	242.1	4	I	F	I						June 28, 1949	75, M		58	
20cc1	Elmer Walstrom	500	6	I	F	I	Top of 4-inch valve	2.0	7,593.3	+19.58	Nov. 2, 1950		125, M	13.5, M	62	
20cc2	do	432.8	8	I	F	I							300, E		60	
20dc	William Wiescamp		6	I	F	S, I									60	
21bb	Joe W. Dowd	500	8	I	F	I						June 28, 1949	225, M			
22cc1	Frank Gigilo	595	6	I	F	I						July 6, 1949	375, M		62	Obtains water from Santa Fe formation.
22cc2	do		6	I	F	I							100, E		61	
22dd	Alamosa County	9.1	3	GI	N	O	Top of pipe, south side	.5	7,561.1	4.90	Apr. 22, 1949					Jetted well.
23cd	Edward Terpstra		3, 2	I	F	D, I						Aug. 5, 1949	34, M		63	
23dd1	Berta L. Sturderant		6, 2	I	F	I						Aug. 5, 1949	56, M		56	
23dd2	do		2	I	F	I						Aug. 5, 1949	8, M		53	
25cc	Frank and C. Yoshida	69.1	6	I	F	I							20, E		59	
27bc	William A. Heersink		4	I	F	I									59	
28bb	Alamosa County	7.2	3	GI	N	O	Top of pipe, west side	.6	7,579.2	5.23	Apr. 22, 1949					Do.
28bc	L. E. Wells		6	I	F	I										
29bb1	E. B. Dolfin		6	I	F	I										
29bb2	do		6, 4	I	F	I										
31ac	Walter Harper	650	8, 6	I	F	S, I							350, E		62	Obtains water from Santa Fe formation.
31cc1	Clifford A. Coleman		4	I	F	I							23, M		53	
31cc2	do	81.6	2	I	F	I						June 28, 1949	21, M		51	
32ac1	Gervit Gesink	535	5	I	F	I							150, E		57	Obtains water from Santa Fe formation. Lava flow at 435 feet.
32ac2	do	500	8, 7	I	F	I, O	Hole in casing, east side	.4		+27.45	Nov. 2, 1950		548, M			Obtains water from Santa Fe formation. Lava flow at 400 feet. Sample.
32bc1	B. F. Owens		4	I	F							June 28, 1949	37, M		58	Unused domestic well.
32bc2	do	552	7	I	F	I						Aug. 12, 1949	273, M		59	
32cc	William C. Ford		8	I	F	I							400, M		61	
32dd	Alamosa County	9.3	3	GI	N	O	Top of pipe, east side	.3	7,586.5	5.25	Apr. 21, 1949				62	Jetted well. Sample.
33ca	H. F. and Alfreda Wiescamp.		3	I	F	S						Aug. 6, 1949	15, M		50	
33cc	W. J. Clair		6	I	F	I									57	
33cd	do		6	I	F	I									54	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
37-9-34cb1	G. W. Robertson		8	I	F	I							150, E		56	
34cb2	do	480	6	I	F	I							190, E		54	
34cc	do	513	6	I	F	I	Bottom of 6-inch valve	1.5	7,575.8	+27.81	Aug. 18, 1949		281, M	14, M	56	
35cc	Alamosa County	10.2	3	GI	N	O	Top of pipe, west side	.4	7,569.3	7.47	Apr. 21, 1949					Jetted well.
36dc	Ralph Wilcock		6	I	F	I						July 21, 1949	14, M		62	
36dd	Alamosa County	10.0	3	GI	N	O	Top of pipe, south side	.4	7,554.9	2.22	Apr. 21, 1949					Do.
37-10-5bd	do	8.3	3	GI	N	O	do	.3	7,549.1	5.05	Apr. 25, 1949					Do.
8dd	do	10.2	3	GI	N	O	Top of pipe, west side	.4	7,541.2	5.75	Apr. 22, 1940					Do.
10bb	City of Alamosa	760	6	I	F	P							40, R			Sample.
10bd1	do	1,500	12	I	F, T, E	P							900, R			
10bd2	do	1,001	12	I	F, T, E	P							600, R			
11aa	Alamosa County	10.1	3	GI	N	O	Top of pipe, north side	.6	7,531.4	3.45	Apr. 26, 1949					Jetted well.
11cc	City of Alamosa	1,802	24	I	F, T, E	P							2,260, M		96	Discharge measured by city engineer. Sample.
14ca	Alamosa County	9.5	3	GI	N	O	Top of pipe, east side	.2	7,533.0	7.72	Apr. 25, 1949					Jetted well.
16dd	do	9.6	3	GI	N	O	do	.4	7,536.0	7.20	Apr. 25, 1949					Do.
19cc	do	8.7	3	GI	N	O	Top of pipe, west side	.4	7,549.8	5.74	Apr. 22, 1949				56	Jetted well. Sample.
20dd	do	7.8	3	GI	N	O	Top of pipe, east side	.5	7,535.9	3.25	Apr. 22, 1949					Jetted well.
21bc	Mrs. H. H. Curtis		3	I	F	S, I						Aug. 5, 1949	75, M		68	
25aa	Alamosa County	10.0	3	GI	N	O	Top of pipe, north side	.4	7,524.8	6.80	Apr. 29, 1949					Do.
30bb	F. and C. Yoshida	820	10	I	F, T, G	I										Well flows an estimated 200 gpm.
30cc1	Phillip Catolano		4	I	F	I						Aug. 5, 1949	136, M		68	
30cc2	do		6	I	F	I						Aug. 5, 1949	300, M		71	
33aa	Alamosa County	9.5	3	GI	N	O	Top of pipe, east side	.8	7,532.7	8.90	Apr. 25, 1949					Jetted well.
37-11-3dd	do	9.2	3	GI	N	O	do	.2	7,522.2	6.88	Apr. 26, 1949					Jetted well. Sample.
7aa	do	9.2	3	GI	N	O	Top of pipe, north side	.2	7,531.7	5.40	Apr. 25, 1949					Jetted well.

17cc	do	7.7	3	GI	N	O	Top of pipe, west side	.7	7,526.3	4.63	Apr. 25, 1949					Do.
37-12-6bb	do	6.3	3	GI	N	O	Top of pipe, north side	1.0	7,543.7	5.16	Aug. 16, 1946					Jetted well. Sample.
38-7-3aa					T, E	I										
3bb	John Mathias		14	I	T, T	I	Top of casing, west side	.2		56.57	Oct. 12, 1950					
25da	Edward Larick	51.0	2	I	F	I	Top of pipe	2.5		2.03	June 15, 1949					Well flowed an estimated 2 gpm when drilled.
38-8-3dc	A. Helms	31	18	GI	C, E	I	Top of casing, north side	0		1.85	July 19, 1949					Battery of 2 wells.
4ab	Colorado Soldiers and Sailors Home.	43.7		GI	T, E	I	do	0		3.63	Aug. 15, 1949					
4ba	E. G. Davis		2	I	F	S, I						Aug. 15, 1949	14, M		51	
4bc	Elizabeth Faber	34.0	20	GI	T, E	I	Top of casing, south side	0		1.77	Aug. 15, 1949					
4cb	do	23.1	14	GI	C, G	I	Top of casing, east side	2.2		3.68	Aug. 30, 1950					Do.
5ab	City of Monte Vista				T, G	I										
5ba	do	30	14	GI	C, E	I	Top of casing	−2.72		1.75	Aug. 15, 1949					
5ca	State of Colorado	40	10	GI	T, E	F										
5cb1	do	40	16	GI	T, E	F										Battery of 6 wells.
5cb2	do	380	4	I	F	F						July 19, 1949	42, M		55	Sample.
5cb3	do	380	4	I	F	F						July 19, 1949	55, M		55	
5cb4	do	380	4	I	F	F						Aug. 19, 1949	43, M		55	
5cb5	do	380	4	I	F	F						Aug. 19, 1949	46, M		55	
5cb6	do	380	4	I	F	F						Aug. 19, 1949	46, M		55	
5cd1	do	380	4	I	F	F						Aug. 19, 1949	75, M		55	
5cd2	do	380	4	I	F	F						Aug. 19, 1949	50, M		55	
5da	Rio Grande County	8.1	3	GI	N	O	Top of pipe, south side	.5	7,639.9	6.27	Aug. 18, 1949					Jetted well.
10aa	Elena V. Wright	34.9	34	OB	C, E	I	Top of casing	2.3		4.49	July 15, 1949					Battery of 2 wells.
10ba	do				T, E	I										
10bb	E. Wright	29.3	20	I	T, E	I	Top of casing, west side	0		7.83	Mar. 15, 1949					Do.
10da	Rio Grande County	10.8	3	GI	N	O	Top of pipe, west side	.5	7,622.4	8.80	Apr. 19, 1949					Jetted well.
11ab1	Forest Wilkenson	30.4	18	GI	C, G	I	Top of casing, south side	0		.89	July 15, 1949					
11ab2	do	35.5	14	GI	C, E	I	Hole in cover, south side	0		3.19	July 15, 1949					Battery of 2 wells.
11ad	do	35.1	24	GI	T, E	I							920, M	20, R	57	Battery of 3 wells.
12aa	Rio Grande County	5.6	3	GI	N	O	Top of pipe, north side	.4	7,595.4	2.55	Apr. 27, 1949					Jetted well.
13aa	V. and M. Wright	23.6	14	GP	C, E	I	Hole in cover, south side	−1.5		.36	July 13, 1949					Battery of 2 wells.
13bb	H. C. and Newell Kephart.	17.8	18	GI	C, T	I	Top of casing, south side	−3.8		14.50	Aug. 30, 1950		400, E		52	
13da	Rio Grande County	8.5	3	GI	N	O	Top of pipe, east side	.3	7,604.5	6.41	Apr. 19, 1949					Jetted well.
17dd	do	10.3	3	GI	N	O	do	.6	7,628.1	3.51	Apr. 18, 1949					Do.
19cc	do	6.4	1¼	I	N	O	Top of pipe, west side	.9	7,660.6	3.22	Apr. 29, 1949					Do.
22cc	Norman J. Schroeder		2	I	F	S I							20, E		49	
23ac	W. J. and L. P. Gets	150.2	3	I	F	I							5, E		52	
23bb	Rio Grande County	9.2	3	GI	N	O	Top of pipe, north side	.7	7,614.6	6.15	Apr. 19, 1949					Do.
24ba	W. J. and L. P. Gets	29.6	14	GI	C, G	I	Top of casing, south side	−2.10		3.69	Mar. 15, 1949					Battery of 2 wells.
25cc	do		3	I	F	D, I							5, E		49	
25dd	Rio Grande County	9.7	3	GI	N	O	Top of pipe, east side	.5	7,592.2	4.80	Apr. 29, 1949					Jetted well.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
38-8-26ba	W. J. and L. P. Getz	265.7	2	I	F	S, I						June 15, 1949	11, M		52	
26da	do	300	2	I	F	I						June 14, 1949	10, M		54	
26cb	do		2	I	F	I						June 14, 1949	30.5, M		54	
26cd	do		2	I	F	D, I						June 15, 1949	1.5, M		53	
27bd	Norman J. Schroeder	225 8	3	I	F	S, I						June 14, 1949	15, M		54	
27cb	W. J. and L. P. Getz	88.1	3	I	F	S, I						June 10, 1949	33, M		50	
27cc1	do	120.4	3	I	F	S, I						June 10, 1949	22, M		50	
27cc2	do	121.2	2	I	F	S, I						June 10, 1949	20, M		50	
27cd1	do	120.4	2	I	F	S, I						June 10, 1949	7, M		50	
27cd2	do	118.6	2	I	F	S, I						June 10, 1949	9, M		50	
27da1	do	210.2	2	I	F	I						June 14, 1949	11, M		54	
27da2	do	246.2	2	I	F	I						June 14, 1949	11, M		49	
27db	do		2	I	F	I						June 14, 1949	41, M		54	
27dc	do	124.8	6	I	F	I							3, E		50	
27dd	do	127.5	6	I	F	I							2, E		50	
28aa1	do	90.2	2	I	F	S, I							2, E		49	
28aa2	do	111.4	2	I	F	S, I						May 12, 1949	15, M		50	
28aa3	do	105.7	2	I	F	S, I							15, E		50	
28ab1	do		2	I	F	S, I						May 12, 1949	38, M		50	
28ab2	do	116.5	2	I	F	S, I						May 12, 1949	28, M		50	
28ab3	do	121.5	3	I	F	S, I						May 12, 1949	20, M		50	
28ab4	do	106.0	2	I	F	S, I						May 12, 1949	18, M		50	
28bb	Edward A. Schroeder	33 5	2	I	F	S, I						May 18, 1949	20, M		49	
28bc1	do		3	I	F	S, I						May 18, 1949	38, M		50	
28bc2	do		3	I	F	S, I							1, E		50	
28bd1	do		2	I	F	S, I						May 18, 1949	15, M		50	
28bd2	do		2	I	F	S, I							15, E		50	

28cb1	W. J. and L. P. Getz	110.8	2	I	F	S, I						May 12, 1949	25, M		49	
28cb2	do	109.2	2	I	F	S, I						May 12, 1949	15, E		49	
28cb3	do	90.9	3	I	F	S, I						May 12, 1949	19, M		49	
28cc1	do	108.2	3	I	F	S, I						May 18, 1949	6, M		49	
28cc2	do		2	I	F	S, I						May 18, 1949	13, M		50	
28da	do	116.7	2	I	F	S, I						May 11, 1949	25, M		50	
28db	do	113.5	2	I	F	S, I						May 11, 1949	12, M		49	
28dc	do	113.8	3	I	F	S, I						May 11, 1949	50, M		49	
28dd	do		2	I	F	S, I						May 11, 1949	19, M		49	
29ab1	do	110.2	3	I	F	S, I							10, E		49	
29ab2	do	160.8	3	I	F	S, I							2, E		49	
29ac1	do	112.8	3	I	F	S, I						May 11, 1949	25, M		49	
29ac2	do	105.8	3	I	F	S, I						May 11, 1949	20, M		49	
29ad	do	111.4	2	I	F	S, I						May 11, 1949	20, M		49	
29bd	do		2	I	F	S, I							2, E		49	
29db1	do	108.2	2	I	F	S, I							2, E		49	
29db2	do	105.9	2	I	F	S, I							2, E		49	
29dd1	do	103.4	2	I	F	S, I							1, E		49	
29dd2	do	110.1	2	I	F	S, I						May 11, 1949	10, M		49	
29dc	do	105.2	3	I	F	S, I						May 11, 1949	15, M		49	
29dd1	do		2	I	F	S, I							1, E		48	
29dd2	do	106.1	4	I	F	S, I, O	Top of 4-inch valve	0.7	7,619.8	+14.78	Sept. 20, 1950		22, M	13, M	49	
31ab	John Berry	113.8	2	I	F	S, I						May 31, 1949	13, M		48	
31ac1	do		2	I	F	S, I						June 10, 1949	7, M		48	
31ac2	do		2	I	F	S, I						June 10, 1949	19, M		48	
31cc	Rio Grande County	7.5	1¼	I	N	O	Top of pipe	.6	7,653.9	2.90	Apr. 29, 1949					Jetted well.
32aa	John Berry	94.8	2	I	F	S, I							1, E		48	
32ab1	do	116.0	2	I	F	S, I						May 23, 1949	19, M		48	
32ab2	do	102.6	2	I	F	S, I							20, E		48	
32ac1	do	104.2	2	I	F	S, I						May 23, 1949	17, M		48	
32ac2	do	103.7	2	I	F	S, I						May 23, 1949	30, M		48	
32ac3	do	105.7	2	I	F	S, I						May 23, 1949	30, M		49	
32ac4	do	103.4	2	I	F	S, I						May 23, 1949	18, M		48	
32ad1	do	108.5	2	I	F	S, I							1, E		48	
32ad2	do	116.2	2	I	F	S, I							2, E		48	
32ad3	do	156.8	2	I	F	S, I						May 23, 1949	5, M		49	
32bd1	do	272.9	6	I	F	S, I							1, E		51	
32bd2	do	236.6	6	I	F	S, I						May 31, 1949	75, M		51	
32db3	do		2	I	F	S, I						May 31, 1949	38, M		49	
32cd	do		4	I	F	S, I						May 31, 1949	300, M		52	
32da1	do	129.5	2	I	F	S, I						May 24, 1949	15, M		49	
32da2	do	129.6	2	I	F	S, I						May 24, 1949	17, M		49	
32dd1	do	128.8	2	I	F	S, I						May 24, 1949	12, M		49	
32dd2	do	249.9	4	I	F	S, I						May 24, 1949	43, M		51	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (—) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
38-8-32dd3	John Berry	75.8	2	I	F	S, I							1, E		48	
32dd4	do	153.0	2	I	F	S, I						May 24, 1949	17, M		49	
33ab1	do	116.0	3	I	F	S, I						May 24, 1949	20, E		49	
33ab2	do	202.6	6	I	F	S, I						May 24, 1949	27, M		51	
33ac1	do	272.2	6	I	F	S, I						May 24, 1949	33, M		52	
33ac2	do	115.0	2	I	F	S, I							2, E		49	
33bb1	do	107.7	4	I	F	S, I						May 24, 1949	23, M		49	
33bb2	do	299.3	6	I	F	S, I						May 23, 1949	200, M		54	
33bc	do	122.6	2	I	F	S, I						May 23, 1949	18, M		49	
33bd	do	320.0	4	I	F	S, I						May 24, 1949	150, M		54	
33ca	E. and O. W. Robinson		2	I	F	S, I									49	
33cb1	do	310.4	6	I	F	S, I							300, E		53	
33cb2	do	342.4	4	I	F	S, I							250, E		54	
33cc1	do	276.4	4	I	F	S, I							120, E		52	
33cc2	do	187.8	4	I	F	S, I							140, E		52	
33cc3	do	83.8	4	I	F	S, I							25, E		50	
33da	John Berry		2	I	F	S, I						May 24, 1949	28, M		50	
33db	do	340.1	6	I	F	S, I							300, E		54	
33dc1	do	324.0	6	I	F	S, I						May 24, 1949	214, M		53	
33dc2	do	325.2	6	I	F	S, I						May 24, 1949	350, E		53	
34aa	W. J. and L. P. Gets	90.7	2	I	F	S, I						June 10, 1949	5.5, M		53	
34ab1	do	251.2	2	I	F	S, I						June 10, 1949	25, M		54	
34ab2	do	263.4	2	I	F	S, I						June 10, 1949	18, M		53	
34ab3	do	236.5	2	I	F	S, I						June 10, 1949	19, E		53	
34bb	John Berry	118.5	3	I	F	S, I							19, M		50	
34cb	Rio Grande County	8.0	1¼	I	N	O	Top of pipe, west side	0.6	7,612.4	7.40	Apr. 29, 1949					Jetted well.
34da1	W. J. and L. P. Gets	126.9	2	I	F	I						June 14, 1949	12, M		52	
34da2	do	123.0	2	I	F	I						June 14, 1949	17, M		52	

34da3	do	128.9	2	I	F	I						June 14, 1949	15, M		55	
34da4	do	123.7	2	I	F	S, I							5, E		51	
34da5	do	264.2	2	I	F	I						June 14, 1949	10, M		55	
34dd1	do		2	I	F	I							1, E		52	
34dd2	do	127.2	2	I	F	I							6, M		52	
34dd3	do	225.4	2	I	F	I						June 14, 1949	15, M		54	
35ba	do	193.1	3	I	F	S, I						June 14, 1949	20, M		53	
38-9-4bb	Alamosa County	9.5	3	GI	N	O	Top of pipe, north side	.5	7,585.1	2.73	Apr. 19, 1948					Do.
5ab	H. L. Sanderson	38.7	18	GI	T, T	I	Top of casing, west side	.8		4.45	Nov. 27, 1950					
5bb	Alamosa County	9.4	3	GI	N	O	Top of pipe, north side	.8	7,591.5	3.68	Apr. 19, 1948					Do.
12dd	do	8.0	3	GI	N	O	Top of pipe, east side	.5	7,562.9	4.14	Dec. 7, 1948					Do.
17aa	do	9.1	3	GI	N	O	do	.3	7,590.9	7.60	Apr. 27, 1949					Do.
17bb	do		2	I	F	S, I						Aug. 13, 1949	6.5, M		58	Water has odor of hydrogen sulfide.
18aa	Somner Christie		2	I	F	S, I							2, M		52	
18bc	Clause Thompson	26.7	24, 18	GI	C, E	I										Battery of 2 wells.
22aa	Alamosa County	9.4	3	GI	N	O	Top of pipe, east side	.4	7,576.1	5.11	May 13, 1949					Jetted well.
28aa	do	7.2	3	GI	N	O	Top of pipe, north side	.3	7,578.8	2.77	Apr. 25, 1949					Do.
31bb1	H. L. Sanderson	500	4, 2	I	F	D, I							10, E		51	
31bb2	do	187	18	GI	T, T	I	Top of casing east side	1.1		4.68	Oct. 23, 1950		700, M	36, M	53	
38-10-2bb	Alamosa County	9.2	3	GI	N	O	Top of pipe, north side	.4	7,545.4	4.58	Dec. 16, 1949					Do.
9cc	do	8.2	3	GI	N	O	Top of pipe, east side	.5	7,554.5	3.24	Dec. 7, 1948					Do.
11cc	do	4.9	2	GI	N	O	Top of pipe, north side	.6	7,544.8	3.85	Dec. 7, 1948					Do.
28dd	do	7.5	3	GI	N	O	do	.3	7,545.4	5.03	Apr. 26, 1949					Do.
35cc	do	9.2	3	GI	N	O	Top of pipe, west side	.5	7,540.2	5.95	Apr. 26, 1949					Do.
38-11-1cc	do	10.5	3	GI	N	O	Top of pipe	1.6	7,519.7	9.06	Aug. 13, 1946					Dug and bored well. Sample.
1dd	do	10.0	2	GI	N	O	do	1.6	7,517.0	8.83	Aug. 27, 1947					Dug and bored well.
2bb	do	9.1	2	GI	N	O	do	.4	7,519.0	7.85	July 12, 1946					Dug and bored well. Sample.
2cc	do	13.5	3	GI	N	O	do	1.0	7,523.2	10.71	Aug. 13, 1946					Dug and bored well.
4aa	do	12.6	2	GI	N	O	do	1.8	7,526.3	12.33	July 12, 1946					Do.
8cc	do	10.0	1¼	I	N	O	do	.4	7,534.1	6.24	Sept. 20, 1946					
10dd	do	10.3	3	GI	N	O	do	.1	7,523.7	10.24	Mar. 3, 1947					Bored well.
12dd	do	16.2	3	GI	N	O	do	2.3	7,525.6	15.40	Aug. 14, 1946					Bored well. Sample.
13cd	do	10.0	3	GI	N	O	Top of pipe, east side	2.3	7,514.4	8.25	Aug. 14, 1946					Bored well.
13dd	do	5.5	3	GI	N	O	Top of pipe, west side	1.6	7,515.3	5.05	Aug. 14, 1946					Do.
14aa	do	30.2	1¼	I	N	O	Top of pipe	1.1	7,521.5	10.42	July 22, 1946					Jetted well. Sample.
14cc	do	11.8	3	GI	N	O	do	1.7	7,525.4	10.74	Aug. 15, 1946					Bored well.
15bb	do	23.4	1¼	I	N	O	do	.3	7,526.7	8.22	Sept. 20, 1946					
25aa	do	7.8	3	GI	N	O	Top of pipe, north side	1.1	7,526.9	5.88	Aug. 28, 1946					Bored well. Sample.
25bb	do	23.3	1¼	I	N	O	do	1.0	7,515.8	3.31	July 29, 1946					Jetted well. Sample.
26bb	do	8.6	3	GI	N	O	Top of pipe, east side	.4	7,522.1	7.15	Aug. 15, 1946					Dug and bored well. Sample.
31cc	do	7.6	3	GI	N	O	Top of pipe, south side	.3	7,533.3	5.81	Apr. 26, 1949					Jetted well.
33cc	do	7.3	3	GI	N	O	do	.3	7,525.3	3.38	Apr. 26, 1949					Do.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
38-11-34cc	Alamosa County	33.6	1¼	I	N	O	Top of pipe, south side	2.9	7,526.0	9.97	Nov. 11, 1946					
34dc	do	38.3	1¼	I	N	O	do	3.4	7,529.9	14.51	Nov. 11, 1946					Jetted well.
34dd	do	8.8	3	GI	N	O	do	2.4	7,522.5	7.97	Aug. 28, 1946					Dug and bored well. Sample.
35bb	do	11.0	3	GI	N	O	Top of pipe, north side	.1	7,522.2	8.55	Aug. 15, 1946					Do.
35dd	do	44.6	1¼	I	N	O	Top of pipe, south side	.2	7,528.3	8.03	July 30, 1946					Jetted well.
36bb	do	5.8	3	GI	N	O	Top of pipe, west side	.8	7,517.4	5.33	Aug. 15, 1946					Dug and bored well. Sample.
38-12-1cc	C. M. King	250	2	I	F	D, S									45	Sample.
2bb	do	200	2	I	F	S							25, E		54	Water has odor of hydrogen sulfide. Sample.
2cc	do	200	2	I	F	S									55	Do.
11bb	do	200	2	I	F	S							40, E		55	Sample.
15ad	do	200	3	I	F	D, S							20, E		55	Do.
30cc	Alamosa County	7.0	3	GI	N	O	Top of pipe, west side	1.6		6.21	Aug. 15, 1946					Dug and bored well. Sample.
31cb	do	6.3	3	GI	N	O	do	1.1	7,536.7	4.43	Aug. 16, 1946					Jetted well. Sample
39-7-1ac	Arthur H. Montor	75.5	14	GI	T, G	I	Top of casing	.6		3.95	July 1, 1948		850, E			
1bc1	L. B. and A. Waters	79.8	18	GI	T, G	I	Top of casing, south side	.9		2.55	July 1, 1948		700, E			
1bc2	do	72	16	GI	T, T	I		0		2.70	July 1, 1948					
1cb	Martha Montor				T, E	I										
1db	Lois, Edwin, and Ruth E. Darrel.	83.8	16	GI	T, G	I										
2ac	Helen B. Adams and Elenor J. Faus.		18	GI	T, E	I										
2bc	Hanna M. Metz				T, E	I										
2cb1	R. S. and Corrine Long				T, E	I							800, R			
2cb2	do	101	20	GI	T, E	I	Top of casing, south side	0		16.00	June 1, 1950		938, M	28, M	49	

2cc	do	94.9	16	GI	T, E	I	Top of casing, north side	.5		2.90	July 2, 1948		800, E			
2db	do	95.5	16	GI	T, E	I	Top of casing, east side	1.4		3.90	July 1, 1948		900, E			
2dd	do	23.2	14	GI	H	D, O	Top of wooden support, south side.	.5		5.59	Nov. 13, 1947					
3ab	H. L. Clarke		18	GI	T, E	I										
3bb	E. B. Meadows		18	GI	T, E	I										
3cb1	Martha A. and Jack Stone.		20	GI	T, G	I	Hole in casing, west side	0		14.10	Oct. 31, 1950		1,500, R			
3cb2	do		18	GI	T, E	I										
3cb3	do				T, E	I										
4ac	Frank M. Drake				T, E	I							938, M			
4bb	Orville E. Drake				T, E	I							1,000, E			
4cb	Olin L. Drake	68.2	14	GI	T, E	I, O	Top of casing, east side	.5	7,747.5	11.28	Nov. 10, 1947					
5ab	Robert Naduack	103.5	18	GI	T, G	I	Top of casing, west side	1.9		12.70	June 16, 1949					
5ac	do	528	16	GI	T, E	I				15			879, M			
5bc1	A. B. Gjellum	25.4	18	GI	T, E	I	Top of casing, west side	1.5		13.60	June 16, 1949					
5bc2	do				T, E	I										
5dc	Jose I. Valdez				T, B	I										
8ab1	do	32.8	30	I	T, G	I	Top of casing, east side	.6		4.12	Aug. 7, 1950		300, E	18, M	52	
8ab2	do	22.7	12	GI	C, G	I, O	Top of casing, north side	0	7,746.2	7.93	Nov. 10, 1947					
9db	Sophia Trujillo	59.2	14	I	T, T	I	Top of casing, west side	0		6.70	Oct. 31, 1953					
10ab	Marvin Metz	58.4	16	GI	N	O	Top of casing	0	7,719.6	7.03	Nov. 10, 1947					Unused irrigation well.
10bb	Mary Ann and Leland Brewer.		18	GI	T, E	I										
10cc	Rio Grande County	7.8	1¼	I	N	O	Top of pipe	.8	7,715.1	4.83	Apr. 7, 1948					Jetted well.
10db	Lola Neff	60	16	GI	T, G	I							893, M			
11ab	Mary B. Farrow				T, E	I							1,026, M			
11bb	W. A. and M. B. Farrow.	103	18	GI	T, E	I										
11cb1	Elaine Sims Hawkins				T, E	I							1,300, R			
11cb2	do				T, E	I							1,300, R			
11db	do				T, E	I							1,100, E			
12ab	R. S. and Corrine Long.	74.3	18	GI	T, E	I	Hole in casing, east side	.4		4.10	June 20, 1949					
12ba	Leafy M. Travis	75	18	GI	T, E	I	Top of casing, east side	.7		11.33	June 1, 1951		944, M	31, M		
12bb	Plazza Jones	56.8	18	GI	T, E	I, O	Top of casing, north side	.6	7,695.3	6.64	Nov. 10, 1947					
12ca	Lyman Wright				T, G	I							1,004, M			
12cb1	do	78	16	GI	T, E	I							902, M			
12cb2	do	50	16	GI	T, E	I							1,227, M			
13aa	Rio Grande County	9.4	1¼	I		O	Top of pipe, east side	1.5	7,665.5	5.10	Apr. 7, 1948					Do.
13bb	H. A. Mathias	40.5	16	GI	T, T	I, O	Top of casing, east side	.7	7,689.7	7.49	Nov. 21, 1946		900, E			
13da	C. R. Sanderson		2	I	F	S, I							1, E		50	
13db	L. F. Elofson		20	GI	T, E	I							1,491, M	21, M	48	
14ab1	Loy F. Jones	37.9	16	GI	T, T	I, O	Top of casing, north side	.0	7,701.7	7.20	Nov. 21, 1946					

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
39-7-14ab2	Loy F. Jones	39.0	18	GI	T, T	I	Top of casing	0.0		3.77	June 20, 1949					
14db	Ralph Hart		16	GI	T, E	I										
15ab	Howard and Loyal Hart.		18	GI	T, T	I										
22cc	Charles Stephens	33.0	16	GI	C, G	I										
24bb	Clarence and Marguerite Long.	27.6	16	GI	C, T	I, O	Top of casing, east side	−1.0	7,677.7	1.67	Nov. 11, 1947					
25da	Rio Grande County	7.2	3	GI	N	O	Top of pipe	.6		2.95	Apr. 18, 1949					Jetted well.
34ac	Charles and Claude Corlett.	59.0	16	GI	T, E	I										
36bd	Charles Corlett	28.8	18	GI	C, T	I	Top of casing, west side	.5		3.77	July 1, 1948					
36db	City of Monte Vista	365	14	I	F, T, E	P							357, M		50	
39-8-1ab	Ella Wolty	32.3	18	GI	C, G	I, O	Top of casing, east side	.0	7,616.4	3.28	Nov. 10, 1947		500, E			
1bb	Ethel and John Hedges				C, G	I										
1bc1	Raymond E. Robb	36	18	GI	C, E	I	Top of casing, south side	−3.0		2.00	Oct. 25, 1950		600, E			
1bc2	do		2	I	F	S							2, E		53	
1cc1	Claude Mitchael	31.7	16	GI	C, T	I, O	Top of casing, south side	−1.6	7,618.7	1.83	Nov. 11, 1947		525, M	19, M		
1cc2	do	26.7	14	GI	C, G	I	Top of casing, east side	−2.0		1.72	July 8, 1949		595, M	14, M		
1cc3	do	4.0	48	W	N	O	Top of wooden frame, north side.	.6		2.98	Dec. 2, 1946					Unused domestic dug well.
1dc	Jannell Faller	29.4	14	GI	C, G	I	Top of casing, north side	−2.2		.90	July 7, 1949					Battery of 2 wells.
2ab	Mrs. Paul Beck	34.0	16	GI	C, E	I	Top of casing, northwest side.	−.3		2.76	July 7, 1948					Do.
2bc1	G. B. Hawkins	30.1	14	GI	C, E	I	Top of casing, east side	.0		1.85	July 7, 1949					Battery of 3 wells.
2bc2	do		2	I	F	S, I						July 7, 1949	24, M		53	
2bc3	do		2	I	F	I						Oct. 21, 1948	33, M		52	Water has odor of hydrogen sulfide.
2bc4	do		2	I	F	S, I						July 13, 1949	29, M		52	
2cb	do	32.4	22, 18	OB	C, E	I, O	Top of casing, east side	−.9	7,629.0	2.15	Nov. 11, 1947					Battery of 2 wells.

2dc	J. G. and O. L. Roberts	35.2	24	GI	C, E	I	Top of casing, east side	−2.3		.40	July 7, 1949		478, M	13, M		Do.
3ab	Grace Gabhart	29.6	14	GI	C, E	I	do	0		1.55	July 7, 1949					Do.
3cc	Claire F. David	23.6	14	GI	C, E	I, O	do	−3.0	7,637.6	.35	Nov. 11, 1947					
3db1	Willard and Blanch Usher.		14	GI	C, T	I							1,347, M			
3db2	do	33.0	16	GI	C, E	I	Top of casing	−.9		1.10	July 7, 1949					Do.
3dc	do		2	I	F	I						Oct. 21, 1948	6, M		54	
4ab	W. H. Fassett	30.9	14	GI	C, E	I	Top of casing, east side	.5		1.80	July 7, 1949					Do.
4bb	D. T. and Erlyn Akers	27.4	16	GI	C, G	I, O	Top of casing	−3.0	7,649.9	2.26	Nov. 20, 1946		612, M			
4cb	Ester Padgett				C, T	I										Do.
4cc	do		2	I	F	I						Oct. 21, 1948	50, M		50	
4db1	Melvin B. Peterson		16	GI	C, T	I	Edge of concrete foundation, south side.	.7		2.60	July 7, 1949					
4db2	do		2	I	F	S, I							15, E		51	Water has odor of hydrogen sulfide.
5ba	Raymond and Mabel Metz.	74.0	16	GI	T, E	I, O	Top of bolt hole, east side of pump.	.4	7,660.0	6.71	Nov. 21, 1946					
5ca	W. I. Gilbreath		2	I	F	S, I						Aug. 11, 1950	19, M		50	
5cb	do	29.3	20	GI	C, E	I, O	Top of casing, west side	−2.5	7,663.8	1.54	Nov. 11, 1947		2,240, M	10, M		Battery of 2 wells.
5cd	do		2	I	F	S, I						July 7, 1949	20, M		50	
5db1	Fred Scheel		16	GI	T, E	I										
5db2	do	30.6	16	GI	C, E	I	Top of casing	0		2.90	Aug. 11, 1950					Do.
6ac	A. B. and Myrtle Hitpas.	56.9	20	GI	T, E	I		.5		10.06	Sept. 26, 1950					
6bb1	Henry Chapman				C, E	I							740, M			
6bb2	do	40.5	18	GI	T, G	I, O	Top of hole in casing, east side.	−2.0	7,677.9	4.28	Nov. 21, 1946		1,505, M	25, M		
6cb	Raymond and Mabel Metz.	74.6	16	GI	T, E	I	Top of casing, north side	1.1		4.75	July 7, 1948		1,174, M			
6cc	do	50.2	18	GI	T, E	I	Top of casing, south side	.5		2.45	July 7, 1948		1,130, M			
7ab	Walter A. Monter	72.8	18	GI	T, E	I, O	Top of casing, east side	0	7,659.2	5.52	Nov. 11, 1947		1,000, E			
7bb1	Fred Scheel		18	GI	T, E	I										
7bb2	do			GI	T, E	I										
7cb1	Lyman Wright			GI	T, E	I										
7cb2	do		2	I	F	I							20, E			
7db	G. B. and S. R. Gillilan.			GI	T, E	I							1,430, M			
8ab	W. I. Gilbreath			GI	C, E	I	Top of wooden crib, north side.	.4		5.30	Apr. 25, 1951		1,603, M			
8bb	Edmond and Charlotte Kavanaugh.			GI	C, G	I							800, R			
8db	John M. LaRue			GI	T, E	I										
8dd	Rio Grande County	8.1	3	GI	N	O	Top of pipe	.7	7,649.3	4.00	Apr. 16, 1948					Jetted well.
9ab	Roland O. Sawyer			GI	T, E	I										
9bb1	Charles and Pearl Johnson.		2	I	F	S, I						July 7, 1949	52, M		50	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
39-8-9bb2	Charles and Pearl Johnson.			GI	T, E	I										
9bb3	do		2	I	F	S, I						July 11, 1949	19, M		49	Water has odor of hydrogen sulfide.
9cb	Charles F. David			GI	T, E	I										
9db1	Lyman Wright			GI	T, E	I										
9db2	do			GI	C, G	I										Battery of 2 wells.
9dd	Rio Grande County	9.7	3	GI	N	O	Top of pipe	0.6	7,638.7	3.25	Apr. 16, 1948					Jetted well.
10bb	Dwight M. Goff			GI	C, E	I										
10cb	Homer L. and Lillian Strickland.			GI	C, G	I										
10cd				GI	C, E	I										
11ac	Elizabeth Johns			GI	C, E	I										
11bc	Austin and Edna Dobey.			GI	C, E	I										Battery of 2 wells.
11cc1	Homer L. and Lillian Strickland.			GI	C, B	I										Do.
11cc2	do	8.0	3	GI	N	O	Top of pipe	.4	7,628.8	4.63	Apr. 16, 1948					Jetted well.
12ac1	Gilbert and A. F. Ritchey.				C, E	I										Battery of 2 wells.
12ac2	do				C, G	I										
12bc	R. E. Johns, Jr.	60	16	GI	C, E	I	Top of casing, south side			2.76	Apr. 25, 1951		1,250, M			Do.
12cb	F. S. and L. E. McDaniel.				C, G	I							800, R			
12cc	do	26.5	14	GI	C, G	I, O	Top of casing, north side	.3	7,621.4	3.22	Dec. 2, 1946		740, M			
13ab1	G. E. and Helen Oxley	50	18	GI	T, E	I	Top of hole in pump base	.6	7,616.9	4.98	Oct. 9, 1948		1,474, M	17, M		
13ab2	do		3	I	F	S, I						July 11, 1949	33, M		54	
13bb	do	18.9	14	GI	N	O, D	Top of casing, west side	.7	7,620.7	4.95	Nov. 13, 1947					Unused domestic well.

13cc	A. E. Schroff	50.2	20	GI	T, G	I, O	Top of casing, north side	.4	7,618.4	2.95	Nov. 13, 1947					
13cd	do	49.1	18	GI	T, E	I	do	.8		1.10	July 9, 1948		820, M	13, M		
14bb	Theo. and Clestina Schwarzback.				T, E	I	Top of casing, south side	.9		5.92	Apr. 25, 1951		1,522, M			
14cc	Henry and Mary Prentis.				T, E	I							1,300, R			
15ab1	Theo. and Clestina Schwarzback.				T, E	I							1,100, E			
15ab2	do				C, E	I										
15cc	B. R. and V. D. Sotherland.	29.4	16	GI	C, E	I, O	Top of hole in concrete cover.	0	7,637.1	4.00	Nov. 13, 1947		708, M			Battery of 2 wells.
16bb	Fred W. Wright	28.2	16	GI	C, E	I	Top of casing, east side	0		2.00	July 11, 1949		700, E			Do.
16bc	do	30.8	23	OB	C, E	I, O	Top of casing, north side	0	7,646.6	2.23	Nov. 11, 1947					Do.
16dd	Walter W. Wright		2	I	F	S						Aug. 11, 1950	4, M		52	
17ab	John and Myrtle LaRue.	28.7	18	GI	C, G	I	Top of casing	1.2		2.45	July 11, 1949		1,150, M			Do.
17bb	Frank and Matilda McGee.	29.5	24	GI	C, E	I, O	Hole in wash tub cover	1.2	7,660.8	4.08	Nov. 20, 1946		1,221, M	11, M		Battery of 2 wells Sample.
17dc	G. C. Van Nostrand				C, E	I	Top of casing, east side	.9		10.54	Apr. 25, 1951		1,124, M			Do.
18ba	Ella Welty	33.7	18	GI	C, E	I, O	Top of casing, north side	−1.3	7,665.2	1.15	Nov. 20, 1946					Sample.
18bc	do				T, E	I										
18dc	Frank and Matilda McGee.	31.1	18	GI	C, E	I	Top of casing	0		2.24	June 13, 1945		650, E			Battery of 2 wells.
19ab	Herman Burk	28.4	18	GI	C, E	I	do	0		.01	July 8, 1948					
19bb1	do		16	GI	C, E	I							900, E			
19bb2	do	36.1	18, 14	GI	C, T	I, O	Top of casing, west side	−3.5	7,661.1	.06	Nov. 11, 1947		806, M			
20cb	L. and E. Frownfelter	28.1	14	GI	C, E	I, O	do	−1.9	7,652.3	3.55	Nov. 11, 1947		890, M	6, M		Do.
21ab1	B. R. and V. D. Sotherland.		2	I	F	I						Aug. 11, 1950	17, M		52	
21ab2	do		2	I	F	I						Aug. 11, 1950	14, M		52	
21ab3	do	30.2	16	GI	C, E	I	Top of casing, west side	2.84		4.63	Aug. 11, 1950					
21ab4	do		2	I	F	I							1, E		52	
21ac	Martha Mahl	39.0	16	GI	C, T	I	Top of casing, east side	−1.0		3.21	Aug. 11, 1950					
21ad	do	31.7	16	GI	C, T	I	Top of casing, west side	−.9		4.29	Aug. 11, 1950					
22bb	A. G. Robertson	72.5	14	GI	T, E	I, O	Top of casing, north side	−1.9	7,639.2	3.57	Nov. 13, 1947		665, M	15, M		
22bc	do	50			C, E	I							623, M	4.7, M		
22cb	D. D. David				C, E	I										
23bb	R. and L. Morford	55.2	14	GI	T, G	I, O	Top of casing, east side	0	7,627.9	3.45	Nov. 13, 1947					
23cb1	Edward P. Long	42.6	16	GI	T, E	I	Top of casing, north side	.7		4.10	July 9, 1948		1,167, M			
23cb2	do		2	I	F	S							1, E		52	
23cb3	do		18	GI	T, E	I							1,487, M			
23cd	do		2	I	F	S							1, E			
23db	do	31.7	16	GI	T, E	I	Top of casing, east side	0		6.71	Sept. 9, 1950		1,168, M	21, M		Battery of 3 wells.
24bb	do				C, E	I							470, R	13, R		
26bb	C. and M. Headlee		2	I	F	S						Aug. 22, 1950	13, M		52	
31cd	City of Monte Vista	475	20, 12	I	F, T, E	P						Aug. 22, 1950	520, M		52	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
39-8-32cc	L. Howard	13.6	12	GI	C, E	I	Top of casing, west side	−1.6		4.04	July 1, 1948					
32cd	City of Monte Vista		2	I	F	P						July 15, 1949	13, M		51	
33cb	J. N. and T. D. Scott		2	I	F	I							2, E		48	Water has odor of hydrogen sulfide.
39-9-1aa	Alamosa County	9.6	4	GI	N	O	Top of pipe	.4	7,573.2	7.62	Jan. 22, 1948					Jetted well. Sample.
1dc	A. M. Simonds		2	I	F	S						July 14, 1948	3, M		58	Water has odor of hydrogen sulfide.
1dd	Alamosa County	9.4	4	GI	N	O	Top of pipe	0	7,572.9	6.70	Jan. 22, 1948					Jetted well. Sample.
2aa	do	9.3	4	GI	N	O	do	.6	7,578.7	7.40	Jan. 22, 1948					Do.
2bb	do	16.6	12	B	N	O	do	1.6	7,582.7	4.20	Apr. 15, 1948					Well equipped with automatic recorder.
3bb	do	9.6	4	GI	N	O	do	.4	7,589.9	6.10	Jan. 22, 1948					Jetted well. Sample.
3cb	George Roberts	65	18	GI	T, E	I	Top of casing, south side	.8		4.25	Nov. 21, 1950		1,215, M	33, M		
3dd	Alamosa County	9.9	4	GI	N	O	Top of pipe	.6	7,583.9	6.03	Jan. 22, 1948					Do.
4cc	R. F. and L. P. McNitt	30.0	16	GI	C, E	I, O	Top of casing, east side	−2.0	7,596.3	3.25	Nov. 10, 1947		690, M	19, M		Battery of 3 wells. Sample.
4dd	Alamosa County	9.7	3	GI	N	O	Top of pipe	.6	7,590.8	6.00	Jan. 22, 1948					Jetted well. Sample.
5ab1	W. B. Ortega		3	I	F	I, D						Sept. 27, 1950	5, M		54	
5ab2	do	36.0	24	I	T, G	I	Top of casing, north side	.3		4.52	Oct. 27, 1950					
5bb1	do	75	18	GI	T, E	I	Top of casing, west side	0		5.72	Oct. 27, 1950					
5bb2	do		3	I	F	I							5, E		54	
5cc1	Anthony Beiriger		16	GI	T, E	I										
5cc2	do	53.6	16	GI	T, E	I, O	Top of cross board, east side.	.3	7,605.8	3.53	Nov. 11, 1947					
5cd	do				C, E	I										
6aa	W. C. Gilmore		2	I	F	S							10, E		54	
6ab	do				C, E	I							819, M	12, M		

6bb	Joseph Selfors	29.7	16	GI	C, E	I	Top of casing, north side	−2.3		2.04	Oct. 4, 1948					Battery of 2 wells.
6cc	W. C. Gilmore		14	GI	T, E	I	Top of casing, south side	.4		4.60	Oct. 14, 1948		804, M			
7ab	Raymond Entz	32.5	18	GI	T, E	I	Top of casing, north side	0		3.15	July 13, 1948		1,016, M			
7ba	Warren Clarke	31.5	16	GI	C, G	I	Top of casing, west side	0		3.95	July 13, 1948					
7bb	do	32.4	14	GI	C, E	I, O	Top of board, south side	0	7,613.5	5.22	Nov. 11, 1947		570, M			Do.
7cb	Adolph Schaak	35.6	14	GI	C, T	I							1,060, M			
8ab	Evert Entz	28.1	16	GI	C, G	I	Top of casing, east side	−1.5		.60	July 11, 1949		1,100, R			Do.
8cb	Grace Montgomery				C, E	I							1,313, M			Do.
8cc	do	35	16	GI	C, E	I	Top of hole in barrel cover.	0		3.50	July 25, 1950		1,382, M		51	Do.
8db	do	30.2	16	GI	C, E	I	Top of casing, north side	−.6		3.60	July 13, 1948		694, M			Do.
9bb	Evert Entz				C, G	I							800, R			
9cc1	P. Van Freese		2	I	F	I						Oct. 23, 1950	11, M		55	
9cc2	do	26.1	24, 14	GI	C, E	I, O	Top of oil barrel, north side.	0	7,596.8	4.04	Nov. 11, 1947		791, M	13, M		Do.
9dc	John F. Greene	84.5	3	I	F	S							2, E		54	
10bb	R. F. and L. P. McNitt.	24.1	18	GI	C, T	I	Top of casing, east side	−3.0		2.00	Aug. 22, 1950		574, M	11, M	50	
10cc	Alamosa County	9.8	3	GI	N	O	Top of pipe	.1	7,588.5	7.40	Jan. 23, 1948					Jetted well. Sample.
10dd	do	9.9	3	GI	N	O	do	.5	7,581.4	6.22	Jan. 22, 1948					Do.
11aa	do	5.6	2	GI	N	O	do	.4	7,577.2	1.19	May 15, 1947					Do.
11dd	do	9.0	3	GI	N	O	do	.6	7,575.2	3.60	Jan. 22, 1948					Do.
12dd	do	9.9	3	GI	N	O	do	.5	7,569.2	8.80	Jan. 22, 1948					Do.
13aa	R. F. and L. P. McNitt.	270.9	2	I	F	S, I						July 14, 1948	3, M		56	Water has odor of hydrogen sulfide.
13dd	Alamosa County	6.9	2	GI	N	O	Top of pipe	1.1	7,568.1	5.70	Jan. 23, 1948					Jetted well. Sample.
15bb	W. L. and Raymond Entz.		2	I	F	S						Oct. 22, 1948	43, M		60	Water has odor of hydrogen sulfide.
17ab	W. L. Entz				C, G	I							600, R			
17bb	P. A. Entz	26.0	16	GI	C, T	I	Top of casing, north side	−1.5		2.48	Oct. 30, 1950					
18ab	R. and C. Steffens	29.1	14	GI	C, E	I, O	do	−1.5	7,605.7	2.68	Nov. 11, 1947		1,080, M			Battery of 2 wells.
18bb	Albert B. Keck	39.0	16	GI	C, E	I	do	−3.0		2.77	Oct. 30, 1950		853, M	16, M		
18cc	Jessie Hathaway	46.6	22, 18	GI	C, E	I, O	Top of casing, south side	0	7,609.6	2.53	Nov. 13, 1947		1,030, M	12, M		
19dc	Phillip T. Ward		16	GI	T, G	I										
20aa	Alamosa County	10.0	3	GI	N	O	Top of pipe	.7	7,594.1	5.47	Jan. 23, 1948					Jetted well. Sample.
20bb	do	9.6	3	GI	N	O	do	.3	7,600.1	3.20	Jan. 23, 1948					Do.
21cc	do	9.9	3	GI	N	O	do	.9	7,595.2	7.99	Jan. 23, 1948					Jetted well.
22aa	do	8.6	3	GI	N	O	do	.3	7,580.0	4.03	Jan. 23, 1948					Jetted well. Sample.
22cc	do	9.9	3	GI	N	O	do	1.3	7,588.8	6.50	Jan. 23, 1948					Do.
23cc	do	10.0	3	GI	N	O	do	.7	7,580.7	8.08	Jan. 23, 1948					Do.
24cc	do	9.9	3	GI	N	O	do	.4	7,572.2	9.30	Jan. 23, 1948					Do.
24dd	do	9.0	3	GI	N	O	do	.5	7,567.6	5.70	Jan. 23, 1948					Do.
25aa	McKinley Bros.		2	I	F	S							1.5, M		55	Water has odor of hydrogen sulfide.
26cc	Alamosa County	8.0	3	GI	N	O	Top of pipe	.2	7,580.9	4.50	Apr. 19, 1948					Jetted well. Sample.
26dd	do	8.8	3	GI	N	O	do	.6	7,576.8	6.01	Apr. 19, 1948					Do.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
39-9-27bb	Merrel C. McKean	300	16	GI	T, G	I	Top of casing	0.9		5.50	May 12, 1950		605, M	164, M	51	Water has odor of hydrogen sulfide.
27cc	Alamosa County	8.5	3	GI	N	O	Top of pipe	.5	7,588.7	6.10	Apr. 19, 1948					Jetted well.
28cc	do	8.8	3	GI	N	O	do	.5	7,592.4	3.67	Apr. 19, 1948					Do.
30ab1	K. E. Riggenback	28.2	14	GI	C, T	I	Top of casing, east side	−3.1		1.22	Nov. 13, 1947					Battery of 2 wells. Sample.
30ab2	do	204	3	I	F	S						July 16, 1948	8, M		55	
30bb	Jack Bever	31.6	14	GI	C, T	I	Top of casing, south side	1.1		6.39	Nov. 13, 1947		535, M	16, M		Battery of 2 wells.
30cc	Alamosa County	9.3	3	GI	N	O	Top of pipe	.8	7,597.1	3.50	Apr. 19, 1948					Jetted well.
31bb	do	6.5	3	GI	N	O	do	.8	7,600.8	6.48	Apr. 19, 1948					Do.
31cc	do	10.0	3	GI	N	O	do	1.2	7,568.6	4.92	Apr. 19, 1948					Do.
33aa	Walter A. Skidmore				T, G	I										
33bb	do	400	6	I	F	I						Aug. 30, 1950	300, M		58	
34cc	Alamosa County	9.8	3	GI	N	O	Top of pipe	.5	7,582.0	2.93	Apr. 19, 1948					Do.
35cc	do	8.0	3	GI	N	O	do	.3	7,579.6	4.62	Apr. 19, 1948					Jetted well. Sample.
35dd	do	9.5	3	GI	N	O	do	.1	7,572.9	5.63	Apr. 19, 1948					Jetted well.
36dd	do	8.4	3	GI	N	O	do	.5	7,566.9	7.00	Apr. 19, 1948					Jetted well. Sample.
39-10-7cc	A. W. and L. B. Nissen.	120	14	GI	T, T	I	Top of casing	.3		3.60	Nov. 23, 1950		1,400, E			
8aa	Alamosa County	8.1	1½	GI	N	O	Top of pipe	0		4.61	May 15, 1947					Bored well.
9cc	do	8.3	3	GI	N	O	do	.5	7,558.4	4.64	Dec. 7, 1948					Jetted well.
10dd	do	8.5	3	GI	N	O	do	.4	7,551.0	6.49	Dec. 7, 1948					Do.
12aa	do	10.0	3	GI	N	O	do	.7	7,539.2	9.69	Sept. 16, 1946					Do.
16bb	Joseph B. Sexton	100	18	GI	T, G	I	Bolt hole, south side of pump base.	.4		7.12	Oct. 25, 1950		1,226, M	39, M		
19cc	McKinley Bros.		4	I	F	S					Aug. 14, 1948	Aug. 14, 1948	14, M		59	Water is brown and has odor of hydrogen sulfide.
22dd	Alamosa County	9.6	3	GI	N	O	Top of pipe	1.5	7,549.7	7.36	Dec. 7, 1948					Jetted well. Sample.

25aa	do	9.9	2½	GI	N	O	do	.3	7,536.3	8.06	Oct. 24, 1946					Do.
29cc	do	8.5	2	GI	N	O	do	1.0	7,569.3	7.00	Apr. 19, 1948					Jetted well.
32dd	do	8.7	3	GI	N	O	do	.5	7,555.2	6.20	Dec. 7, 1948					Jetted well. Sample.
36aa	do	10.0	2½	GI	N	O	do	0	7,536.8	7.60	Oct. 24, 1946					Do.
39-11-1bb	do	4.7	2	GI	N	O	do	.7	7,522.4	2.78	May 7, 1946					Bored well. Sample.
1dd	do	9.8	2	GI	N	O	do	.3	7,523.0	7.31	June 18, 1946					Jetted well. Sample.
3bb	do	48.9	1¼	I	N	O	do	1.1	7,524.7	4.98	Nov. 7, 1946					Do.
4cc	do	9.5	2	GI	N	O	do	.2	7,526.5	4.91	June 18, 1946					Do.
6aa	do	7.9	2	GI	N	O	do	.2	7,531.5	3.44	Apr. 16, 1946					Bored well. Sample.
6dd	do	9.9	3	GI	N	O	do	.6	7,533.3	6.78	Oct. 16, 1946					Jetted well. Sample.
7cc	do	10.0	3	GI	N	O	do	.4	7,538.9	6.57	Oct. 17, 1946					Do.
7dd	do	9.9	3	GI	N	O	do	.5	7,532.7	9.37	Oct. 17, 1946					Do.
9aa	do	9.5	2	GI	N	O	do	.6	7,522.6	3.88	June 17, 1946					Do.
9cc	do	10.0	2½	GI	N	O	do	.8	7,528.1	8.80	Oct. 28, 1946					Do.
9dd	do	9.4	2	GI	N	O	do	.8	7,522.1	4.87	June 17, 1946					Do.
10aa	do	11.5	2	GI	N	O	do	.2	7,522.9	7.13	June 18, 1946					Do.
11bd	do	10.4	2	GI	N	O	do	.2	7,521.9	4.98	June 18, 1946					Do.
12cc	do	7.8	2	GI	N	O	do	1.3	7,523.5	7.36	Aug. 9, 1946					Bored well.
13cb	do	49.3	1¼	I	N	O	do	.4	7,520.2	5.40	July 10, 1946					Jetted well. Sample.
13cc	do	10.0	2	GI	N	O	do	1.2	7,520.6	8.68	Aug. 9, 1946					Bored well. Sample.
14cc	do	8.0	2	GI	N	O	do	2.0	7,521.7	6.50	July 12, 1946					Do.
15aa	do	10.0	2	GI	N	O	do	.2	7,521.8	6.28	Oct. 29, 1946					Jetted well. Sample.
15cc	do	9.9	2	GI	N	O	do	0	7,522.0	6.14	Oct. 28, 1946					Do.
16ad	do	48.4	1¼	I	N	O	do	1.9	7,525.3	7.61	Sept. 16, 1946					Jetted well.
16cc	do	10.0	2	GI	N	O	do	.8	7,526.7	8.04	Oct. 28, 1946					Jetted well. Sample.
18cc	do	9.9	3	GI	N	O	do	.5	7,537.5	9.39	Oct. 17, 1946					Do.
19aa	do	9.5	3	GI	N	O	do	.4	7,532.7	9.35	Oct. 17, 1946					Do.
21cc	do	9.9	2	GI	N	O	do	.4	7,527.3	7.91	Oct. 28, 1946					Do.
23cc	do	8.3	2	GI	N	O	do	1.7	7,522.1	8.00	July 12, 1946					Bored well. Sample.
23dd	do	49.0	1¼	I	N	O	do	.7	7,518.6	4.84	July 15, 1946					Jetted well.
25aa	do	10.2	2	GI	N	O	do	.4	7,518.9	6.74	Oct. 29, 1946					Bored well.
25cc	do	9.4	3	GI	N	O	do	2.6	7,518.6	7.09	Aug. 27, 1947					Bored well. Sample.
25dd	do	9.8	2	GI	N	O	do	0	7,516.5	6.77	Oct. 29, 1946					Jetted well. Sample.
29bb	do	39.0	1¼	I	N	O	do	3.4	7,534.3	11.36	Sept. 17, 1946					Jetted well.
32ba	do	9.9	2	GI	N	O	do	.1	7,529.8	8.51	Oct. 28, 1946					Do.
32bb	do	17.7	1¼	I	N	O	do	2.2	7,533.6	11.61	Oct. 28, 1946					Jetted well. Sample.
33dd	do	30.0	1¼	I	N	O	do	.4	7,524.1	4.97	Sept. 10, 1946					Jetted well.
35dd	do	22.6	1¼	I	N	O	do	.5	7,521.5	11.00	July 20, 1946					Do.
39-12-2bb	do	4.2	2	GI	N	O	do	.4	7,608.7	2.16	May 10, 1946					Bored well. Sample.
3bb	do	54.0	1¼	I	N	O	do	1.3	7,587.1	5.01	Nov. 7, 1946					Jetted well.
6dd	do	8.5	2	GI	N	O	do	.3	7,527.0	6.05	June 18, 1946					Jetted well. Sample.
7cd	do	40.2	1¼	I	N	O	do	1.9	7,522.8	5.80	Aug. 11, 1946					Jetted well.
18bb	do	9.8	2	GI	N	O	do	.2	7,523.2	7.25	June 19, 1946					Jetted well. Sample.
19ad	do	9.5	2	GI	N	O	do	1.1	7,524.0	7.47	June 19, 1946					Do.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
39-12-19bb	Alamosa County	8.7	2	GI	N	O	Top of pipe	0.2	7,518.5	4.12	June 19, 1946					Jetted well. Sample.
20cc	do	17.0	1¼	I	N	O	do	2.0	7,525.9	8.65	Sept. 11, 1946					Jetted well.
20dd	do	51.0	1¼	I	N	O	do	3.0	7,535.6	7.88	Sept. 13, 1946					Do.
29bd	do	8.8	3	GI	N	O	do	.1	7,524.3	5.29	Aug. 9, 1946					Bored well. Sample.
31cc	do	13.3	3	GI	N	O	do	2.7	7,519.6	11.10	Aug. 12, 1946					Do.
32ca	do	9.3	3	GI	N	O	do	3.8	7,524.3	8.42	Aug. 12, 1946					Do.
40-6-2dc	Mose Pacheco	27.3	20	I	N	O	Top of casing, south side	2.0	7,799.5	17.90	Oct. 29, 1947					Unused irrigation well. Sample.
2dd	do	90	16	GI	T, E	I							960, M		50	
11ab	Loyde and Frances Martz.	21.2	48	W	N	O	Top of wooden crib, west side.	.4		11.80	Nov. 13, 1947					Unused domestic dug well.
12aa	Rio Grande County	13.0	1¼	I	N	O	Top of pipe	.6	7,667.0	3.89	May 4, 1948					Driven and jetted well.
13ab	M. I. Chenoweth	15.0	36	W	N	O	Top of wooden cover, south side.	.6	7,893.9	3.66	Oct. 30, 1947					Unused domestic dug well.
13bb	do	40	4	I	P, H	D	Top of casing	.4		6.34	Oct. 30, 1947					
14ab	Rio Grande County	13.4	1¼	I	N	O	Top of pipe	.4	7,811.0	6.25	Apr. 23, 1948					Driven and jetted well.
14cc	F. M. Burnett	106.9	14	GI	T, T	I	Hole in casing, east side	.8	7,818.0	4.69	Oct. 31, 1947					Sample.
15cc	A. B. Gjellum		18	GI	T, G	I										
16cc	Harry L. Benson	22.4	36	W	P, H	D, O	Top of ground, south corner of well.	0	7,852.7	7.70	Oct. 31, 1947					Dug well. Sample.
20cc	Jessie K. Russell	41.2	14	GI	T, T	I, O	Top of casing, south side	1.0	7,878.0	14.45	Nov. 6, 1947					
21aa	Rio Grande County	7.8	1¼	I	N	O	Top of pipe	.7	7,836.5	6.70	May 3, 1948					Driven and jetted well.
21bd	Starbuck and Linger	52.1	16	GI	T, T	I	Top of casing	1.1		3.40	July 29, 1948					
22aa	Rio Grande County	16.5	1¼	I	N	O	Top of pipe	.7	7,817.8	6.79	Apr. 20, 1948					Do.
22dc	Shrive Collins	125	18	GI	T, B	I	Top of casing	2.0		21.30	Mar. 24, 1948					
23aa	Rio Grande County	15.5	1¼	GP	N	O	Top of pipe	1.0	7,798.9	6.78	Apr. 20, 1948					Do.

23cc	Shrive Collins	123	16	GI	T, G	I							1,601, M			
23dc	do	110	18	GI	T, B	I	Top of casing	1.1		17.50	Mar 24, 1948.					
24aa	Rio Grande County	12.8	1¼	GP	N	O	Top of pipe	.1	7,779.3	7.05	Apr. 20, 1948					Do.
24cc1	P. T. and S. T. Lincoln.	158	18	GI	T, G	I							2,234, M	43, R	50	
24cc2	do	94.7	14	GI	T, B	I, O	Hole in pump base, south side.	.4	7,804.9	8.15	Nov. 6, 1947		1,067, M	18, M		
25ab	do		16	GI	T, G	I										
25bc	Ralph Wheeler	59.4	16	GI	T, G	I	Top of casing, west side	.9		3.70	June 29, 1948					
25cd	Anton Schmidt	21.8	36	W	N	O	Top of wooden crib, east side.	.8	7,796.4	17.00	Apr. 23, 1948					Unused domestic dug well.
26ac	D. M. Wells				T, G	I										
26bd	Anton Schmidt	13.3	36	W	N	O	Top of wooden platform, north side.	.6	7,816.5	6.64	Nov. 13, 1947					Do.
26cc	Off Bros.	27.0	14	GI	T, T	I, O	Top of casing, east side	1.0	7,826.1	19.19	Nov. 6, 1947					
27aa	Anton Schmidt	86.4	14	GI	T, T	I, O	Top of casing, south side	.5	7,829.1	9.23	Nov. 6, 1947		1,846, M			
28bb	State of Colorado				C, T	I										
36bc	Don W. Fleshman				T, T	I										
36da	do	96	16	GI	T, E	I				30			457, M		47	
40-7-1ac	Alfred Karmer	18.9	14	GI	C, E	I	Top of casing	0		2.00	June 25, 1948		2,154, M			Battery of 2 wells.
1ad	do		2	I	F	S, I						June 23, 1949	2.5, M		53	
1cc	Karl Meyers	104	14	GI	N	O	Top of casing	1.3	7,684.6	3.84	Oct. 30, 1947					Unused irrigation well. Equipped with automatic water-level recorder, 1949–52. Sample.
1db	D. D. and Agnes Thompson.	38.9	16	GI	C, E	I	Top of casing, east side	−1.9		.21	June 25, 1948		902, M	16, M	54	Battery of 2 wells.
2cc	C. and E. Brackney	90	16	GI	T, G	I							938, M			
2dd	Ralph Dabney	14.4	30	OB	N	O	Top of casing	1.3		5.83	Apr. 15, 1948					Unused domestic well. Equipped with automatic water-level recorder, 1947–49.
3aa	Rio Grande County	13.2	1¼	GP	N	O	Top of pipe	1.2	7,694.7	5.90	May 19, 1948					Driven and jetted well.
3cc	Carl Keck	70.5	14	GI	T, G	I, O	Top of casing, north side	0	7,715.9	3.60	Oct. 30, 1947					
4cc	F. W. and Ester Pepper		18	GI	T, T	I							1,302, M			
4dc	J. C. Pepper		18	GI	T, G	I										
5bb	Rio Grande County	8.6	1¼	GP	N	O	Top of pipe	.7	7,741.4	8.06	Dec. 9, 1948					Do.
5bc1	Ella Welty	38.5	18	GI	T, T	I	Top of casing, south side	.7		6.60	June 15, 1949					
5bc2	do	90	3	I	N		Top of pipe	1.6		3.50	June 15, 1949					Unused stock well. Flowed when drilled.
5dc	D. L. Roberts	165	16, 12	GI	T, E	I										

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-7-6ba	E. Newmeyer and S. F. Klecker.	26.2	2	I	P, H	D, O	Top of pipe, east side	1.8	7,752.5	11.70	Oct. 29, 1947					
6cd	do	20	4	I	P, H	D, S, O	Top of pipe, west side	.9	7,752.1	3.07	Oct. 29, 1947					Sample.
6dc	do	215	14	GI	T, E	I	Top of casing	.8		9.50	Nov. 28, 1950		1,475, R	126, R		
8ac	Elmer and Bethine Crown.		16	GI	T, G	I										
8bb	Rio Grande County	13.0	1¼	GP	N	O	Top of pipe	.8	7,750.5	5.70	May 4, 1948					Driven and jetted well.
8bc	Ernest R. Biery	10.5	36	W	N		Top of wooden crib, west side.	.4		5.58	Oct. 30, 1947					Unused domestic well.
9aa	M. I. Chenoweth	27.2	12	GI	P, H	D, O	Top of casing, east side	.4		2.27	Oct. 29, 1947					Sample.
9bb	do	15.1	16, 14	GI	N	O	Top of wooden brace post, west side.	0	7,733.2	5.10	Nov. 13, 1947					Unused irrigation well. Equipped with automatic water-level recorder, 1952-53.
9bc	do		16	GI	T, E	I										
9cc	R. W. and N. M. Dillon.	40.0	18	GI	T, G	I, O	Top of casing, south side	1.1	7,740.4	5.96	Oct. 30, 1947					
9dc	Robert J. Graham				T, E	I							872, M			
10ac	R. W. Naudack		20	GI	T, T	I	Top of casing	.9		3.00	June 28, 1948					
10cc	R. J. Graham		4	I	H	D, O	Top of pipe, south side	0	7,720.2	2.90	Oct. 30, 1947					
11ac	Karl Meyers		14	GI	T, E	I										
11bb1	Rio Grande County	10.3	1¼	GP	N	O	Top of pipe	.9	7,701.3	8.15	Apr. 15, 1948					Driven and jetted well.
11bb2	J. A. Henry		4	I	N											Unused domestic and stock well.
11bc	do	100	16	GI	T, E	I	Hole in casing, east side	0		9.00	Aug. 8, 1950		1,020, M	23, M		

11cc	C. W. and Sara V. Corlett.	117	16	GI	T, E	I							1,009, M			
11dc	Murray Macy	63.5	16	GI	T, G	I, O	Top of casing, east side	.1	7,696.2	5.64	Nov. 21, 1946					
12ac	R. McConnell	35.2	18	GI	T, E	I	do	−.8		2.19	June 25, 1948		935, M	26, M		
12bc	M. S. Shown		16	GI	C, E	I	Hole in barrel, east side	−1.1					799, M			Battery of 2 wells.
12cc	Louis C. Wertz		16	GI	T, E	I		1.10		5.36	June 1, 1951		1,500, M			
12dc	R. Watson	59.0	16	GI	T, E	I, O	Top of casing, north side	1.0	7,682.9	6.68	Nov. 21, 1946		1,330, M	26, M		
13ac	Roy and Ada Wertz				T, E	I							1,642, M			
13bc	Louise, Helen, and Reed Hynds.	48.6	24	GI	T, E	I	Top of casing, east side	0		2.32	June 28, 1948		1,289, M			
13cc	Cora L. Davis				T, E	I							950, R			
13dc	Edith Macy		20	GI	T, E	I							893, M			
13dd	do	20.3	12	GI	C, E	S, O	Top of wooden enclosure, south side.	2.7	7,682.4	6.35	Oct. 31, 1947					Sample.
14ab	Ester B. Macy				T, E	I										
14cc	Edna Macy and Joseph Boats.	72	16	GI	T, E	I, O	Top of pump base, south side.	0	7,705.4	5.85	Nov. 21, 1946					Do.
14dc	Robert Macy	60	20		T, G	I							1,100, R			
15aa	Rio Grande County	9.7	1¼	GP	N	O	Top of pipe	.9	7,704.8	5.83	Apr. 27, 1948					Driven and jetted well.
15cb	J. S. Schmidt		22	GI	T, G	I	Top of casing, south side	.7		9.72	Apr. 25, 1951		1,287, M	40, M		
15cc	Hattie Wertz	87.1	14	GI	T, E	I, O	Bottom of pump base, east side.	0	7,724.5	5.08	May 28, 1948		1,152, M			
15dc	do				T, T	I										
16dc	Leroy and Juanita Davis.		16	GI	T, E	I							1,308, M			
17ab	C. L. Worley		16	GI	T, G	I										
17dc	E. J. and Dorothy Pepper.		12	GI	T, G	I, O	Top of hole, south side	0	7,753.2	6.78	Oct. 31, 1947					
18aa	Rio Grande County	11.5	1¼	GP	N	O	Top of pipe	.5	7,759.1	5.19	May 3, 1948					Do.
18bb	Union Central Life Ins. Co.	11.3	4	I	N	O	Top of casing	.9	7,783.6	4.34	Oct. 30, 1947					Unused domestic well.
18dc	M. I. Chenoweth	21.5	3	I	P, H	D, O	Top of casing, west side	.4	7,768.2	2.78	Oct. 31, 1947					Sample.
19aa	Rio Grande County	13.2	1¼	GP	N	O	Top of pipe	.5	7,762.0	9.72	Apr. 20, 1948					
19ac	J. Therman Herbour				T, E	I										
19cc	Lenard and Gladys Wellman.	27.2	14	GI	T, T	I, O	Top of casing, south side	.4	7,784.9	3.21	Nov. 6, 1947					
19db	Ralph and Ethel Scheel	73.9			T, E	I	Top of casing	.2		5.63	June 29, 1948		961, M	40, M		
20ac	do	73.1	18	GI	N		Top of casing, east side	.4		4.51	June 29, 1948		1,150, R			Unused irrigation well.
20bc	do	86.5	18	GI	T, E	I	Top of casing, west side	.7		5.65	June 15, 1949					
20cb1	Frank Bernett	51.0		GI	T, E	I	Top of 1¾-inch pipe, east side.	.8		5.80	June 15, 1949					
20cb2	do				T, E	I										
20db	Hazel Pepper				T, E	I	Top of casing, south side	1.3		14.59	Apr. 25, 1949		1,157, M	38, M		
20dd	Rio Grande County	10.9	1¼	GP	N	O	Top of pipe	.9	7,747.6	10.00	Apr. 9, 1948					Driven and jetted well.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-7-21aa	Union Central Life Ins. Co.	17.2	3	I	P, H	D	Top of pump base, north side.	3.3		8.20	Oct. 31, 1947					Sample.
21ac	do	27.1	14	GI	T, E	I, O	Top of casing, south side	0	7,734.9	7.12	Nov. 6, 1947					
21cb	N. Norman Chapman	120	16	GI	T, E	I							1,430, M		50	
21cc1	do				T, E	I										
21cc2	do				T, E	I							932, M			
21dd	Rio Grande County	10.2	1¼	GP	N	O	Top of casing	1.2	7,727.7	9.08	Apr. 9, 1948					Driven and jetted well.
22ac	Robert Haws	86.7	16	GI	T, E	I, O	Top of casing, north side	.8	7,718.7	7.07	Nov. 6, 1947		1,485, M	26, M		
22bc	State of Colorado				T, E	I										
22cb	W. A. Farrel		20	GI	T, E	I										
22dd	Rio Grande County	8.5	1¼	GP	N	O	Top of pipe	.9	7,708.9	6.12	Apr. 8, 1948					Do.
23aa	do	9.2	1¼	GP	N	O	do	1.1	7,692.8	5.73	Apr. 15, 1948					Do.
23ac	G. K. and Lucille Harris.				T, E	I										
23bc	Howard and Edith Macy.				T, E	I										
23cb	A. C. Monter and R. Bloss.				T, E	I							1,296, M			
23db1	Fred Gragg	63.8	24, 14	GI	N	O	Top of casing, west side	1.6	7,701.1	4.96	Oct. 31, 1947					Unused irrigation well.
23db2	do	40.1	14	GI	T, E	I	Top of casing, north side	.3		4.29	Oct. 31, 1947					
24ac	Howard W. Macy				T, E	I							1,218, M			
24bb	do				T, E	I										
24cb	James and Ruth Harbour.	105.3	14	GI	T, E	I, O	Top of casing, east side	.3	7,728.2	5.32	Nov. 7, 1947		875, M			
24cc1	do				T, E	I										
24cc2	Rio Grande County	11.2	1¼	GP	N	O	Top of pipe	1.8	7,693.0	6.10	Apr. 8, 1948					Driven and jetted well.

24dc	Sarah V. Mathias	40	16	GI	T, E	I	Top of casing, west side	1.1		2.50	June 30, 1948					
25ab	Henry L. Hougland	24	16	GI	C, E	I, O	Top of casing	−.7	7,684.1	4.49	Nov. 21, 1946					Sample.
25ac	do		14	GI	T, E	I							700, R			
25bc	John W. Shaffer				T, E	I										
25cc	S. C. and H. G. Sanderson.	32.0	18	GI	T, G	I	Top of casing, north side	.7		4.55	June 16, 1949					
25db	R. McConnell				T, E	I							1,400, R			
26ac	Carl C. Hoffman				T, E	I							1,313, M			
26bc	Walter A. Monter				T, E	I										
26cb	J. H. Braunell				T, E	I										
26cc	Rio Grande County	13.2	1¼	GP	N	O	Top of pipe	.5	7,709.7	6.37	Apr. 23, 1948					Driven and jetted well.
26db	C. and L. Anderson	105.0	18	GI	T, E	I	Hole in casing, east side	0		9.50	Jan. 10, 1951		1,022, M	22, M		
26dd	Rio Grande County	13.3	1¼	GP	N	O	Top of pipe	1.4	7,696.0	6.97	May 4, 1948					Do.
27ac	Paul Harris				T, E	I										
27bc1	H. J. Gilbreath	159	16, 12	GI	T, E	I							1,382, M			
27bc2	do	109	18	GI	T, E	I	Top of pipe, east side of pump base.	.9		7.00	Aug. 9, 1950		1,174, M	29, M		
27db	John C. Davis				T, E	I										
28ac	M. V. and R. I. Davis.	132	18	GI	T, E	I	Top of casing, west side	.9		3.31	June 30, 1948					
28bc1	Ella Welty		16	GI	T, E	I										
28bc2	do	7.5		W	N	O	Bench mark on post, northeast corner of well.	1.0	7,745.4	6.24	Nov. 13, 1947					Unused domestic well.
28cb1	George Millikan				T, E	I										
28cb2	do				T, E	I										
28db	do				T, E	I										
28dd	Rio Grande County	9.8	1¼	GP	N	O	Top of pipe	.8	7,726.2	4.38	Apr. 23, 1948					Driven and jetted well.
29ac	Helda Black				T, G	I										
29cb	Leland and Orva Brewer.		18	GI	T, E	I										
29db	J. E. and Lillis Jackson				T, E	I										
30aa	Chester Mathias	19.1	23	OB	C, T	I, O	Top of casing, west side	1.2	7,765.4	4.46	Nov. 6, 1947					
30ac	do				T, E	I										
30cb	Chester, Frank, and Dorothy Hinds.	88.7	16	GI	T, T	I, O	Top of pump base, south side.	.7	7,787.1	15.73	Nov. 7, 1947					Sample.
31bb	J. Smith		16	GI	T, E	I							962, M			
31cb	do		20	I	N		Top of casing, south side	.4		14.62	Oct. 31, 1950					Unused irrigation well.
31cc	Rio Grande County	7.8	1¼	GP	N	O	Top of pipe	.5	7,781.9	6.78	Sept. 21, 1948					Driven and jetted well.
32ab	M. DeFreese	33.2	25	OB	T, E	I, O	Top of pump base, north side.	0	7,755.8	5.33	Nov. 7, 1947					
32bb	V. A. Drake				T, E	I										
32cb	Pearl Burkhart				T, E	I										

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-7-32cc	Pearl Burkhart	71.2	18	GI	T, E	I, O	Top of casing, south side	0.4	7,763.3	14.82	Nov. 10, 1947					
33bb	Florence Clarke		18	GI	T, E	I							768, M			
33cc	Wallace Ecord		18	GI	T, N											Unused irrigation well.
33dc	C. T. Blackwell	18.4	22½	GI	N	O	Top of casing, south side	1.6	7,740.1	3.52	Nov. 10, 1947					Do.
34ac1	Stanley Sanderson				T, E	I										
34ac2	do				T, E	I										
34bc	Flossie Michael	75.0	18	GI	T, E	I	Top of casing, northeast side.	0		6.00	June 16, 1949					
35ac	Stanley Sanderson				T, E	I										
35bb1	do	97	18	GI	T, E	I										
35bb2	do	106	18	GI	T, E	I	Top of casing, east side	0		3.00	June 16, 1949					
35cb	Louise Hynds	56.8	16	GI	T, E	I, O	Top of casing, north side	0	7,712.9	8.53	Nov. 20, 1946		1,200, E			
35cc	do	90	20, 18	GI	T, E	I	Top of casing	−.5		3.30	July 1, 1948					
35dd	Rio Grande County	11.3	1¼	GP	N	O	Top of pipe	.7	7,696.5	8.02	Apr. 7, 1948					Jetted well.
36ac	C. R. Sanderson	80	18	GI	T, G	I	Top of casing	.5		3.21	July 1, 1948					
36bc	V. H. Sanderson		18	GI	T, E	I										
36cb	do				T, E	I										
36cc	G. K. and F. Michael	74.2	18	GI	T, E	I	Top of casing, west side	.5		5.35	June 16, 1949					
36db	C. R. Sanderson	82.4	16	GI	T, E	I, O	Hole in casing, north side.	.6	7,688.0	5.10	Nov. 10, 1947					
40-8-1ac	A. G. Fike				C, E	I							507, M			
1bb	Roy F. Lofton, Jr.		2	I	F	S, I						Nov. 1, 1948	15, M			Water has odor of hydrogen sulfide.
1bc	do	33.3	22	GI	C, E	I, O	Top of casing	1.6	7,614.1	4.28	Aug. 29, 1947		1,182, M			Battery of 2 wells. Sample.
1cc	Glen G. Davis		18	GI	T, E	I	Hole in casing, east side	.8		5.08	Apr. 25, 1951		840, M			
1dc	William and Cora Fike				C, E	I										
1dd	Rio Grande County	9.4	4	GI	N	O	Top of pipe	.5	7,607.0	6.00	June 19, 1948					Jetted well.

2ac	Charles W. Graves	55.7	20	GI	T, G	I	Top of casing, west side	.5		2.65	June 23, 1949					
2cc1	W. D. and Annabelle Miller.		2	I	F	D, S						June 23, 1949	56, M		54	
2cc2	do	78.0	16	GI	C, E	I	Top of casing, east side	.5		3.01	Dec. 2, 1946					
2db	Max Selters		2	I	F	I						Aug. 30, 1950	60, M		55	Water has odor of hydrogen sulfide.
2dc1	do	63.5	16	GI	T, E	I	Top of casing, south side	0		4.74	Oct. 31, 1947		993, M	34, M		
2dc2	do	11.8	45	W	N	O	Top of wood cover, north side.	0	7,619.5	3.95	Oct. 31, 1947					Unused domestic well.
3ab	Mrs. G. E. Bowsher		4	I	F	S, I						June 24, 1949	107, M		56	Water has odor of hydrogen sulfide.
3ac1	do	80.9	20	GI	T, E	I	Top of casing, east side	0		2.70	June 23, 1949					
3ac2	do	188.5	4	I	F	I						June 23, 1949	71, M		55	Do.
3ac3	do				C, G	I							1,000, E			Battery of 2 wells.
3bc	Dorothy and Robert Burns.				C, E	I										
3cb	Daisy Burns				C, G	I										
3cc	do	69.9	16	GI	T, E	I, O	Top of casing, south side	0	7,634.9	4.57	Oct. 30, 1947					Sample.
3dc1	Harvey N. and Henry Kophman.	71.7	18	GI	T, T	I	do	0		2.00	June 15, 1949					
3dc2	do	52.6	20	GI	T, E	I	Top plank, southeast of pump base.	.8		5.90	Aug. 21, 1950					
3dc3	do	51.6	18	GI	T, E	I	Top of casing, south side	0		2.00	June 15, 1949					
4ac1	Ida Oliver				C, T	I										
4ac2	do				T, E	I										
4ba	Lulu Ann Bowden		2	I	F	D						Oct. 14, 1950	30, M		54	Water has odor of hydrogen sulfide.
4bc	do	34.9	14	GI	C, G	I, O	Top of casing, north side	−2.6	7,641.3	2.25	Nov. 21, 1946					Sample.
4cc	Mabel Schmittle	32.6	18	GI	C, E	I	Top of casing, west side	−.5		2.70	June 23, 1949					Battery of 2 wells.
5bc	C. B. Lockhart				C, G	I										Do.
5cc	do	28.1	14	GI	C, E	I, O	Top of casing, east side	−1.2	7,655.2	1.12	Oct. 30, 1947		1,288, M			Battery of 2 wells. Sample.
5dc	M. and W. L. Clark	33.0	18	GI	C, E	I	Top of casing, north side	.4		3.60	June 24, 1949					Battery of 2 wells.
5dd	Rio Grande County	8.4	1¼	GP	N	O	Top of pipe	.1	7,646.4	5.23	Apr. 16, 1948					Driven and jetted well.
6aa	F. and M. McCormick		3	I	F	S, I						June 15, 1949	36, M		54	
6ac	do	26.9	18	GI	C, G	I	Top of casing, south side	−2.0		2.50	Aug. 30, 1950					Battery of 2 wells.
6bc	R. V. Burkholder	29.1	32	OB	C, E	I, O	do	2.8	7,670.0	4.78	Sept. 29, 1947		1,260, M	15, M		Do.
6cc	Carl Hoffman	44.0	14	GI	C, E	I, O	Top of casing, west side	−1.5	7,667.7	1.95	Sept. 30, 1947		635, M	18, M		
7ac1	V. C. Gromer				T, E	I							1,135, M			
7ac2	do	36.0	24	GI	C, E	I	Top of casing, south side	−3.6		1.50	June 24, 1949		921, M			Do.
7bc	Roy McConnell	28.5	16	GI	C, E	I	Top of casing, north side	−.7		1.60	June 24, 1949					Do.
7cc	Roy and Ada Werts	79.0	18	GI	T, N		Top of casing, east side	.6		3.20	June 24, 1949					Unused irrigation well.
7dc	D. E. Newcomb		18	GI	T, E	I							1,211, M			

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (—) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-8-8ac1	Mabel Schmittle	32.0	18	GI	C, E	I	Top of barrel casing, east side.	0.9		3.15	June 24, 1949					Battery of 2 wells
8ac2	do	69.0			T, E	I	Top of casing, east side	1.1		4.65	June 24, 1949					
8dc	Clyde Whitter	24.9	23	OB	T, E	I, O	do	0	7,656.3	6.18	Nov. 21, 1946		1,746, M			
9ac1	V. C. Gromer				T, E	I							1,045, M			
9ac2	do	31.5	20	GI	C, E	I	Top of casing, east side	—.6		1.75	June 24, 1949		921, M			
9bc	Harold Selters	29.0	18	GI	C, G	I	Top of barrel	.5		3.10	June 24, 1949					Do.
9cb	Clyde Whitter	44.5	16	GI	T, E	I	Top of casing, south side	0		3.94	Nov. 21, 1946					
9dc	James and Daisy Burns		20	GI	C, E	I					Apr. 6, 1948		1,126, M			
10ac	Grace Montgomery	42.5	20	GI	C, E	I	Top of casing, south side	—1.9		.60	June 27, 1949					
10bb1	Nellie Newmeyer		4	I	F	S						June 23, 1949	16, M		55	
10bb2	do	32.2	18	GI	C, E	I	Top of casing, south side	—.3		3.40	Oct. 25, 1950					Do.
10bc	do	179.7	3	I	F	S, I					June 9, 1948		88, M		53	
10cb	Pauline Bowsher		2	I	F	I						June 27, 1949	23, M		54	
10cc	do	56.4	22	GI	T, E	I, O	Top of casing, south side	.4	7,636.9	3.77	Oct. 31, 1947					
10db1	W. H. Fassett				C, E	I		0		1.70	June 27, 1949		1,080, M			Do.
10db2	do	184.0	2	I	F	I							5, E		54	Water has odor of hydrogen sulfide.
10dc1	do				C, E	I										
10dc2	do		2	I	F	I						June 27, 1949	50, M		55	
11ac	Charles W. Dorney	42.0	16	GI	C, E	I	Top of casing	1.0		4.30	June 27, 1949		1,742, M	11.5, M		Battery of 3 wells.
11bc	R. C. and Nina Wilson	27.0	20	GI	C, E	I	Top of casing, east side	—2.7		.25	June 27, 1949		852, M	14.5, M		Battery of 2 wells.
11cc	W. H. and Gladys Kopfman.	28.0	18	GI	C, E	I	Top of barrel, southwest side.	.2		2.75	June 27, 1949		771, M	23, M		Do.
11db	Lloyd and Bessie Bloxsom.	29.5	24	GI	C, E	I	Top of casing, north side	0		3.20	June 27, 1949					Do.
12cc1	Nina Wilson	38.0	20	GI	C, E	I	Top of casing, south side	.5		2.85	June 27, 1949		832, M	19.5, M		Do.
12cc2	do		2	I	F	S, I							1, E			

12dc1	J. H. Goehl		2	I	F	S							2, E		56	Water has odor of hydrogen sulfide.
12dc2	do	68	16	GI	T, E	I	Top of hole in pump base, east side.	.9		4.38	July 7, 1950		1,105, M			
12dc3	do	29.8	14	GI	C, E	I, O	Top of wooden crib, west side.	0	7,612.4	4.09	Oct. 31, 1947					Battery of 2 wells.
13ab1	R. P. Perdew	31.3	18	GI	C, E	I	Top of casing, south side.	0		2.75	June 28, 1949					Do.
13ab2	do		2	I	F	S, I						June 27, 1949	20, M		55	Water has odor of hydrogen sulfide.
13bc	Albert Eagles	37.1	16	GI	C, E	I	Top of wooden enclosure, south side.	.9		2.65	June 28, 1949					
13cc	Gale Bowsher	40.1	18	GI	C, E	I	Top of wooden box, north side.	.5		3.65	June 28, 1949		1,251, M			Battery of 2 wells.
13dc1	Virgil and Helene Eagles.	38.5	18	GI	C, E	I	Top of wooden box	1.0		3.50	June 27, 1949					Battery of 3 wells.
13dc2	do		2	I	F	S, I						June 27, 1949	47, M		54	
14bb1	Francis and Ida Harden.	29.1	14	GI	C, G	I, O	Top of casing, north side.	−2.0	7,625.3	2.24	Oct. 31, 1947		1,105, M	13.5, M		Battery of 2 wells.
14bb2	do	248.4	2	I	F	I						Oct. 22, 1948	31, M		55	
14bc1	do				C, G	I										
14bc2	do	188.5	2	I	F	S, I						June 28, 1949	54, M		55	Water has odor of hydrogen sulfide
14bc3	do	36.9	16	GI	T, E	I, O	Top of casing, north side.	1.0	7,629.2	4.83	Nov. 6, 1947		1,000, M	22, M		
14cb1	M. P. and M. Haller		3	I	F	I						June 28, 1949	725, M		54	Do.
14cb2	do		3	I	F	I						June 28, 1949	79, M		55	Do.
14cc1	do	54.0	18	GI	T, E	I	Top of casing, east side.	1.1		3.65	June 28, 1949		1,000, M	27, M		
14cc2	do	9.8	3	GI	N	O	Top of pipe	.1	7,627.5	4.20	Apr. 16, 1948					Jetted well.
14db	Russell Patterson	49.8	16	GI	C, E	I	Top of wooden box, north side.	1.0		3.90	June 28, 1949		1,114, M	9, M		
15ac1	Pauline Bowsher	52.5	18	GI	T, E	I	Top of casing, south side.	.5		3.50	June 28, 1949		1,601, M	21.5, M		
15ac2	do		2	I	F	I						June 28, 1949	38, M		54	
15bc1	J. P. Burns				T, E	I										
15bc2	do		2	I	F	I						June 28, 1949	47, M		54	Water has odor of hydrogen sulfide.
15cb1	R. V. Bowsher	55.2	18	GI	T, E	I	Top of casing, east side.	.9		3.50	June 28, 1949					
15cb2	do		2	I	F	I						June 28, 1949	37, M		55	
15cc	do	72.6	16	GI	T, G	I, O	Bolt hole, south side of casing.	.5	7,639.5	4.99	Nov. 6, 1947					
16ac	Vern and Gale Bowsher.	59.4	18	GI	T, E	I	Top of casing, south side.	.7		3.30	June 28, 1949					
16bc	J. H. Goehl	30.7	14	GI	C, E	I	Top of barrel cover, east side.	1.0		2.45	June 28, 1949		1,150, R			Battery of 2 wells.
16cc1	Samuel Holland				C, E	I										
16cc2	do	27.1	14	GI	C, E	I, O	Top of casing, south side.	−1.0	7,648.2	.27	Nov. 6, 1947		535, M			Do.
17dc	Harland and Martha Scott.	29.0	14	GI	C, E	I, O	Top of casing, northwest side.	0	7,654.6	1.10	Nov. 6, 1947					
18ac	D. E. Newcomb				T, E	I							1,227, M			

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of— Water level	Date of measurement of— Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-8-18bc	S. F. Klecker				T, E	I	Top of hole in barrel cover, east side.	1.5		8.33	Apr. 25, 1951		1,067, M			
18cb	San Luis Valley Potato Association.	41.5	20	GI	C, E	I	Top of casing, south side	0		2.20	July 29, 1949		956, M			
18dc	Henry Selters				C, E	I										Battery qf 2 wells.
19ac	James R. Selters	31.2	20	GI	C, E	I	Top of barrel, east side	.6		3.30	June 29, 1949		1,300, R			Battery of 3 wells.
19bc	E. R. Lofton			GI	C, E	I							1,084, M	16, M		
19cb	Habert Selters	31.2			C, E	I	Top of 2-inch pipe, south of pump house.	.9		4.30	June 29, 1949		776, M			Sample.
19db	Eva W. Clifton	30.2	18	GI	C, E	I	Top of casing, south side	−2.4		1.00	June 29, 1949					Battery of 2 wells.
20bc1	B. E. and S. Holland	28.5	18	GI	C, E	I	Top of casing, east side	−1.4		2.20	June 29, 1949		1,084, M	16, M		
20bc2	do	28.3	18	GI	C, E	I	Top of casing, north side	0		3.20	June 29, 1949					Do.
20cb	Fred H. Gragg		20	GI	T, E	I							1,000, R			
20cc	do				C, E	I										Do.
21ab	Leto Kehler				C, E	I										Do.
21ac	do				C, E	I										Do.
21ad	do				F	I						Oct. 23, 1950	9.5, M		53	
21bc	Joseph Selters	46.7	20	GI	C, E	I	Top of casing, east side	0		2.90	June 29, 1949		1,194, M	19, M		Do.
21cb	Elizabeth and E. Macy	29.8	20	GI	C, G	I	Top of casing, north side	0		2.85	June 29, 1949					Do.
21da	H. and M. Sanderson		1	I	F	S							10, E		55	
21db	Elizabeth and E. Macy				C, E	I										Battery of 3 wells.
22bb	Leto Kehler				C, E	I										Battery of 2 wells.
22cb	Lajune Kehler	51.8	20	GI	C, E	I	Top of casing, east side	.8		3.40	June 29, 1949		1,394, M			Do.
23ac	Starbuck and McDonald.	55.0	18	GI	T, E	I	do	.7		3.90	June 30, 1949					
23bb1	W. J. and Edith Meyers		2	I	F	D						Oct. 21, 1948	37, M		54	
23bb2	do		2	I	F	I						Oct. 21, 1948	9.5, M		54	
23bc1	do		2	I	F	S						June 30, 1949	6.5, M		54	Water has odor of hydrogen sulfide

23bc2	do				C, G	I										Battery of 2 wells.
23cc	Ray F. Holland	33.8	20	GI	C, G	I	Top of casing, east side	−4.6		.93	June 30, 1949					
24ac1	Helirey Keyes	66.3	18	GI	T, E	I	do	.6		3.45	June 30, 1949					
24ac2	do	28.5	16	GI	C, E	I	Top of casing, south side	0		3.35	June 30, 1949		900, R			
24bb1	Gale and R. Bowsher	46.0	16	GI	C, T	I, O	Top of casing, northwest side.	−1.1	7,618.2	3.80	Nov. 6, 1947					Do.
24bb2	do		2	I	F	D						Oct. 21, 1948	12, M		53	Water has odor of hydrogen sulfide.
24bc	do		14	GI	C, G	I									49	
24cb	R. and V. Patterson	40.0	20	GI	C, E	I	Top of wooden box, south side.	1.2		3.70	June 30, 1949		1,114, M	12, M		Battery of 2 wells.
25ac1	J. MacArthur	27.4	16	GI	C, E	I	Top of casing, east side	−2.2		.85	June 30, 1949					Do.
25ac2	do	174.3	2	I	F	S, I						June 30, 1949	41, M		54	
25bb1	Ella Welty		2	I	F	I						Oct. 21, 1948	58, M		55	
25bb2	do	63.5	2	I	F	S, I						July 13, 1949	63, M		56	Water has odor of hydrogen sulfide.
25bb3	do		2	I	F	I						Oct. 21, 1948	39, M		58	Do.
25bc	do		5	I	F	I						Oct. 21, 1948	79, M		56	
25cb	do	50	16	GI	C, G	I, O	Top of casing, northwest side.	0	7,618.1	1.43	Dec. 2, 1946					
25cc	do		2	I	F	S, I						July 13, 1949	21, M		54	Do.
26bc1	Zoe Cunningham		2	I	F	S, I						July 13, 1949	38, M		54	
26bc2	do	26.6	20	GI	C, E	I	Top of casing, east side	−2.8		.20	July 13, 1949					
26bc3	do		2	I	F	S, I						July 13, 1949	29, M		54	
26bc4	do		2	I	F	S, I						July 13, 1949	37, M		54	
26bc5	do		2	I	F	S, I						July 13, 1949	47, M		54	
26cb1	Bertha Collins	27.4	24	GI	C, G	I, O	Top of hole, northwest corner.	.7	7,629.8	3.25	Nov. 7, 1947		660, M			Battery of 2 wells.
26cb2	do	70	16	GI	T, E	I	Top of casing, west side	2.5		6.00	Apr. 3, 1949		1,380, M	16, M		
26cc	Rio Grande County	11.5	1¼	GP	N	O	Top of pipe	.5	7,629.5	3.81	May 26, 1948					Driven and jetted well.
26dd	do	13.2	1¼	GP	N	O	do	.3	7,620.3	3.92	Apr. 27, 1948					Do.
27ac	W. E. and Clara Allen				T, E	I										
27bc	J. Max Selters		18	GI	T, E	I							1,287, M			
27cb	Robert Selters				T, E	I										
27db1	Leonard Prentice	60	18	GI	T, E	I	Top of casing, east side	−.4		6.50	Apr. 3, 1950		1,440, M	11, M		
27db2	do	31.3	20	GI	C, E	I, O	Top of casing, north side	−2.9	7,631.6	.55	Nov. 7, 1947					Battery of 2 wells.
28ac	Evert and Susan Sanderson.				C, E	I										Battery of 3 wells.
28bc	Marvin and Dolora Sawyer.				C, E	I										Battery of 2 wells.
28cb	Robert Selters	30.8	22, 18	GI	C, E	I, O	Top of casing, north side	.2	7,653.5	4.82	Nov. 7, 1947		1,200, E			Do.
28db	do	44.4	18	GI	T, E	I, O	do	0	7,646.9	4.05	Nov. 7, 1947					
29ac	Meade David	30	16	GI	C, E	I		−1.9		.40	June 30, 1949					Do.
29bc	C. H. Corlett	26.8	16	GI	C, E	I, O	Top of casing, north side	−1.6	7,663.1	1.76	Nov. 7, 1947					Do.
29db1	Joseph Selters				T, E	I							1,000, E			

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point			Distance to water level above (+) or below measuring point (feet)	Date of measurement of—		Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
							Description	Distance above or below (−) land surface (feet)	Height above sea level (feet)		Water level	Discharge				
40-8-29db2	Joseph Selters				C, E	I							1,645, M	14, M		Battery of 2 wells.
30aa	Rio Grande County	8.1	1¼	GP	N	O	Top of pipe	0.3	7,663.8	3.75	Apr. 15, 1948					Jetted well.
30ac	Phyllis L. Phillips	30.2	14	GI	C, E	I	Top of casing, north side	0	7,671.6	2.94	Nov. 7, 1947					Battery of 2 wells.
30ad	C. W. Dorney				T, E	I										
30bc1	Henry Selters	43.2			C, G	I	Top of 2-inch pipe	.8		3.40	July 1, 1949					
30bc2	do	85.8	18	GI	T, G	I, O	Top of casing, west side	0	7,679.2	4.00	Nov. 7, 1947		850, E			
30db	Robert Shown	57.6	18	GI	T, E	I	Top of casing, east side	.7		4.75	July 1, 1949		1,373, M	34, M		
30dc	do		18	GI	T, N											Unused irrigation well.
31ac	J. Shown	83	16	GI	T, E	I							1,000, E			Sample.
31bb	Rio Grande County	13.1	1¼	GP	N	O	Top of pipe	2.2	7,682.4	7.96	Jan. 7, 1948					Jetted well.
31bc	Felix Kieser				T, E	I							1,264, M			
31cb	Virginia and Kenneth Metz.				T, E	I										
31da	Raymond and Mable Metz.		2	I	F	S						Oct. 23, 1950	2, M		51	
32ac1	Emley McDonald	31.7	18	GI	C, E	I	Top of casing, east side	0		3.10	July 1, 1949		1,026, M	30, M		Battery of 2 wells.
32ac2	do		2	I	F	S, I						July 1, 1949	20, M		51	
32ac3	do				T, E	I										
32bb	Rio Grande County	13.5	1¼	GP	N	O	Top of pipe	1.7	7,667.7	5.07	Apr. 15, 1948					Jetted well.
32bc	H. C. and H. F. Boyce				T, E	I							1,550, M			
32bd	do		2	I	F	S, I						July 14, 1948	7.5, M		51	
32cb	Ephrian Clarke				T, E	I										
32db1	Frank Worley				C, E	I										
32db2	do	31.8	14	GI	C, E	I, O	Top of wooden crib, east side.	1.6	7,660.8	3.70	Nov. 10, 1947					Battery of 2 wells.
33aa	P. Starbuck	12.5	12	BS	N	O	Top of casing, west side	1.1		4.10	Apr. 15, 1948					Well equipped with automatic water-level recorder.

33bb1	Albrey Starbuck		2	I	F	S, I						July 6, 1948	13, M		51	
33bb2	do				C, E	I										
33cb	George and Leota Mix		2	I	F	S, I						Oct. 25, 1950	27, M		51	
33cc	do				C, E	I										Battery of 2 wells.
33db	Ursala D. Rierson	31.0	14	GI	C, E	I, O	Top of board cover, north side.	.7	7,646.7	4 05	Nov. 10, 1948					Do.
34ac1	Orval F. Holman	36.0	18	GI	T, E	I	Top of wooden pump support, south side.			5.57	Apr. 25, 1951		1,217, M	14, M	50	
34ac2	do	45.9	24	GI	T, E	I	Top of casing, south side	0		4.45	Apr. 25, 1951		1,363, M	14, M	50	Battery of 2 wells. Siphon system.
34bc	Kathern and Henry Selters.				C, E	I										Battery of 2 wells.
34db1	Harry DeFreese	31.4	18	GI	C, E	I	Top of casing, north side	0		2 46	July 6, 1949		1,100, E			Do.
34db2	do		2	I	F	I						Oct. 23, 1950	19, M		52	
35ac1	B. L. and J. P. Seamster.	33.0	18	GI	C, G	I	Top of casing, west side	0		2.90	July 6, 1949					Do.
35ac2	do		2	I	F	S, I						July 6, 1949	65, M		53	
35ac3	do	94.2	24	GI	T, E	I	Top of casing, west side	−.5		3.20	July 6, 1949					
35bb	Orval F. Holman		2	I	F	D, I						Oct. 21, 1948	23, M		55	
35bc	do		2	I	F	D, I						July 6, 1949	37, M		55	
35cb	Alton Waters				C, G	I										
35cc1	do	125	2	I	F	D						Oct. 21, 1950	72, M		51	Water has odor of hydrogen sulfide.
35cc2	do	99.0	18	GI	T, G	I, O	Top of casing, south side	0	7,630 5	4 52	Dec. 2, 1946					
35dc	John and Ethel Hedges	31.3	14	GI	T, E	I, O	Top of casing, east side	0	7,626.0	2.55	Nov. 10, 1947		684, E	17, R		
36ac1	L. V. and C. M. Harmond.	28.4		GI	C, E	I	Top of barrel, west side	.6		3.10	July 6, 1949					Battery of 4 wells.
36ac2	do		2	I	F	S, I						July 6, 1949	19, M		53	
36bc	Ella Welty	31.5	16	GI	C, E	I	Top of casing, east side	0		1.40	July 6, 1949					Battery of 2 wells.
36dc	C. W. and R. M. Soleman.	27.6	14	GI	C, E	I	do	−2.0		.52	July 6, 1949		950, R			Battery of 4 wells.
40-9-1aa1	Alamosa County	17.0	1¼	I	N	O	Top of pipe	.6	7,572.0	8.29	May 8, 1950					Jetted well.
1aa2	J. Fultz		2	I	F	D, S						July 8, 1949	5, M		57	Water has odor of hydrogen sulfide.
1ac	do		3	I	F	S, I						Oct. 21, 1947	4, M		60	Do.
1bd	Ray F. Holland		16	GI	C, G	I										Battery of 2 wells.
1cb	do		2	I	F	S, I						July 8, 1949	30, M		62	Water has odor of hydrogen sulfide.
2ad	do	58.9	18	GI	T, E	I	Top of casing, south side	2.3		8.75	Oct. 4, 1948		1,150, M	45.5, M		
2dd	Alamosa County	10.0	3	GI	N	O	Top of pipe	.5	7,577.2	9.95	Jan. 16, 1948					Jetted well. Sample.
3ab	S. B. Collins		3	I	F	I						July 2, 1948	8.5, M		62	
3bb	Charles Fahnestock	183.5	3	I	F	I, S						July 2, 1948	40, M		56	Water has odor of hydrogen sulfide.
4cc	do	185.1	3	I	F	S, I							5, E		55	
4dd	Alamosa County	9.8	4	GI	N	O	Top of pipe	.7	7,583.2	4.33	Jan. 16, 1948					Jetted well.
5ab	Arthur Spicer		3	I	F	S						July 2, 1948	26, M		56	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-9-5ac	Arthur Spicer	204	24	GI	T, E	I	Top of casing, south side	1.0		7			1,200, M	37, M		Water reported to have risen to within 1 foot of surface when drilled.
5bb	O. E. Holman		2	I	F	I, S						July 2, 1949	8, M		54	
5dc	E. R. Lofton	34.6	14	GI	C, E	I	Top of casing, east side	−1.6		2.57	Oct. 30, 1947		940, M	18, M		Battery of 4 wells. Sample.
5dd	Alamosa County	8.2	3	GI	N	O	Top of pipe	.8	7,591.2	5.10	Oct. 19, 1948					Jetted well. Sample.
6ab	Diss Bros.		4	I	F	S, I						June 22, 1949	33, M		55	Water has odor of hydrogen sulfide.
6bc	W. J. Meyers	40	20	I	C, E	I							1,200, R			
6cb	Earl T. Yocum	800	2	I	F	I						Aug. 24, 1950	34, M		55	Do.
6cc	do				C, G	I										Battery of 2 wells.
6dc	Craig Johnson	29.5	14	GI	C, E	I	Top of casing, east side	0		3.52	Oct. 30, 1947					Battery of 2 wells. Sample.
6dd	Alamosa County	9.9	4	GI	N	O	Top of pipe	.7	7,599.0	7.25	Jan. 19, 1948					Jetted well. Sample.
7bc1	D. W. Meyers	40	20	GI	T, E	I							1,200, R			
7bc2	do	40.0	18	GI	C, G	I				5			1,250, M	7, M		Battery of 2 wells.
7dc	Michael Curtain	29.9	14	GI	C, T	I, O	Top of casing, north side	−1.1	7,602.7	2.42	Oct. 31, 1947					Do.
8ad	J. H. Goehl		3	I	F	S							3, E		55	
9bc	Charles Fahnestock		2	I	F	S						July 16, 1948	9.5, M		55	
9cc	Julie M. Spicer	109	16	GI	T, E	I	Hole in pump base, west side.	.9		9.08	Sept. 7, 1950		2,124, M	38, M		
10aa	Alamosa County	10.0	3	GI	N	O	Top of pipe	.3	7,582.6	8.14	Jan. 16, 1948					Jetted well.
10cb	Clyde Whittier	133.1	18	GI	T, E	I	Top of casing, north side	.7		4.33	July 16, 1948					
10cc1	Alamosa County	9.6	4	GI	N	O	Top of pipe	.5	7,592.1	9.00	Jan. 20, 1948					Do.
10cc2	Clyde Whittier		2	I	F	S, I						July 8, 1949	28, M		60	Water has odor of hydrogen sulfide.

10dc	John H. Braunell	57.0	16	GI	T, E	I	Top of casing, north side	1.5		8.90	Apr. 25, 1951		526, M	21, M	51	
10dd	do		2	I	F	S, I						Oct. 26, 1950	14, M		61	Do.
11bb	S. B. Collins				C, G	I										
11bc1	do		3, 2	I	F	I							15, M		60	Sample. Water has odor of hydrogen sulfide.
11bc2	do	100	12	GI	T, G	I				7						Sample.
11bc3	do	600	8	I	F	I						Oct. 31, 1947	521, M		72	Do.
11cc	Alamosa County	8.9	4	GI	N	O	Top of pipe	.6	7,585.4	8.90	Jan. 20, 1948					Jetted well. Sample.
11dc	John Achatz				C, G	I										
11dd	Alamosa County	8.0	4	GI	N	O	Top of pipe	13.0	7,578.1	7.80	Jan. 20, 1948					Do.
12dd	do	9.9	2	GI	N	O	do	.4	7,568.1	5.45	Oct. 23, 1946					Do.
13cc	Alta S. Halferty		2	I	F	S							1, E		53	Water has odor of hydrogen sulfide.
14ab	John Achatz		3	I	F							Oct. 28, 1948	2, M			Unused domestic well.
14cb	do	130	18	GI	T, B	I										
14cc	Alamosa County	10.0	3	GI	N	O	Top of pipe	.7	7,580.5	5.16	Jan. 20, 1948					Jetted well. Sample.
14dd	do	9.8	4	GI	N	O	do	.8	7,574.7	7.58	Jan. 20, 1948					Do.
15ab	Otto Burbacker	45.5	14	GI	T, T	I	Top of casing, west side	.9		10.02	Sept. 8, 1950					
16ba	Roy Wertz	675	3	I	F	S, I						July 8, 1949	75, M		62	Water has odor of hydrogen sulfide.
16bb1	do	650	3	I	F	I						Aug. 8, 1950	53, M		58	
16bb2	do		18	GI	T, G	I, O	Top of casing, west side	.4	7,599.4	9.21	Oct. 31, 1947					
16dd	Alamosa County	9.1	4	GI	N	O	Top of pipe	.8	7,588.5	4.58	Jan. 20, 1948					Jetted well.
17cc	John Heiman	53.8	20	GI	T, E	I, O	Top of casing, east side	.4	7,604.6	6.73	Nov. 6, 1947		1,050, M	25, M		Sample.
17dc	W. J. Wolfe				C, T	I										
17dd	Alamosa County	9.3	4	GI	N	O	Top of pipe	.6	7,596.0	5.90	Jan. 20, 1948					Jetted well. Sample.
18bb	Henry Holmann		18	GI	T, E	I	Top of casing, north side	.9		4.88	Apr. 25, 1951		936, M			
18cb	Loren Tolliver	179.2	2	I	F	S, I						July 8, 1949	58, M		55	
18cc	do	40.0	16	GI	C, E	I, O	Top of casing, west side	.6	7,608.0	2.18	Dec. 2, 1946		878, M	9.5, M		Battery of 2 wells. Sample.
18db	M. C. Beiriger	32.6	18	GI	C, E	I	Top of barrel cover, east side.	.0		3.13	Oct. 27, 1950					Battery of 2 wells.
18dc	do	54	18	GI	T, G	I	Top of casing, east side	.5		5.75	Feb. 16, 1951		1,050, M	25, M	51	
19ab	Harold C. Wells	39.5	18	GI	T, E	I	do	—.7		2.15	July 12, 1948					
19bc	Myrtle Perdew	37.6	18	GI	C, E	I	Top of casing, west side	0		2.25	July 8, 1949					
19cb	Carla Scathoff				C, E	I										
19cc	Alamosa County	9.6	3	GI	N	O	Top of pipe	.7	7,613.1	5.98	Jan. 20, 1948					Jetted well.
19dd	do	9.9	3	GI	N	O	do	1.1	7,605.5	9.43	Jan. 20, 1948					Jetted well. Sample.
20bc	M. G. Beiriger	41.3	16	GI	C, E	I	Top of casing, west side	0		1.30	July 8, 1949					
20dc	do	275.0	2	I	F	S, I						July 8, 1949	30, M		55	Water has odor of hydrogen sulfide.
20dd	Alamosa County	9.6	4	GI	N	O	Top of pipe	.3	7,597.4	6.22	Jau. 20, 1948					Jetted well. Sample.
21cc	A. R. Irvin	19.6	18	GI	C, G	I	Top of casing, south side	—8.0		1.70	July 12, 1948					

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-9-21dd	Alamosa County	9.9	4	GI	N	O	Top of pipe	0.5	7,590.0	6.35	June 21, 1948					Jetted well. Sample.
23bc	Ralph Irvin	168.8	2	I	F	I						July 13, 1948	29, M		58	Water has odor of hydrogen sulfide.
23cc	do		2	I	F	S							.5, M		54	
23da	Earl Linger	223.5	2	I	F	D, I						July 13, 1947	7, M		56	Do.
24bc	C. K. and E. G. Clifton		2	I	F	S							1, E			
24dc	Phoebe Jones		2	I	F	S							1.5, M			Do.
25bb1	Alamosa County	9.5	4	GI	N	O	Top of pipe	.3	7,575.3	6.60	Jan. 21, 1948					Jetted well.
25bb2	Lulu McAllister	103	20, 16	GI	T, G	I	Top of casing, north side	1.2		7.35	Aug. 30, 1950					
25dc1	L. and Clyde Whittier	130	14	GI	T, E	I	Top of casing, east side	1.0		19.49	Aug. 7, 1950					
25dc2	do				C, G	I										
25dd	Alamosa County	9.9	4	GI	N	O	Top of pipe	.4	7,573.6	7.99	Jan. 21, 1948					Jetted well. Sample.
26bb	do	9.2	4	GI	N	O	do	0	7,581.8	7.02	Jan. 21, 1948					Do.
26dd	do	9.6	4	GI	N	O	do	.6	7,577.6	6.08	Jan. 21, 1948					Do.
27cc	do	9.8	4	GI	N	O	do	.9	7,590.2	7.30	Jan. 21, 1948					Do.
27dd	do	9.5	4	GI	N	O	do	.4	7,583.2	6.10	Jan. 21, 1948					Jetted well.
28cd	C. C. Morris	149.4	2	I	F	S, I						Oct. 27, 1950	8, M		53	
29bb	C. K. Clifton		2	I	F	I						July 14, 1948	18, M		53	Water has odor of hydrogen sulfide.
29cc	Harry Crow	27.7	14	GI	C, E	I							1,041, M			
30ac1	Wayne Bieriger	37.8	16	GI	C, E	I	Top of casing, east side	−2.4		1.05	July 12, 1948		703, M			
30ac2	do		3	I	F	I						July 14, 1948	20, M		54	
30cb	R. V. and Alma Bowles	35.5			C, G	I	Top of barrel, west side	0		4.25	Apr. 20, 1951		1,385, M	10, M		Battery of 2 wells.
31bc	L. L. Nelloy	33.6	24, 18	GI	C, E	I, O	Top of casing, north side	1.6	7,611.5	6.14	Nov. 18, 1947		868, M	4, R		Do.
31cb	O. M. Wolfe	32.5	16	GI	C, E	I	Top of casing, east side	.4		3.70	July 12, 1948		868, M	9, M		
31cc	do	35.2	18	GI	C, E	I	Top of barrel cover, east side.	.4		2.45	July 8, 1949		1,000, R			
31dc1	C. M. and Ray Soleman	30.6	23	OB	C, E	I, O	Top of casing, north side	1.2	7,610.0	5.70	Nov. 10, 1947					

31dc2	do		2	I	F	S, I							3, E		55	
32bb	Alamosa County	9.9	4	GI	N	O	Top of pipe	.9	7,605.3	5.30	Jan. 22, 1948					Jetted well. Sample.
32bc	O. E. Holman		2	I	F	S, I						Oct. 27, 1950	15, M		53	Water has odor of hydrogen sulfide.
32cc1	do	44.7	24	GI	T, E	I	Top of casing, west side	0		1.95	July 8, 1949					Sample.
32cc2	do		2	I	F	D, S, I						July 8, 1950	10, M		55	
32cc3	Alamosa County	9.0	4	GI	N	O	Top of pipe	.5	7,604.6	7.70	Jan. 22, 1948					Jetted well.
32dd	do	9.9	4	GI	N	O	do	.3	7,597.0	5.47	Jan. 22, 1948					Do.
33bb	do	9.6	3	GI	N	O	do	.4	7,596.8	4.95	Jan. 21, 1948					Do.
33bc	C. C. Morris		3	I	F	D							I, E		51	Water has odor of hydrogen sulfide.
33cc	do	178.0	3	I	F	S						July 16, 1948	3, M		53	
34da	J. M. Crow	212.9	3	I	F	I						Oct. 30, 1950	24, M		59	Do.
35cc1	Matt Kampt	169.2	3	I	F	I							2, E		63	Do.
35cc2	do		1	I	F	S, I							7, E		54	
35cc3	Alamosa County	9.3	4	GI	N	O	Top of casing	.5	7,584.3	5.60	Jan. 22, 1948					Jetted well. Sample.
40-10-1bb	do	6.5	2	GI	N	O	Top of pipe	.2	7,537.2	5.01	Apr. 2, 1946					Bored well. Sample.
1cd	do	8.4	2	GI	N	O	do	.8	7,537.2	6.09	Apr. 3, 1946					Do.
1dc	do	5.7	2	GI	N	O	do	1.3	7,536.5	4.68	Apr. 3, 1946					Do.
1dd	do	6.8	2	GI	N	O	do	.3		3.56	Apr. 3, 1946					Do.
2bb	do	7.9	2	GI	N	O	do	.1	7,542.9	6.10	Apr. 2, 1946					Do.
2cc	E. G. Cooper	34.2	1¼	GP	N	O	do	0	7,545.0	5.66	Dec. 12, 1947					
3cc	Alamosa County	8.3	2	GI	N	O	do	0	7,554.8	7.56	Apr. 4, 1946					Do.
4db	Quincy Cornelius	170	16, 10	I	T, E	I	Top of casing, east side	1.1		10.36	Apr. 25, 1951				51	
5bc	Carl Percival	335	18, 16	GI	T, B	I	Top of casing, south side	0		4.00	July 5, 1950		1,286, M	30, M	51	
5cc	Alamosa County	22.9	1¼	GI	N	O	Top of pipe	1.4	7,567.4	10.52	Oct. 6, 1946					Jetted well.
5dd	do	11.7	3	GI	N	O	do	.8	7,563.5	10.70	Sept. 2, 1946					Bored well.
6aa	do	11.6	2	GI	N	O	do	0	7,563.2	9.60	Oct. 14, 1946					Bored and jetted well. Sample.
6bc	Hugh Slane				T, B	I										
6cc	Alamosa County	9.6	3	GI	N	O	Top of pipe	.4	7,568.3	6.43	Oct. 23, 1946					Bored well. Sample.
9ac	E. G. Cooper	110	16	GI	T, G	I							950, M		51	
9cc	Alamosa County	9.8	2	GI	N	O	Top of pipe	0	7,560.4	8.10	Oct. 14, 1946					Bored and jetted well. Sample.
10aa	do	7.2	2	GI	N	O	do	0	7,545.6	4.86	May 6, 1946					Jetted well. Sample.
11aa	do	7.7	2	GI	N	O	do	.6	7,541.3	6.01	Apr. 3, 1946					Bored well. Sample.
13bb	do	8.8	2	GI	N	O	do	.7	7,543.3	7.60	Apr. 8, 1946					Do.
13dd	do	8.0	2	GI	N	O	do	0	7,539.2	7.01	Apr. 10, 1946					Do.
14bb	do	6.1	2	GI	N	O	do	0	7,547.3	5.87	Apr. 4, 1946					Do.
14dd	do	10.0	2	GI	N	O	do	.8	7,542.9	7.77	Oct. 22, 1946					Do.
15bb	do	9.8	2	GI	N	O	do	0	7,554.0	6.87	Apr. 3, 1946					Do.
16cc	do	10.1	2	GI	N	O	do	.4	7,557.0	8.80	Oct. 4, 1946					Jetted well. Sample.
19aa	do	10.0	2	GI	N	O	do	.3	7,564.2	7.40	Oct. 14, 1946					Jetted well.
19bb	do	9.0		GI	N	O	do	.5	7,568.9	6.21	Oct. 23, 1946					Jetted well. Sample.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
40-10-19cc	Eva C. Clifton		2	I	F	I, S					July 14, 1948	July 14, 1948	8, M		60	Water has odor of hydrogen sulfide.
20cb	Alamosa County	32.5	1¼	GP	N	O	Top of pipe	1.9	7,564.7	7.40	Oct. 11, 1946					Jetted well.
21ad	do	44.7	1¼	GP	N	O	do	2.4	7,554.5	8.50	Oct. 16, 1946					Do.
22bb	do	9.4	3	GI	N	O	do	.6	7,552.5	7.45	Oct. 16, 1946					Do.
22dd	do	7.1	2	GI	N	O	do	.3	7,548.0	4.52	Apr. 9, 1946					Bored well. Sample.
23bb	do	6.8	3	GI	N	O	do	.1	7,546.9	6.50	May 9, 1946					Do.
23dd	do	9.6	3	GI	N	O	do	1.4	7,544.4	8.13	Oct. 22, 1946					Jetted well. Sample.
26cc	Frank Williams	184	16	GI	T, G	I	Top of casing, north side	2.0		6.50	Aug. 4, 1950					
26dd	Alamosa County	8.3	3	GI	N	O	Top of pipe	.4	7,543.5	7.09	Oct. 23, 1946					Do.
27bb	do	10.0	3	GI	N	O	do	.3	7,553.6	9.15	Oct. 16, 1946					Do.
27dd	do	8.8	3	GI	N	O	do	.4		6.47	Dec. 7, 1948					Jetted well.
28bb	do	9.9	3	GI	N	O	do	.9	7,557.9	9.75	Oct. 16, 1946					Jetted well. Sample.
29bb	do	9.9	3	GI	N	O	do	.5	7,563.3	9.08	Oct. 16, 1946					Do.
30bb	do	7.8	3	GI	N	O	do	.8	7,569.1	5.67	Oct. 23, 1946					Do.
30cc	Clyde Whittier	97.1	20	GI	T, E	I	Top of casing, west side	1.0		6.35	Aug. 23, 1948					
—30dc	do	247	16	GI	T, E	I	Top of casing, south side	.4		20.00	Aug. 7, 1950		1,040, M	58, M	55	Water has odor of hydrogen sulfide.
31cc	R. M. Dunn		3	I	F	S, I							1, E			Do.
32aa	Alamosa County	9.4	3	GI	N	O	Top of pipe	.5	7,558.8	5.29	Dec. 7, 1948					Jetted well.
36aa	do	9.9	2	GI	N	O	do	1.1	7,539.1	7.64	Oct. 22, 1946					Jetted well. Sample.
36dd	do	8.2	3	GI	N	O	do	.5	7,540.3	6.65	Aug. 29, 1950					Do.
40-11-1da	do	33.2	1¼	GP	N	O	do	1.8	7,555.1	9.15	June 14, 1946					
2cc	do	6.4	2	GI	N	O	do	−.5	7,535.0	3.65	Apr. 4, 1946					Bored well, Sample.
2dc	do	6.7	2	GI	N	O	do	.8	7,538.6	4.62	Apr. 1, 1946					Do.
3ad	do	7.0	2	GI	N	O	do	.8	7,544.5	3.92	Apr. 1, 1946					Do.
4dd	do	8.3	3	GI	N	O	do	.2	7,531.2	3.03	Apr. 4, 1946					Jetted well. Sample.
5aa	do	5.0	2	GI	N	O	do	0	7,535.2	3.78	Apr. 3, 1946					Bored well. Sample

5ab	do	5.4	2	GI	N	O	do	−.2	7,531.2	.74	Apr. 3, 1946					Do.
5cc	do	5.8	2	GI	N	O	do	.2	7,531.9	3.33	May 6, 1946					Do.
6bd	do	8.1	2	GI	N	O	do	1.5	7,533.0	4.54	Oct. 21, 1946					Jetted well. Sample.
6cc	do	22.7	1¼	GP	N	O	do	0	7,536.8	13.03	May 29, 1946					
7aa	do	9.4	2	GI	N	O	do	1.2	7,534.8	7.28	Oct. 21, 1946					Do.
7cc	do	10.0	2	GI	N	O	do	.3	7,538.6	8.24	Apr. 4, 1946					Bored well, Sample.
8dc	do	8.8	2	GI	N	O	do	1.6	7,530.2	4.40	Apr. 9, 1946					Do.
9bb	do	64.4	1¼	GP	N	O	do	.1	7,533.5	5.67	Jnne 11, 1946					
10aa	do	44.3	1¼	GP	N	O	do	1.3	7,534.6	9.26	June 11, 1946					
14aa	do	5.7	2	GI	N	O	do	−.8	7,531.5	3.93	Apr. 1, 1946					Do.
14bb	do	6.6	2	GI	N	O	do	.2	7,528.7	4.68	Apr. 1, 1946					Do.
14cc	do	2.5	2	GI	N	O	do	.8	7,525.5	2.24	June 5, 1946					Bored well.
14dc	do	6.0	2	GI	N	O	do	1.0	7,527.0	4.50	Apr. 12, 1946					Bored well. Sample.
14dd	do	5.1	3	GI	N	O	do	1.0	------	4.12	Apr. 15, 1946					Do.
15bb	do	7.6	2	GI	N	O	do	0	7,526.5	4.49	June 4, 1946					Jetted well. Sample.
15cd	do	54.3	1¼	GP	N	O	do	1 0	7,529.9	7.12	July 2, 1946					
15dd	do	7.8	2	GI	N	O	do	.7	7,529.9	6.55	Apr. 12, 1946					Bored well. Sample.
17bb	do	8.4	2	GI	N	O	do	−.1	7,535.1	7.26	Apr. 9, 1946					Do.
17cc	do	7.0	2	GI	N	O	do	.4	7,534.4	6.57	Apr. 8, 1946					Do.
17dd	do	9.7	2	GI	N	O	do	.4	7,529.6	5.33	Oct. 22, 1946					Jetted well. Sample.
18bd	do	9.0	2	GI	N	O	do	.2	7,536.7	7.20	Apr. 8, 1946					Bored well. Sample.
19bc	do	45.9	1¼	GP	N	O	do	1.7	7,539.2	8.03	Sept. 27, 1946					Jetted well.
19dd	do	6.1	2	GI	N	O	do	.2	7,533.1	3.42	Apr. 9, 1946					Bored well. Sample.
20dd	do	9.7	2	GI	N	O	do	1.1	7,528.4	7.03	Oct. 24, 1946					Jetted well. Sample.
22bc	do	6.0	2	GI	N	O	do	−.1	7,526.5	3.90	Apr. 10, 1946					Do.
22dd	do	50.9	1¼	GP	N	O	do	1.1	7,527.1	6.95	Nov. 2, 1946					Jetted well.
25ba	do	9.8	2	GI	N	O	do	.5	7,529.4	6.25	June 5, 1946					Bored well. Sample.
26ab	do	4.7	2	GI	N	O	do	1.0	7,525.5	4.02	June 11, 1946					Do.
26bb	do	7.3	2	GI	N	O	do	0	7,528.6	6.53	June 11, 1946					Do.
26db	do	7.7	2	GI	N	O	do	.8	7,524.4	4.35	Oct. 23, 1946					Jetted well. Sample.
27aa	do	6.7	2	GI	N	O	do	.5	7,527.3	5.31	June 5, 1946					Bored well. Sample.
27ab	do	6.6	2	GI	N	O	do	.2	7,526.3	4.42	June 11, 1946					Bored well.
27cb	do	7.9	2	GI	N	O	do	0	7,525.8	5.41	Oct. 22, 1946					Jetted well. Sample.
29dd	do	6.4	2	GI	N	O	do	.4	7,527.9	3.87	May 9, 1946					Bored well. Sample.
30bb	do	10.0	2	GI	N	O	do	.4	7,538.4	6.93	Oct. 22, 1946					Jetted well. Sample.
30dd	do	6.2	2	GI	N	O	do	.3	7,532.2	4.67	May 9, 1946					Bored well. Sample.
32cc	do	45.3	1¼	GP	N	O	do	2.8	7,534.6	7.49	Aug. 14, 1946					Jetted well.
33cc	do	6.0	2	GI	N	O	do	.1	7,525.4	2.62	Apr. 16, 1946					Bored well. Sample.
33cd	do	6.6	2	GI	N	O	do	.4	7,523.9	4.66	Oct. 22, 1946					Jetted well. Sample.
33dd	do	5.2	2	GI	N	O	do	0	7,523.8	3.64	May 7, 1946					Bored well. Sample.
34dd	do	6.5	2	GI	N	O	do	.3	7,524.0	4.47	May 9, 1946					Do.
35db	do	5.2	2	GI	N	O	do	3.2	7,524.0	3.15	June 5, 1946					Bored well.
35dd	do	48.2	1¼	GP	N	O	do	1.0	7,524.5	5.10	June 14, 1946					Jetted well.
40-12-7dd	do	6.8	2	GI	N	O	do	0	7,544.2	5.21	June 5, 1946					Bored well. Sample.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
4)-12-17ac	Alamosa County	5.4	2	GI	N	O	Top of pipe	0	7,550.2	3.00	June 5, 1946					Bored well. Sample.
18bb	do	6.9	2	GI	N	O	do	0	7,534.5	4.16	June 6, 1946					Do.
20ba	do	8.2	3	GI	N	O	do	.1	7,545.4	2.30	May 6, 1946					Jetted well. Sample.
29dc	do	5.8	2	GI	N	O	do	.6	7,538.4	3.48	May 10, 1946					Bored well. Sample.
30aa	do	6.4	2	GI	N	O	do	.1	7,532.8	3.80	June 6, 1946					Do.
31ab	do	6.5	2	GI	N	O	do	.8	7,529.2	4.01	May 10, 1946					Do.
31cc	do	9.5	2	GI	N	O	do	−.1	7,524.5	5.21	May 10, 1946					Do.
31dd	do	7.4	2	GI	N	O	do	0	7,529.5	6.37	May 7, 1946					Do.
32cc	do	58.4	1¼	GP	N	O	do	1.1	7,533.9	7.50	Nov. 7, 1946					Jetted well.
33cc	do	9.3	2	GI	N	O	do	.3	7,550.2	5.37	May 10, 1946					Bored well. Sample.
41-6-13ac	do	38.4	42	R	N	O	Top of stone crib, south side.	.7	7,835.3	21.57	June 24, 1948					Unused domestic well.
35dd	do	90	20	I	T, T	I	Top of wooden box, south side.	−2.3		9.93	Apr. 25, 1951		972, M	42, M	54	
36cc	do	28.2	14	GI	N	O	Top of casing, west side.	−2.1		2.88	Oct. 29, 1947					Well equipped with automatic water-level recorder.
36dc	do	123	16	GI	T, E	I										
41-7-1ca	C. D. Wadsworth		2	I	F	S, I							10, R			
1dd	R. H. David		2	I	F	S						Aug. 10, 1950	15, M		54	Water has odor of hydrogen sulfide.
2ba	B. Bowers		2	I	F	D, S							3, M		49	
2bb	do	120	2	I	F	D, S						Oct. 10, 1947	18, M		50	
2cc	Herbert Bowers	120	2	I	F	D, S						Oct. 27, 1947	9, M		48	
2cc2	do	14.7	42	BS	C, T	I	Top of casing, west side.	2.2		4.62	Oct. 27, 1947					
2cc3	Saguache County	11.8	1¼	GP	N	O	Top of pipe	.7	7,654.6	3.13	May 20, 1948					Jetted well.
3aa	do	13.2	1¼	GP	N	O	do	.8	7,650.4	4.62	May 4, 1948					Driven and jetted well.
3aa2	J. W. Gardner	110	2	I	F	D	do						5, E		49	

3ab	do	39.2	14	GI	C, G	I	Top of casing, north side.	0		5.11	Oct. 10, 1947					
3bb	F. H. Soter	25.9	16	GI	C, G	I	Top of casing, west side.	0		3.53	Oct. 10, 1947					Sample.
3cc1	Raymond Torres	30	1¼	GP	H	D, S										
3cc2	do		16	GI	C, T	I	Top of door casing, east side.	0		5.88	Oct. 27, 1947		1,770, M	22, M		
3dc	Frank Bowers		2	I	F	S, I					Oct. 27, 1947	Oct. 27, 1947	1, M		49	
3dd1	do		2	I	F	D, S					Oct. 27, 1947	Oct. 27, 1947	7, M		47	
3dd2	do		2	I	F	S							25, E		48	
4ab	H. C. Keck	97.8	16	GI	T, G	I, O	Hole in casing, west side.	.2	7,698.4	31.86	Nov. 22, 1946		1,073, M			
4db	Virgil Palmgram	130			T, B	I										
8dc	F. G. Sulvester	300	16	I	T, G	I	Top of casing, east side.	0		38.00	Jan. 10, 1951		1,500, M	17, M		
9ab	Byron Bowers	71.1	16	GI	T, T	I, O	Top of casing	.4	7,686.8	12.15	Oct. 28, 1947		662, M			
9bb	Frank Collier	370	18	I	T, B	I	Top of casing, east side.	.4		1.50	Oct. 5, 1950					Layer of rock at 203-205 feet.
10aa	Frank Bowers		2	I	F	S, D						Oct. 27, 1947	7, M		48	
10bb	Willis Bowers	65	14	GI	C, E	I	Top of casing, east side.	−.4					606, M	6, M	49	
11ac1	R. H. David	140.4	3	I	F	S, I							5, E		52	
11ac2	do	58.1	16	I	C, T	I	Top of casing, north side.	−1.9		.22	June 9, 1948		868, M			Battery of 2 wells.
11bc	A. Newmeyer		3	I	F	S, I							2, E		56	
12aa1	R. H. David		3	I	F								10, E			
12aa2	do		2	I	F	S							20, E			
12ad1	do		2	I	F	D, S							5, E			
12ad2	do		2	I	F	S							25, E			
12ba	do		2	I	F	S							15, E			
12cc1	W. W. Felmee	51.0	14	GI	C, G	I	Top of wooden crib, northeast corner.	0		2.00	June 9, 1948					
12cc2	do	13.3	1¼	GP	N	O	Top of pipe	.9	7,650.3	4.88	Apr. 13, 1948					Driven and jetted well.
12cd	do		2	I	F	S						Oct. 5, 1950	13, M		50	Water has odor of hydrogen sulfide.
12da	John Gardner		2	I	F	D, S						Oct. 27, 1947	3, M		50	Do.
12dc	do	133.9	2	I	F	I							10, E			
13cb	Ralph E. Edwards	120	2	I	F	I						Aug. 10, 1950	10, M		51	
13cc	Saguache County	10.8	1¼	I	N	O	Top of wooden crib, northeast corner.	.5	7,656.8	2.40	Apr. 12, 1948					Driven and jetted well.
13dc1	Ralph E. Edwards	56.8	16	GI	C, G	I	Top of casing, east side.	−3.0		3.00	June 14, 1949					
13dc2	do				F								1, E			Unused stock well. Wooden plug driven in top of casing.
13dd	Saguache County	13.2	1¼	GP	N	O	Top of pipe	.9	7,648.6	3.96	Apr. 12, 1948					Driven and jetted well.
14ab	A. Newmeyer		2	I	F	I							35, E		53	
14cc1	Vaughn Sheesly	50	18	GI	T, T	I	Top of hole in pump base, north side.	.7		3.83	Aug. 1, 1950					

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
41-7-14cc2	Saguache County	13.1	1¼	GP	N	O	Top of pipe	2.1	7,670.5	5.01	Apr. 12, 1948					Driven and jetted well.
14da	Vaughn Sheesly	120	2	I	F	I						Aug. 10, 1950	10, M		51	
-14dc	do	28.0	24	GI	C, G	I	Top of casing, south side	−2.4		.50	June 14, 1949		1,030, M	18, M		
15aa	Saguache County	10.4	1¼	GP	N	O	Top of pipe	.8	7,664.9	3.10	Apr. 13, 1948					Do.
15cc	H. E. Brown	40	24	GI	T, N											Unused irrigation well.
15cd	do		1¼	GP	F	S							1, E		52	
16aa	Saguache County	13.1	1¼	GP	N	O	Top of pipe	1.3	7,673.8	3.50	Apr. 13, 1948					Driven and jetted well.
16ba	Frank Sulvester			I	C, N											Unused irrigation well.
16cb	J. D. Lee		14	GI	T, G	I	Hole in casing, south side.	.4		10.56	May 27, 1948					
17aa	H. McAnich	81.7	16	GI	C, E	I	Top of casing, west side	−2.8		11.60	Oct. 27, 1947					
-17ba	J. D. Lee	186	18	GI	T, B	I	Hole in casing, northeast side.	.5					1,456, M		52	
18ab	Frank Collier	150	18	GI	T, G	I, O	Top of casing, east side	.5	7,796.7	21.48	Sept. 28, 1948					
20ac	E. Lowder	88.4	14	GI	T, G	I, O	Top of casing, south side	.1	7,697.3	12.85	Oct. 28, 1947					
21aa	Gladys and M. Nielson	80		GI	Cy, E	D, S										
21ac	do	80.4	18	GI	T, T	I	Top of casing, south side	0		4.10	June 24, 1948					
21bd	J. P. Biery	32	16	GI	T, G	S, I										
21cc	do	84	20	GI	T, E	I							2,505, M			
21dc	A. B. Framel		16	GI	T, T	I										
22ac	H. E. Brown		16	GI	T, G	I										
22bb	Saguache County	12.8	1¼	GP	N	O	Top of pipe	2.0	7,681.0	7.10	Apr. 12, 1948					Driven and jetted well.
22bc	Allen Turner		16	GI	T, G	I										
22cc	F. C. Ashley	37.0	16	GI	C, G	I	Top of casing, south side	.8		4.82	Oct. 5, 1950					

22dc	H. E. Brown		16	GI	T, N											Unused irrigation well.
23aa	Melvin Sotley		2	I	F	S, I						Oct. 28, 1947	9, M		50	Water has odor of hydrogen sulfide.
23ab	do		2	I	F	S						Aug. 10, 1950	11, M		52	
23ac	do	39.4	14	GI	C, T	I	Top of casing, south side	0		2.01	Oct. 28, 1947					Battery of 2 wells.
23bc	do		16	GI	T, G	I										
23cc	Joe Braco		16	GI	T, G	I							1,325, M			
23cd	do	19.6	14	GI	C, T	I, O	Top of casing, east side	.5	7,670.7	3.17	Nov. 22, 1946					
23dc	do	36.9	14	GI	N		Top of casing	1.7		2.60	June 24, 1948					Unused irrigation well.
23dd	do		2	I	F	D, S									53	
24ac	John M. Davis	114	16, 12	GI	T, E	I	Top of casing, south side	.5		2.00	July 5, 1950		1,750, M	19, M		Reported to have flowed when drilled.
24bc	Charles Graves	51.4	16	GI	C, G	I	Top of casing, east side	2.0		2.85	June 23, 1948					
24cc	Joe Braco		16	GI	T, G	I										
24cd	do		3	I	F	D, S							10, E		54	
25aa	Thomas Sharp		2	I	F	D, S						Sept. 10, 1950	10.5, M		53	
25ac1	do	30.2	16	GI	C, T	I	Top of casing, north side	−1.0		1.93	Aug. 10, 1950					
25ac2	do	70	18	GI	T, E	I	Top of casing, west side	.4		5.18	Aug. 30, 1950		1,507, M	26, M		
25cc	P. H. Davis	87	18	GI	T, G	I										
25dc	Paul Felmee	51.7	18	GI	C, G	I, O	Top of casing, south side	−2.6	7,664.9	1.15	Oct. 28, 1947					
26bc	Ernest Lowder		16	GI	T, T	I										
26dc	Paul McCormick	22.7	18	GI	C, T	I, O	Top of casing, north side	−2.8	7,674.3	.01	Oct. 28, 1947					Sample.
27ac	Ray Sheesly	31.9	16	GI	C, G	I	Top of casing, east side	−1.8		.11	June 25, 1948				60	
27bc	W. E. Kinser	43.9	18	GI	C, T	I, O	Bottom of elbow on discharge pipe.	.6	7,688.6	3.11	Oct. 28, 1947					
27cc	Olin Ellis	42.2	14	GI	C, N	O	Top of wooden crib, north side.	0	7,697.3	1.91	Oct. 28, 1947					Unused irrigation well. Sample.
27dc	L. A. Fyock	72	16	GI	T, G	I										
28aa	Saguache County	13.7	1¼	GP	N	O	Top of pipe	.6	7,688.5	5.82	Apr. 12, 1948					Driven and jetted well.
28ac	H. McAnich		18	GI	T, G	I										
28bc	S. W. Buchanan	98.5	18	GI	T, G	I	Top of casing, south side	.6		7.80	June 14, 1949					
28cc	S. V. Cooper	159	14	GI	T, E	I, O	Hole in casing, south side,	1.0	7,712.2	12.46	Nov. 22, 1946					Sample.
31dc	D. T. Hubbard	159.0		I	T, G	I										
32bb	S. V. Cooper	16.8	25	T	N	O	Top of tile casing	1.2	7,727.1	10.32	Oct. 28, 1947					Unused domestic dug well. Sample.
32dc	do		37	GI	C, T	I							829, M			
32dd	Saguache County	10.8	2	I	N	O	Top of pipe	2.0	7,723.9	5.94	May 20, 1948					Jetted well.
33ac	O. F. Gilder		16	GI	T, G	I										
33cc	D. R. Brooks		14	GI	T, G	I										
33dc	Earnest Lowder		14	GI	T, G	I										
33dd	Saguache County		1¼	GP	N	O	Top of pine	−.2	7,704.7	3.33	Sept. 28, 1948					Driven and jetted well.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
41-7-34ac	Leslie Fyock	88	18	GI	T, G	I							1,325, M			
34bc	M. L. James	102	10	GI	C, T	I										
34cc	S. W. Buchanan		16	GI	T, G	I										
35ac	P. H. Davis		20	GI	T, G	I										
35dc	P. L. Martin	49.3	14	GI	C, G	I, O	Top of casing, east side	−1.5	7,680.7	3.45	Nov. 21, 1946		450, R			
36cc	do		16	GI	C, E	I										
36dd	Opal King		2	I	F	S, D						June 14, 1949	46, M		53	
41-8-1bb	Saguache County	9.9	3	GI	N	O	Top of pipe	.6	7,585.3	2.25	Mar. 25, 1948					Jetted well. Sample.
1bc	R. C. Patterson	122.5	2	I	F	S						Oct. 15, 1947	24, M		54	Water has odor of hydrogen sulfide.
1dd1	Luis Kirk	127	2	I	F	S, I						Oct. 16, 1947	14, M		53	Do.
1dd2	do		2	I	F	D, S						Oct. 16, 1947	4, M		54	
2bb	Mr. Parkin		2	I	F	S						Oct. 13, 1947	5, M		52	
2dc	R. C. Patterson		3	I	F	S							10, E		55	Do.
3aa	A. W. Waycoff	10.0	3	GI	N	O	Top of pipe	.8	7,594.4	1.91	Apr. 20, 1948					Jetted well. Sample.
3bb	Saguache County	8.6	3	GI	N	O	do	.4	7,602.6	3.03	Nov. 22, 1946					Sample.
3bc	Glen Farnham		3	I	F	D, S						Oct. 13, 1947	30, M		52	
3cc1	Adolph Corrs Co.	24.2	14	GI	C, T	I	Top of casing, north side	−2.0		.96	Oct. 13, 1947					Battery of 2 wells.
3cc2	do		3	I	F	D, S						Oct. 13, 1947	5.5, M		53	
3cc3	do	183.6	3	I	F	S, I						Oct. 13, 1947	41, M		54	
4ac1	Victor Anderson	155.0	3	I	F	S						Oct. 13, 1947	20, M		53	Water has odor of hydrogen sulfide.
4ac2	do	40.3	16	GI	C, T	I	Top of casing, west side	−1.5		2.00	Oct. 13, 1947					
4bb	Saguache County	10.0	3	GI	N	O	Top of pipe	1.0	7,611.9	9.05	Jan. 7, 1947					Jetted well. Sample.
4cb	R. W. Naudack	170.8	3	I	F	I						June 18, 1949	72, M			Water has odor of hydrogen sulfide.
4cc	do	170	3	I	F	S						Oct. 14, 1947	12, M		53	
5ab	Elmer Meese		2	I	F	I							20, E			

5cb	John McCormick		2	I	F	S, I							2, E			
5cc	do		2	I	F	D, S						Oct. 14, 1947	3.5, M		50	
5cd	do		3	I	F	S						Oct. 14, 1947	27, M		51	Do.
5dd	A. J. Padgett	170	2	I	F	D, S							6, R		52	
6cc1	H. W. Ford		2	I	F	S							25, E		55	Sample.
6cc2	Saguache County	6.2	3	GI	N	O	Top of pipe	.7	7,632.9	4.80	Jan. 9, 1947					Jetted well. Sample.
7ac	H. W. Ford	23.0	18	GI	C, N		Top of casing, north side	−3.3		.01	June 20, 1949					Unused irrigation well.
7ad	do		2	I	F	I						Oct. 5, 1950	31.5, M		52	
7cc	Saguache County	8.9	3	GI	N	O	Top of pipe	.8	7,640.4	5.15	Jan. 14, 1948					Jetted well.
7cd1	C. W. Bell		2	I	F	S						Oct. 24, 1947	4, M		53	
7cd2	do	28.4	16	GI	C, T	I	Top of casing, east side	−2.4		.60	Oct. 24, 1947					
7dd1	E. Hazard	10.0	3	GI	N	O	Top of pipe	.4	7,631.4	2.82	Mar. 25, 1948					
7dd2	do		2	I	F	S						Oct. 24, 1947	9, M		52	
8aa	R. Naudack	8.2	¾	I	N	O	Top of pipe	.9	7,616.5	3.79	Oct. 13, 1947					
8ac1	do	168.8	2	I	F	I						Oct. 13, 1947	58, M			
8ac2	do	189	20	GI	T, B	I	Top of casing, east side	1.0		2.00	Aug. 23, 1950					Reported to have flowed when drilled.
8bb	Saguache County	9.2	3	GI	N	O	Top of casing	.6	7,625.9	4.78	Jan. 9, 1948					Jetted well.
8cc	John Howendobler		3	I	F	D, S						Oct. 24, 1947	49, M		52	
8da1	Alice Hitpas	170	3	I	F	D							30, E		55	
8da2	do	170	3	I	F	I						Oct. 13, 1947	39, M		55	
8db	do		16	GI	T, B	I	Top of casing, east side	.6		.58	Oct. 13, 1947					
8dc	do		18	GI	T, G	I	Hole in pump base, south side.	.9		6.08	July 5, 1950					
8dd	do		2	I	F	D, S							20, E		55	
9bb	J. W. and Kathryn Metsker.		2	I	F	I						Oct. 15, 1947	24, M		51	Water has odor of hydrogen sulfide.
9bc1	do		3	I	F	S						Oct. 5, 1947	1, M		52	
9bc2	do		4	I	F	S						June 21, 1949	13, M		53	
9cc	do		2	I	F	S						June 21, 1949	36, M		54	
9dc	do		3	I	F	S						Oct. 13, 1947	22, M		55	Do.
10ab	Adolph Coors Co.	200	2	I	F	D, S									53	Do.
10bc	do	60.0	16	GI	T, E	I	Center of discharge pipe	1.1		5.50	May 11, 1951		1,875, M	13, M	56	Battery of 2 wells. Siphon system.
10ca	do	50	14	GI	T, E	I	Top of ¾-inch pipe	.5		7.00	Mar. 5, 1951		3,030, M	19, M		Battery of 3 wells. Siphon system. One well is 24 inches in diameter.
10cc1	do	80	16	GI	T, E	I	Hole in casing, north side.	0		2.31	Aug. 7, 1948		1,700, M	29.5, M		Sample.
10cc2	do		2	I	F								1, E			Unused stock well.
11aa	Saguache County	9.8	4	GI	N	O	Top of pipe	.4	7,591.1	3.98	Mar. 25, 1948					Jetted well.
11ad	G. M. Daugherty		2	I	F	S							5, R		54	Water has odor of hydrogen sulfide.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of— Water level	Date of measurement of— Discharge	Discharge (gpm)	Drawdown (fee)	Temperature (°F)	Remarks
41-8-11cb1	San Luis Valley Irrig. Dist.		2	I	F	S						Oct. 22, 1947	12, M		57	
11cb2	Adolph Coors Co.	57	24	GI	T, G	I	Top of casing, east side	0.8		2.75	July 6, 1950		1,336, M	30.5, M	50	
11cc	do		2	I	F	S						Oct. 14, 1947	60, M		61	
11da	Union Central Life Ins. Co.		2	I	F	S						Oct. 15, 1947	14, M		54	Water has odor of hydrogen sulfide.
11dc	Otis Azay	52.6			T, G	I, O	Top of bolt hole, north side.	−.7	7,599.6	4.48	Nov. 23, 1943					
12aa	Saguache County	5.0	2	GI	N	O	Top of pipe	−.3	7,583.1	4.95	Nov. 23, 1946					Bored well.
12bc	Louise Wilson		3	I	F	S						June 18, 1948	100, M			Water has odor of hydrogen sulfide.
12cb	do		18	GI	T, T	I	Top of hole in pump base, east side.	.7		5.50	Sept. 1, 1950					
12cc1	Otis Azay		2	I	F	S						Oct. 15, 1947	1, M		54	Do.
12cc2	do		3	I	F	D, S						Oct. 14, 1947	43, M		59	
13aa	Saguache County	9.7	3	GI	N	O	Top of pipe	.6	7,587.3	3.83	Mar. 25, 1948					Jetted well. Sample.
13bb	do	9.8	4	GI	N	O	do	.6	7,595.4	2.70	Mar. 25, 1948					Do.
13bc1	R. K. Thomas		2	I	F	S						June 21, 1949	29, M		57	Water has odor of hydrogen sulfide.
13bc2	do	67	16	GI	T, G	I					July 17, 1950		1,292, M		49	
13cb	do		2	I	F	S, I						Oct. 22, 1947	35, M		58	
13cc1	do	24.0	22	OB	C, G	I	Top of casing	2.5		.63	Oct. 22, 1947					
13cc2	do	700	2	I	F	D, S							2, E		56	
14aa1	M. Boden		3	I	F	D, S										
14aa2	do		3	I	F	D, S							1, E		57	
14ac	do	28.7	20	OB	C, G	I	Hole in barrel, north side.	−.5		1.57	Oct. 23, 1947					Battery of 2 wells.
14ba	W. S. Maurice	192.3	2	I	F	D, S						Oct. 22, 1947	20, M		57	

14bc	do		3	I	F	D, S						Oct. 23, 1947	21, M		60	Water has odor of hydrogen sulfide.
14cc	Hugh Bartee		2	I	F	D, S							1, E		53	Do.
14dd	do	175	3	I	F	D, S						Oct. 22, 1947	8.5, M		60	
15aa1	Saguache County	9.9	3	GI	N	O	Top of pipe	.8	7,604.8	5.60	Jan. 9, 1948					Jetted well.
15aa2	Frank Mitchell		2	I	F	S										
15aa3	do		2	I	F	D, I						Oct. 14, 1947	25, M		59	Water has odor of hydrogen sulfide
15aa4	do		2	I	F	I						Oct. 14, 1947	7, M		57	Do
15ab	do	36.3	16	GI	C, G	I, O	Top of wooden crib, west side.	.3	7,608.8	4.60	Oct. 14, 1947					Battery of 2 wells
15ac	do	127.2	3	I	F	I						Sept. 1, 1950	15, M		55	Water has odor of hydrogen sulfide.
15bc1	Adolph Coors Co.	280	3	I	F	I						Oct. 13, 1947	4, M		54	
15bc2	do	53.6	14	GI	T, G	I	Hole in casing, west side.	.5		4.58	Oct. 13, 1947		1,556, M	10, M		
15cc1	Clarence Gray		3	I	F	D, S						Nov. 23, 1947	1, M		57	
15cc2	do	32.9	18	GI	C, T	I	Top of barrel cover	0		4.38	Oct. 23, 1947					Battery of 2 wells.
16aa	Saguache County	9.4	3	GI	N	O	Top of pipe	.7	7,614.0	5.35	Jan. 9, 1948					Jetted well.
16ab	C. W. Bell	280	2	I	F	S						Oct. 13, 1947	60, M		56	
16ac	do		2	I	F	S						Oct. 5, 1950	47, M		56	
16bb	Saguache County	7.5	1¼	GP	N	O	Top of pipe	0	7,622.4	5.01	Jan. 9, 1948					Do.
16bc	C. W. Bell		18	GI	T, G	I	Hole in pump base, east side.	.4		5.05	Aug. 10, 1950					
16cc1	Adam Plummer	174.1	2	I	F	S, I						Oct. 24, 1947	40, M		54	
16cc2	do	175	2	I	F	S, I						Oct. 24, 1947	38, M		54	
16cc3	do	175	2	I	F	S, I						Oct. 24, 1947	43, M		54	
16cc4	do	175	2	I	F	I						Oct. 24, 1947	31, M		54	
16cc5	do	42.8	14	GI	C, T	I, O	Top of casing, east side.	0	7,626.8	4.10	Oct. 24, 1947					
16cc6	do		3	I	F	I						Oct. 24, 1947	32, M		54	
16cd	do		2	I	F	I						Oct. 23, 1947	5, M		53	
16dc	G. F. Gossman		16	GI	T, G	I							2, E		53	
16dd	do		2	I	F	S, I										
17bb1	Floyd Bartee		1¼	GP	F	S						Oct. 24, 1947	2, M		51	
17bb2	do	83.2	3	I	F	S						Oct. 24, 1947	7.5, M		51	
17bc	do	127.9	2	I	F	S						Oct. 24, 1947	7, M		52	
17cc1	Dean Patterson		2	I	F	D, S						Oct. 24, 1947	8.5, M		54	
17cc2	do	26.4	30	GI	C, G	I	Top of casing, east side.	−2.2		2.33	Oct. 24, 1947					Battery of 2 wells.
17db	Adam Plummer		2	I	F	S, I						Oct. 24, 1947	31, M		52	
17dc	do	47.5	16	GI	C, B	I	Top of casing, east side.	.9		4.49	Oct. 24, 1947					
17dd	do	175	2	I	F	D, S									54	
18aa	E. Hazard		2	I	F	S, I							20, E		52	
18ba	D. M. Bratton		2	I	F	D						Oct. 24, 1947	13, M		51	
18bc1	do		2	I	F	I						June 21, 1949	18, M		52	
18bc2	do	27.4	20	GI	C, T	I	Top of casing, south side.	−2.0		3.50	Aug. 28, 1950		908, M	9.5, M		
18cc1	L. R. Sims		18	GI	T, G	I	Top of casing, west side.	0		1.20	June 21, 1949					
18cc2	do		2	I	F	S, I						Oct. 24, 1947	49, M		53	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
41-8-19aa1	E. Hazard		2	I	F	S						Oct. 24, 1947	4.5, M		52	Water has odor of hydrogen sulfide.
19aa2	do		2	I	F	D, S						Oct. 24, 1947	3, M		53	
19ba	Ray and Esther Felmee	100	2	I	F	D, I						Oct. 24, 1947	30, M		53	
19bc1	do	110	14	GI	C, E		Top of casing	−3.5		0.01	Apr. 18, 1950		1,261, M	17.5, M		Reported to bottom in the first artesian aquifer.
19bc2	do		2	I	F	S, I						Aug. 21, 1950	38, M		55	
19cc	Walter McCormick	34.9	18	GI	C, G	I, O	Top of casing	−1.9	7,651.1	3.36	Nov. 22, 1946					
19dc	L. T. Sharp	32.3	18	GI	C, T	I, O	Top of casing, east side	−1.2	7,646.4	2.61	Nov. 22, 1946					
20aa	Saguache County	10.0	3	GI	N	O	Top of pipe	1.2	7,577.6	3.84	Mar. 25, 1948					Jetted well.
20bc	George Crown	101	16	GI	T, T	I	Top of casing, south side	.8		3.00	Aug. 24, 1950		2,494, M	20, M	49	
20cc	R. E. Finley	38.4	14	GI	C, G	I, O	Top of casing	−2.0	7,642.0	3.92	Nov. 22, 1946					
20cd	do			I	F	S, I							3.5, M		52	
21ad	F. and E. M. Noffsinger.	248.6	2	I	F	I						Oct. 23, 1947	12, M		54	Water has odor of hydrogen sulfide.
21bb	Walter Dady	190	2	I	F	D						Oct. 24, 1947	2.5, M		53	
21cc	W. W. Felmee	32	16	GI	C, G	I							1,244, M			Battery of 2 wells.
21dd	Saguache County	10.0	3	GI	N	O	Top of pipe	.4	7,623.3	3.58	Mar. 25, 1948					Jetted well.
22aa	do	10.0	3	GI	N	O	do	.6	7,609.4	3.87	Mar. 25, 1948					Do.
22ab	Walter Felix		3	I	F	I						Oct. 23, 1947	8.5, M		54	
22bb1	do	241	3	I	F	I							1, E			
22bb2	do		2	I	F	D, S							1, E		54	Water has odor of hydrogen sulfide.
22bc1	do	65	24	GI	T, B	I		0		5.00	Aug. 22, 1950		2,234, M	25, M		
22bc2	do	37.6	26	GI	C, G	I	Top of cross board, west side.	0		4.83	Oct. 23, 1947		940, M	12, R		
22cc1	Carl Schmittle	224.2	2	I	F	S, I						Oct. 23, 1947	75, M		56	Do.
22cc2	do		3	I	F	D, I							2, E		55	Do.

22dd	Mr. Miller		3	I	F	D, S						Oct. 21, 1947	3.5, M		55	Do.
23ac	F. Rodenbeck	87	18	GI	T, B	I	Hole in pump base, south side.	.4		4.50	July 18, 1950		998, M		50	
23ad	do	350	3	I	F	D, S						Oct. 22, 1947	5, M		56	
23bc1	Floyd Noffsinger	81	20	GI	T, T	I		0					1,706, M		50	
23bc2	do		2	I	F	D, S						Oct. 23, 1947	32.5, M		55	Do.
23cc1	Fred Noffsinger		2	I	F	D, S						Oct. 25, 1947	8, M		55	Do.
23cc2	do	57.8	16	GI	T, G	I	Top of casing, east side	0		3.67	Oct. 23, 1947					
23dc	A. B. Hughes		3	I	F	D, S							3, E		55	
24aa	Saguache County	9.9	3	GI	N	O	Top of pipe	.5	7,589.4	3.83	Jan. 13, 1948					Jetted well. Sample.
24bb	R. K. Thomas		2	I	F	D, S						Oct. 22, 1947	6.5, M		55	
24bc	do	24.6	36	W	C, T	I, O	Top of wooden crib, west side.	−3.5	7,621.5	.65	Oct. 22, 1947					
24cc	William H. Leach	59.8	14	GI			Top of casing, west side	.6		2.37	Oct. 22, 1947					Unused irrigation well.
24dd	do		3	I	F	S						Oct. 21, 1947	5, M		56	
25aa1	Nels Olsen		2	I	F	D, I							20, R		55	
25aa2	do		3	I	F	I							3, E		55	
25ac1	do	33.8	18	GI	C, G	I	Top of casing, east side	1.0		2.96	Oct. 16, 1947		600, R			Battery of 2 wells.
25ac2	do		3	I	F	I						Oct. 16, 1947	43, M		55	Water has odor of hydrogen sulfide.
25bc	Flora Noffsinger	44.0	18	GI	T, G	I	Top of casing	.8		3.52	June 22, 1949		1,420, M		51	
25dc	Ella Welty	27.1	14	GI	C, T	I	Top of barrel cover, north side.	0		3.00	Aug. 24, 1950		1,000, E	16, R	49	Battery of 2 wells.
26ac1	A. B. Hughes		2	I	F	I						June 22, 1949	55.5, M		64	
26ac2	do	45	18	GI	C, G	I	Top of casing	0		1.65	June 22, 1949					Battery of 3 wells.
26bc	E. H. Thacher		2	I	F	S						June 22, 1949	75, M		56	
26cc1	do	76	24	GI	T, E	I	Top of casing, west side	1.3		4.78	July 17, 1950					
26cc2	Saguache County	9.9	3	GI	N	O	Top of pipe	.4	7,630.9	6.60	Jan. 15, 1948					Jetted well.
26cc3	Stuart Willis	160	2	I	F	D, S							2, E		55	
26cd	do		2	I	F	D, S							5, R		52	
26dd	Saguache County	9.9	3	GI	N	O	Top of pipe	.6	7,610.0	8.06	Jan. 15, 1948					Do.
27bb1	F. and E. M. Noffsinger.		3	I	F	D, S							30, R		55	
27bb2	do	18.4	14	GI	C, E	I	Top of casing, east side	1.1		4.10	Oct. 23, 1947					Dug well
27bd	do		2	I	F	S, I						Oct. 23, 1947	3, M		53	Water has odor of hydrogen sulfide.
27dc1	Byron Sutley	102.4	3	I	F	S, I						June 23, 1948	158, M		55	
27dc2	do	84	20	GI	T, E	I	Top of bolt hole in pump base.	.3		3.50	July 5, 1950		1,487, M	38.5, M	50	
28ab	J. Hafferty		2	I	F	S						June 22, 1949	10, M		53	
28ac1	do	43.1	14	GI	C, G	I	Top of casing	2.4		6.55	Sept. 14, 1950		902, M	7, M		Battery of 2 wells.
28ac2	do	42.0	18	GI	C, G	I	Top of barrel cover	1.8		5.80	Sept. 14, 1950					Do.
28bc	Mr. Shaffer	36.5	24	B	C, G	I, O	Top of casing	−2.6	7,632.7	2.02	Oct. 28, 1947					

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of— Water level	Date of measurement of— Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
41-8-28dc	William Harmon	33.1	28	OB	C, T	I, O	Top of casing	−1.9	7,630.6	1.77	Oct. 28, 1947		1,671, M	34, M	49	Sample.
29ac	Floyd and Vera Rockey	33.2	18	GI	C, G	I	do	−.5		3.10	June 22, 1949		1,151, M	9, M		Battery of 2 wells.
29cc1	Mildred S. Barkley	145.9	2	I	F	S						Aug. 24, 1950	11.5, M		52	
29cc2	do	71.8	18	GI	T, E	I, O	do	0	7,648.0	3.90	Oct. 28, 1947					Sample.
29cc3	do		2	I	F	S							2, R		55	
29db	R. E. Finley		2	I	F	S						June 22, 1949	38.5, M		54	
30ac	Albert E. Turner		18	GI	C, G	I	do	−2.8		.04	June 22, 1949					Battery of 2 wells.
30bc	Mr. Kassen	32.5	16	GI	C, G	I	Top of casing, east side	0		1.5	June 22, 1949					
30cc	Saguache County	12.2	1¼	GP	N	O	Top of pipe	.7	7,660.0	4.03	Apr. 12, 1948					Driven and jetted well.
31ac1	Thelma Finley	180	2	I	F	I						Aug. 8, 1950	50, M		54	
31ac2	do	78	18	GI	T, E	I	Top of casing, north side	0		3.75	Aug. 8, 1950		1,272, M	33.5, M		
31ac3	do	32.6	20	GI	C, E	I	Top of casing	−4.0		2.00	Aug. 8, 1950					
31bc	Virgil Helmick		2	I	F	D, S							3, R		58	
31cc1	Mrs. E. Lindstrom	60	18	GI	T, E	I										
31cc2	Saguache County	9.0	1¼	GP	N	O	Top of pipe	.6	7,667.4	4.88	Jan. 7, 1948					Jetted well.
32bc	R. N. Rockey	102	20	GI	T, B	I	Top of casing, east side	−.9		2.92	Aug. 24, 1950		1,963, M	21.5, M		
32cc	William Filger	60	18	GI	T, E	I	do	0		3.00	Aug. 29, 1950		1,234, M		51	
32dc	Lee Bassett	35.7	14	GI	C, G	I, O	do	−.5	7,645.5	2.62	Nov. 21, 1946		600, R			
33aa	Carl Schmittle		3	I	F	I						Aug. 10, 1950	111, M		55	
33ac1	do	69	24	GI	T, E	I	Top of casing	1.1		6.25	July 5, 1950		1,768, M			
33ac2	do		2	I	F	D							2, R			
33bb	Ben J. Walker		2	I	F	S, I						June 25, 1948	20, M		55	
33bc	do	67	16	GI	T, E	I										
33cc	A. Fry	196	2	I	F	D						Oct. 2, 1950	25, M			
34aa	E. Newmeyer	8.9	12	B	N	O	Top of pipe, east side	2.7		4.30	Apr. 15, 1948					Well equipped with automatic water-level recorder.

34ac	do	32.2	18	GI	C, E	I										Battery of 2 wells.
34cb	Charles Dillon	73.8	18	GI	T, B	I	Top of casing, west side	.6		4.42	Aug. 4, 1950					
34cc1	do	150	3	I	F	I	Bottom of 3-inch elbow	1.5		+15.42	Aug. 4, 1950	Aug. 4, 1950	60, M		57	
34cc2	Saguache County	9.9	3	GI	N	O	Top of pipe	.8	7,630.9	7.58	Jan. 16, 1948					Jetted well.
34db1	Loran Dillon	75	18	GI	T, B	I	Hole in pump base, east side.	1.0		5.05	Aug. 4, 1950					
34db2	do		3	I	F	I							70, E		55	Water has odor of hydrogen sulfide.
35ac	Walter Dady	64.8	18	GI	T, G	I	Top of casing, east side	0		2.50	June 22, 1949					
35cc1	Roy David	37.8	18	GI	C, E	I	Top of crib, east side	0		3.90	Oct. 28, 1947					Battery of 2 wells.
35cc2	do	72.6	14	GI	T, G	I, O	Top of casing	.3	7,621.8	4.26	Oct. 28, 1947		715, M	11, M		
35cd	do		2	I	F	S, I						Aug. 10, 1950	52, M		56	
36ac	Mac Sutley	75	16	GI	C, E	I	Top of casing, east side	0		4.60	Sept. 14, 1950		897, M			Do.
36bb	Velra Wright		2	I	F	S, I						Aug. 29, 1947	24, M		54	Water has odor of hydrogen sulfide.
36bc	do	34.2	18	GI	C, T	I, O	Top of casing	−2.9	7,607.7	1.46	Oct. 29, 1947					Sample.
36cc	W. F. Sutley	120.5	20	GI	T, E	I	do	.9		3.57	Oct. 29, 1947		2,110, R	34, R		Well drilled to first artesian aquifer
41-9-1aa	Saguache County	10.0	3	GI	N	O	Top of pipe	.7	7,550.2	5.98	Apr. 1, 1948					Jetted well. Sample.
1ac	J. Garistakis	110	18	GI	T, G	I	Top of casing, south side	0		4.45	Oct. 24, 1948		1,220, M			Reported to have flowed when drilled. Sample.
2bb	Saguache County	9.8	3	GI	N	O	Top of pipe	.6	7,557.6	2.12	Apr. 27, 1948					Jetted well. Sample.
2dd	William Kennedy	270.9	2	I	F	D, S							1, E		57	Water has odor of hydrogen sulfide.
3ba	Laura A. Harvey		3	I	F	S						Oct. 13, 1947	5.5, M		57	Do.
3bb	Saguache County	10.0	3	GI	N	O	Top of pipe	.3	7,561.3	1.58	Mar. 31, 1948					Jetted well. Sample.
3cd	G. W. Daugherty		2	I	F	S						Oct. 16, 1947	6.5, M		56	Water has odor of hydrogen sulfide.
3dd	do		3	I	F	S						Oct. 16, 1947	8.5, M		56	Do.
5dc	do	290.9	2	I	F	S						Oct. 15, 1947	6.5, M		54	Do.
5dd	do	301.4	2	I	F	S						Oct. 15, 1947	20, M		55	Do.
6aa	Saguache County	10.0	3	GI	N	O	Top of pipe	.7	7,571.4	3.59	Mar. 31, 1948					Jetted well. Sample.
6bb1	do	9.8	3	GI	N	O	do	.2	7,576.9	2.67	Mar. 25, 1948					Do.
6bb2	G. W. Daugherty	232	2	I	F	D, S, I							25, E		53	Water has odor of hydrogen sulfide.
6bc	do	10		R	C, G	I							500, R		53	Dredged pit, 40 feet long, 15 feet wide, and about 10 feet deep.
6cc	do	232.0	3	I	F	I							17, M		53	Water has odor of hydrogen sulfide
6cd	do	200	3	I	F	S							3, M		54	Do.
6dd	Saguache County	8.0	3	GI	N	O	Top of pipe	.5	7,575.5	4.65	Apr. 21, 1948					Jetted well.
7bc	G. W. Daugherty	63	14	GI	C, G	I	Top of casing, west side	−4.3		3.00	Aug. 22, 1950		500, R	9, R	51	
7cc	do	96	18	GI	T, T	I	Hole in pump base, east side.	.2		4.00	Aug. 22, 1950		1,481, M	24, M	51	
9ba	do	221	2	I	F	S							1, E		52	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
41-9-9bb1	Saguache County	9.9	3	GI	N	O	Top of pipe	0.8	7,568.1	4.54	Jan. 12 ,1948					Jetted well.
9bb2	G. W. Daugherty	221.7	2	I	F	S							1, E		52	Water has odor of hydrogen sulfide.
10bb	Saguache County	8.4	3	GI	N	O	Top of pipe	.7	7,564.9	4.38	Jan. 12, 1948					Jetted well. Sample.
11bb	do	8.5	3	GI	N	O	do	1.1	7,561.4	3.61	Jan. 12, 1948					Jetted well.
11cc	William Kennedy		3	I	F	S						Oct. 16, 1947	11,M		57	Water has odor of hydrogen sulfide.
11dc	do	431.0	3	I	F	S, I						Oct. 20, 1947	12, M		59	Do.
12aa	Saguache County	9.9	3	GI	N	O	Top of pipe	.5	7,551.0	7.55	Jan. 8, 1948					Jetted well. Sample.
13ab	do	4.9	2	GI	N	O	do	0	7,554.8	4.10	May 20, 1947					Bored well.
13cc	do	9.9	3	GI	N	O	do	.6	7,561.2	4.14	Mar. 30, 1948					Jetted well. Sample.
13cd1	C. D. Elred		28	OB	P, H	S	Top of casing, east side	0		4.21	Oct. 20, 1947					Dug well.
13cd2	do		2	I	F	D, S						Oct. 20, 1947	1, M		59	Water has odor of hydrogen sulfide.
13dd1	do		2	I	F	S, I						Oct. 20, 1947	1.5, M		57	Do.
13dd2	Saguache County	5.8	2	GI	N	O	Top of pipe	0	7,556.4	4.60	May 20, 1957					Bored well. Sample.
14ba	do	5.2	2	GI	N	O	do			4.85	May 20, 1947					Bored well.
14bb	do	10.0	3	GI	N	O	do	.8	7,562.9	4.40	Jan. 12, 1948					Jetted well. Sample.
14dd	Lewis Cotton		3	I	F	D, S							5, E		58	Water has odor of hydrogen sulfide.
16aa	Saguache County	9.9	3	GI	N	O	Top of pipe	.3	7,565.4	2.70	Jan. 14, 1948					Jetted well.
16bb	do	9.0	3	GI	N	O	do	.7	7,571.3	2.54	Apr. 21, 1948					Do.
18aa	do	7.8	3	GI	N	O	do	.8	7,578.5	4.22	Jan. 14, 1948					Jetted well. Sample.
19aa	do	10.0	3	GI	N	O	do	.7	7,583.5	4.40	Jan. 13, 1948					Jetted well.
19cc1	Glen Jones	500	3	I	F	D, S						Oct. 16, 1947	22, M		56	
19cc2	do	40	16	GI	T, T	I	Hole in pump base, east side.	.8		5.00	Aug. 23, 1950		825, M	15, M		
19cc3	Saguache County	9.9	3	GI	N	O	Top of pipe	.5	7,596.2	4.45	Jan. 13, 1948					Jetted we l. Samp e

20cc	do	9.9	3	GI	N	O	do	.8	7,588.7	2.35						Do.
20dd1	G. W. Daugherty		3	I	F	S, I							4, E		55	Water has odor of hydrogen sulfde.
20dd2	Saguache County	10.0	3	GI	N	O	Top of pipe	1.0	7,582.1	2.90	Mar. 31, 1948					Jetted well. Sample.
21aa	do	10.0	3	GI	N	O	do	.5	7,569.5	4.59	Jan. 13, 1948					Jetted well.
21ad	Alta Halferty	525	2	I	F	S, I						Oct. 16, 1947	32, M		60	Water has odor of hydrogen sulfide.
21cc	do		3	I	F	S						Oct. 16, 1947	13, M		57	Do.
22cc	Omar Gilder	228.7	3	T	F	S, I							1, E		56	
22cd1	Maude Peden	525	2	I	F	S, I						Oct. 16, 1947	32, M		61	Sample.
22cd2	do	500	3	I	F	I							30, E		58	Water has odor of hydrogen sulfide.
22dd	Saguache County	9.9	3	GI	N	O	Top of pipe	.5	7,569.5	3.72	Mar. 30, 1948					Jetted well. Sample.
23bb	do	10.0	3	GI	N	O	do	.6	7,567.5	4.15	Mar. 31, 1948					Do.
23ca	Alice Fogel	29.6	14	GI	C, G	I	Top of casing, east side	−2.5		1.65	Oct. 20, 1947					Battery of 2 wells. Sample.
23cb	do		2	I	F	D, S						Oct. 16, 1947	27, M		61	
23cc	do	490	2	I	F	I						Oct. 17, 1947	24.5, M		61	Water has odor of hydrogen sulfide.
23db	Floyd Robinson	500	2	I	F	S, I						Oct. 20, 1947	13, M		60	Do.
23dc1	do	510	2	I	F	D, I									61	
23dc2	do	340	2	I	F	D, S							5, E		56	Do.
24ad	Mr. Grady		2	I	F	D, S						Oct. 20, 1947	6, M		61	Do.
24bc	Wallace Black		2	I	F	S, I							5, E		57	
24bd	do		2	I	F	S, I						Oct. 20, 1947	3, M		58	Do.
24cc	A. J. Padgett	425	3	I	F	D, S						Oct. 21, 1947	3, M		57	Do.
24dc1	Mr. Childress		2	I	F	S							1, E		58	Do.
24dc2	do		2	I	F	D, S							1, E		63	Do.
25aa	Saguache County	6.3	3	GI	N	O	Top of pipe	.5	7,558.8	6.20	Oct. 3, 1946					Bored well. Sample.
25bb1	do	9.4	3	GI	N	O	do	.8	7,563.7	6.75	Oct. 15, 1946					Jetted well. Sample.
25bb2	A. J. Padgett	278.7	2	I	F	D, S						Oct. 20, 1947	5, M		58	Water has odor of hydrgoen sulfide.
25cc	Saguache County	9.7	3	GI	N	O	Top of pipe	.9	7,564.8	4.30	Jan. 15, 1948					Jetted well. Sample.
26bb	A. J. Padgett		3	I	F	D, S						Oct. 21, 1947	2, M		56	Water has odor of hydrogen sulfide.
26bc	do		3	I	F	S, I						Oct. 17, 1948	120, M		64	Do.
27bb1	Omar Gilder	500	2	I	F	S										
27bb2	do		3	I	F	S, I						Oct. 20, 1947	7.5, M		56	Do.
27bc	do		14	GI	T, G	I	Top of casing	.6		4.43	June 1, 1951		1,071, M			
27cc1	Saguache County	9.6	3	GI	N	O	Top of pipe	.7	7,578.4	4.38	Jan. 15, 1948					Jetted well. Sample.
27cc2	H. E. Versaw	195	3	I	F	D, S							40, E		57	Sample.
27db	do		2	I	F	S							1.5, M		55	
27dd	Saguache County	9.9	3	GI	N	O	Top of pipe	.6	7,571.6	5.16	Jan. 15, 1948					Jetted well.
28aa	do	4.3	2	GI	N	O	do	.5	7,573.8	1.60	May 20, 1947					Bored well. Sample.
28bb	H. E. Versaw	223.3	3	I	F	S						Oct. 16, 1947	18, M		55	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
41-9-28cb	Saguache County	212.8	3	I	F	S						Oct. 16, 1947	14, M		56	Water has odor of hydrogen sulfide.
28cc	do	4.0	2	GI	N	O	Top of pipe	0.5	7,584.6	2.78	May 20, 1947					Bored well.
28da	H. E. Versaw	48	16	GI	C, G	I	Top of casing	−1.7		1.70	June 30, 1950		1,095, M	22, M		Battery of 3 wells.
28dc	do	233.3	3	I	F	S, I							26.5, M		56	Water has odor of hydrogen sulfide. Sample.
29cc	Saguache County	9.9	3	GI	N	O	Top of pipe	.7	7,592.3	6.74	Jan. 15, 1948					Jetted well. Sample.
30ac	Robert Ress	136	20	GI	T, G	I	Hole in pump base, east side.	.3		6.20	Aug. 18, 1950		1,556, M	20, M		
30bc1	Jessie Hughes	70	20	GI	T, E	I	Top of casing, east side	1.3		2.90	July 17, 1950		1,500, M	31, M		
30bc2	do		3	I	F	D, S						Oct. 21, 1947	50, M		57	
30cc	Saguache County	9.8	3	GI	N	O	Top of casing	1.2	7,601.0	5.51	Mar. 25, 1948					Jetted well.
31bc	W. Bieger	55.5	18	GI	T, E	I	do	−.6		1.50	June 22, 1949		897, M			
31cb	A. B. Hughes		2	I	F	S						Oct. 21, 1949	14, M			Water has odor of hydrogen sulfide.
31cc1	do	60			T, E	I										
31cc2	Saguache County	9.9	3	GI	N	O	Top of pipe	.9	7,603.8	4.91	Jan. 16, 1948					Jetted well.
31dc	O. E. Holman	500	2	I	F	S, I						Aug. 21, 1950	25, M		54	
32ba	Mr. Fahnestock	195	3	I	F	D, I						Oct. 21, 1947	22, M		56	
32bb	do	91.0	2	I	F	S						Oct. 21, 1947	5.5, M		52	Water has odor of hydrogen sulfide. Sample.
32bd1	do	195	2	I	F	S							30, R		56	
32bd2	do		2	I	F	I						Oct. 21, 1947	33, M		57	
32cc	Saguache County	9.9	3	GI	N	O	Top of pipe	.7	7,595.7	4.38	Mar. 26, 1948					Jetted well.
32dd	do	9.9	3	GI	N	O	do	.9	7,586.4	6.45	Jan. 15, 1948					Sample.

33aa	E. M. Alexander		2	I	F	D							10.5, M		58	Water has odor of hydrogen sulfide.
33ac	do	403	3	I	F	S, I						Oct. 21, 1947	39, M		59	Do.
33bc	do	193.5	3	I	F	S, I						Oct. 21, 1947	60, M		57	Do.
33dd	Saguache County	3.8	2	GI	N	O	Top of pipe	.2	7,579.4	1.00	May 20, 1947					Bored well.
34ab	H. E. Versaw	266.2	2	I	F	S						Oct. 22, 1947	4.5, M		57	Sample.
34bb	Florence Versaw		2	I	F	S, I						Oct. 22, 1947	16, M		63	
34dc	Ray Holland		3	I	F	S, I						Oct. 26, 1950	79, M		61	Water has odor of hydrogen sulfide.
35aa	Saguache County	12.6	12	GI	N	O	Top of pipe	2.8		3.30	Apr. 15, 1948					Dug well equipped with automatic water - level recorder.
35cc	do	9.4	3	GI	N	O	do	.5	7,574.1	4.40	Jan. 15, 1948					Jetted well.
35dd	do	9.8	3	GI	N	O	do	.5	7,571.2	3.81	Mar. 30, 1948					Sample.
36aa	do	8.0	3	GI	N	O	do	.8	7,561.1	7.02	Oct. 3, 1946					Bored well. Sample.
41-10-1dc	do	9.0	3	GI	N	O	do	1.1	7,532.4	4.45	June 10, 1947					Bored well.
2dc	do	6.3	3	GI	N	O	do	.8	7,533.0	4.90	June 10, 1947					Do.
11cc	do	6.2	3	GI	N	O	do	.6	7,532.7	4.50	June 13, 1947					Do.
13aa	Newhall Land & Farming Co.	6.9	3	GI	N	O	do	.5	7,530.6	6.70	Oct. 3, 1946					Bored well. Sample.
13cb	do	24.9	1¼	GP	N	O	do	2.9	7,534.0	7.51	Oct. 2, 1946					Jetted well.
13dd	do	7.3	3	GI	N	O	do	.8	7,531.1	7.10	Oct. 3, 1946					Bored well. Sample.
15cd	do	8.3	3	GI	N	O	do	.4	7,542.4	7.50	June 12, 1947					Do.
15dc	do	6.7	2	GI	N	O	do	.3	7,538.6	5.40	June 12, 1947					Do.
16dc	do	7.0	2	GI	N	O	do	.4	7,542.5	5.85	June 12, 1947					Do.
17db	A. O. Williamson	236	18, 12	GI	T, G	I	Top of casing	0		3.25	May 26, 1950				55	Water has odor of hydrogen sulfide.
18bb	Saguache County	5.5	2	GI	N	O	Top of pipe	.2	7,553.9	4.67	May 20, 1947					Bored well. Sample.
18cc	James Fogel	625	3	I	F	S						Oct. 20, 1947	38, M		64	Water is brown and has odor of hydrogen sulfide. Sample.
20dd	Saguache County	8.4	3	GI	N	O	Top of pipe	.9	7,548.3	7.90	Oct. 4, 1946					Bored well. Sample.
23cc	do	7.8	3	GI	N	O	do	.6	7,538.4	4.20	Oct. 3, 1946					Bored well.
23dc	do	9.9	3	GI	N	O	do	.5	7,539.2	4.85	Oct. 16, 1946					Jetted well.
25aa	do	9.5	3	GI	N	O	do	1.7	7,529.8	4.80	June 11, 1947					Bored well.
26bc	do	41.8	1¼	GP	N	O	do	3.3		9.61	Oct. 6, 1946					Jetted well.
26dd	do	9.7	3	GI	N	O	do	.6	7,536.0	4.42	Sept. 16, 1946					Bored well. Sample.
27aa	Keystone Farms	4,200	7¾	I	F	D, SW							800, R		116	Obtains water from Santa Fe formation. Sample.
27dd	Saguache County	11.4	2	GI	N	O	Top of pipe	.6	7,540.8	6.50	Oct. 2, 1946					Bored and jetted well. Sample.
28aa	do	9.9	3	GI	N	O	do	.6	7,543.5	6.25	Sept. 15, 1946					Jetted well. Sample.
28dd	do	9.9	3	GI	N	O	do	.4	7,546.1	8.00	Sept. 15, 1946					Do.
29bb1	do	22.7	1¼	GP	N	O	do	1.5	7,551.8	4.27	Oct. 9, 1946					Jetted well.

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of— Water level	Date of measurement of— Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
41-10-29bb2	Saguache County	8.4	3	GI	N	O	Top of pipe	0.4	7,554.2	6.75	Nov. 8, 1946					Bored well. Sample.
29cc1	A. O. Williamson	71	15	GI	T, G	I	Slot in cas ng, northwest side.*	.5		6.04	Feb. 14, 1951		900, M	39.5, M		
29cc2	Saguache County	8.6	3	GI	N	O	Top of pipe	.7	7,555.6	7.20	Oct. 4, 1946					Do.
31cc	do	29.1	14	GI	C, G	I	Top of casing, north side	−2.6		6.34	Oct. 4, 1948					
32aa	do	7.2	3	GI	N	O	Top of pipe	.5	7,549.5	6.63	Oct. 4, 1946					Do.
32dd	do	9.2	2	GI	N	O	do	0	7,558.5	8.50	Apr. 1, 1946					Do.
33dd	do	6.5	2	GI	N	O	do	0	7,548.0	4.16	Apr. 2, 1948					Do.
35dc	do	8.8	2	GI	N	O	do	.4	7,541.7	7.30	Apr. 2, 1946					Do.
36dc	do	9.9	2	GI	N	O	do	1.0	7,535.7	5.95	Oct. 21, 1946					Jetted well. Sample.
36dd	do	4.5	2	GI	N	O	do	.1	7,532.6	2.75	Apr. 2, 1946					Bored well.
41-11-18dd	Newhall Land & Farming Co.	9.9	3	GI	N	O	do	.5	7,533.3	6.45	June 11, 1947					Do.
29bb	do	9.9	3	GI	N	O	do	2.2	7,535.4	8.60	June 13, 1947					Do.
30ca	do	9.8	3	GI	N	O	do	2.4	7,533.9	6.70	June 10, 1947					Dug well.
31cd	do	5.5	2	GI	N	O	do	2.0	7,529.6	3.50	Apr. 15, 1946					Bored well. Sample.
32ba	do	9.7	3	GI	N	O	do	1.4	7,534.7	7.90	June 13, 1947					Do.
42-7-1bc	V. L. Crow	105.3	3	I	F	S, I						Oct. 6, 1947	43, M		62	Water has odor of hydrogen sulfide.
1cc1	Perry Dappin	300	3½	I	F	I						Oct. 6, 1947	33.5, M		62	
1cc2	do		3	I	F	S							5, E		60	
1dc	do	170.4			F	I						Oct. 9, 1947	38, M		55	
2ac	do		3	I	F	S						June 18, 1948	21, M		55	
2ad	do	91.4	3	I	F	S							1, E		52	Sample.
2db	do		3	I	F	I						June 21, 1948	34, M		53	
9ad	do	36.8	24	R	N		Top of wooden crib, south side.	2.7		34.49	June 11, 1948					Unused domestic well.
10aa1	J. A. Pannell	109	1¼	I	F, H	D							1, E			
10aa2	do	109.1	2	I	F	S							1, E		52	

11ab	Perry Dappin		2	I	F	S							25, E		52	
11ac	do	121	3½	I	F	S, I						June 14, 1948	18, M		56	
11db	do	172.7	3½	I	F	S, I						Oct. 9, 1947	30, M		56	
12ac	V. L. Crow		3	I	F	I							200, E		55	
12ad	do		2	I	F	S							3, E		53	
12cc	Perry Dappin		2½	I	F	I							150, E		62	
12dc1	F. M. Bernard		3½	I	F	I						June 9, 1948	75, M		59	
12dc2	do	218.7	3½	I	F	I						June 11, 1948	125, M		60	
12dc3	do	67.9	4	I	F	I						June 11, 1948	147, M		60	
12dc4	do	112.6	3	I	F	I						June 11, 1948	52, M		59	
12dc5	do		3½	I	F	I						June 11, 1948	161, M		62	
13ab	Bernice Jewell		4	I	F	I						June 11, 1948	181, M		61	
13bc	Perry Dappin	140.7	3	I	F	S						June 14, 1948	51, M		60	
13cb1	Shirley and Anna Wells		6½	I	F	S							2, E		52	
13cb2	do	115.8	4	I	F	S						June 14, 1948	43, M		52	
13cc1	do	245.0	3½	I	F	S							10, E		52	
13cc2	do	108.1	3½	I	F	S							30, E		52	
14ac	Perry Dappin	169.3	3½	I	F	I							300, E		51	
14bb	John Pierson		2½	I	F	I							5, E		56	
23cd	Harry Anderson		3	I	F	S, I						June 22, 1948	16, M		50	
24cc1	Perry Dappin	91.9	4	I	F	S, I						June 22, 1948	58, M		50	
24cc2	do	106.4	2	I	F	S, I						June 22, 1948	41, M		50	
25aa	Saguache County	4.0	2	GI	N	O	Top of pipe	.6	7,614.2	3.80	Nov. 22, 1946					Bored well. Sample.
26db	Harry Anderson		2	I	F	D						June 21, 1948	3, M		49	
27ac	Keystone Farms	80	14	GI	T, T	I										
34bc	C. W. Wadsworth	104.2	16	I	T, G	I	Top of casing	0		13.51	Oct. 10, 1947					
34dc	do	120	2	I	F	S						Oct. 10, 1947	1, M		50	
34dd1	do	120	2	I	F	S							2, E		51	
34dd2	do	120	2	I	C, E, F	D							10, R		50	
35cc	do	120	3	I	F	S						Oct. 10, 1947	15, M		50	
35dc	Henry Keck		2	I	F	S						Oct. 10, 1947	3.5, M		50	Water has odor of hydrogen sulfide.
36cc	Saguache County	13.1	1¼	GP	N	O	Top of pipe	.8	7,637.9	2.20	Apr. 22, 1948					Driven and jetted well.
36db	J. C. Schmittle	134.0	2	I	F	S						June 21, 1948	25, M		49	
36dc	do		2	I	F	S, I							15, E			
36dd1	do		2	I	F	S							1, M		52	
36dd2	Saguache County	13.0	1¼	GP	N	O	Top of pipe	2.0	7,629.6	4.13	Nov. 18, 1947					Jetted well.
42-8-1cc	William Hagen	163.0	3	I	F	S							1, E		55	
2cc	do	115.3	3	I	F	S							1, E		54	
4dc	Ross Pryor		3	I	F	S						June 24, 1948	3, M		51	
4dd	do	127.2	3	I	F	S							1, E		49	Water has odor of hydrogen sulfide.
6cc1	do	145.9	3	I	F	S							15, E		55	
6cc2	do		6	I	F	S, I							50, E		57	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
42-8-7bb	Ross Pryor		3	I	F	S, I						June 10, 1948	204, M		57	Sample.
7bc1	do	144.4	4	I	F	S, I						June 10, 1948	128, M		58	
7bc2	do		3	I	F	S, I						June 10, 1948	204, M		58	
7bc3	do	136.5	4	I	F	I						June 10, 1948	272, M		56	
7cd	Peter Harney	264.9	3	I	F	I						June 24, 1948	75, M		51	
7dc	do	153.6	3	I	F	S, I						June 24, 1948	9, M		51	
9dc	Ross Pryor		3	I	F	S, I						June 14, 1948	11, M		51	Water has odor of hydrogen sulfide.
10bb	Saguache County	7.6	3	GI		O	Top of pipe	0.3	7,577.7	4.50	June 8, 1950					Jetted well.
10bd1	Harry Anderson	206.8	3	I	F	D							1, E		51	
10bd2	do	202.4	6	I	F	S							1, E		52	
11ac	do		6	I	F	S							1, E		52	
12aa	Saguache County	5.0	2	GI	N	O	Top of pipe	0	7,560.1	4.93	Nov. 23, 1946					Bored well.
12bb	A. H. Prusick	172.0	3	I	F	S							1, E		53	
14ac	Harry Anderson	203.0	3	I	F	S						June 23, 1948	8.5, M		51	
14ad	do	209.0	2	I	F	S							1, E		52	Water has odor of hydrogen sulfide.
15bc1	E. F. Johnson	184.2	3	I	F	S						June 23, 1948	55.5, M		55	
15bc2	do	105.4	3	I	F	D							1, E		52	Unused domestic well.
18bb1	Peter Harney		3	I	F	S, I						June 21, 1948	200, M		58	
18bb2	do	154.6	3	I	F	I						June 21, 1948	75, M		55	
18bc	do	93.8	6	I	F	S, I									53	
19aa	F. M. Bernard		6	I	F	D, S							50, E		50	
19bb	Peter Harney	83.0	3	I	F	S, I						July 13, 1948	6.5, M		48	
21aa	Saguache County	10.0	2	GI	N	O	Top of pipe	.5	7,587.9	2.75	May 21, 1947					Bored well.
22cb	M. C. Denton	216.2	2	I	F	S						June 22, 1948	6, M		50	

26bb	do		2	I	F	S, I						June 23, 1948	4.5, M		52	Water has odor of hydrogen sulfide.
27db	do		2	I	F	S						June 23, 1948	7, M		52	Do.
31cc	F. M. Bernard		2	I	F	S						July 13, 1948	7, M		50	Do.
31dd	Carl and Opal Neese	360	2	I	F	D, S							30, E		55	Sample.
32cc1	John A. Dabney	360	3	I	F	D, S							70, E		55	
32cc2	Saguache County	9.8	3	GI	N	O	Top of pipe	.3	7,620.2	2.65	Mar. 25, 1948					Jetted well.
33cc	John A. Dabney	120	2	I	F	S, I						Oct. 10, 1047	11, M		50	
33dc	Carl Schmittle		3	I	F	S, I						Oct. 10, 1947	60, M		54	
34cc	do	196.5	2	I	F	S						Oct. 10, 1947	27, M		53	Sample.
34dc	do	189.3	3	I	F	S						Oct. 10, 1947	15.5, M		52	
42-9-3aa			3	I	F	D, S						June 30, 1948	3, M		56	Water has odor of hydrogen sulfide.
3cb	Frank Mishak		2	I	F	D, S						June 30, 1948	2.5, M		60	Water is brown and has strong odor of hydrogen sulfide.
6cc	Harry Anderson		2	I	F	S							.5, M		51	
7cc	do		2	I	F	S							1, E		54	
13aa		6.7	2	GI	N	O	Top of pipe	.4	7,539.7	5.58	May 20, 1947					Bored well.
25aa	Saguache County	5.2	2	GI	N	O	do	0	7,543.9	3.35	May 20, 1947					Do.
32dd	do	10.0	3	GI	N	O	do	.6	7,565.1	2.72	Mar. 31, 1948					Jetted well. Sample.
33dc	Mrs. E. H. Eichelzer		2	I	F	S, I						Oct. 15, 1947	11, M		56	Water has odor of hydrogen sulfide.
36cc	Saguache County	9.9	3	GI	N	O	Top of pipe	.3	7,553.3	1.54	Apr. 27, 1948					Jetted well. Sample.
42-10-5dc	Newhall Land & Farming Co.	10.8	2	GI	N	O	do	.2	7,541.9	10.50	June 9, 1947					Bored well.
8dd	do	9.7	3	GI	N	O	do	.4	7,540.4	9.00	June 9, 1947					Do.
16aa	do	6.6	3	GI	N	O	do	.2	7,536.6	5.30	June 12, 1947					Do.
17da	do	9.0	3	GI	N	O	do	4.0	7,541.5	7.23	June 9, 1947					Do.
19bb	do	7.6	2	GI	N	O	do	.5	7,539.2	3.97	May 20, 1947					Do.
20aa	do	9.9	3	GI	N	O	do	3.3	7,542.7	9.23	June 9, 1947					Do.
20da	do	8.2	2	GI	N	O	do	.1	7,539.6	6.62	June 9, 1947					Do.
22bb	do	9.9	3	GI	N	O	do	2.8	7,539.1	7.00	June 9, 1947					Do.
25ca	do	9.8	3	GI	N	O	do	2.1	7,535.2	9.65	June 11, 1947					Do.
27aa	do	9.8	3	GI	N	O	do	3.2	7,535.9	8.65	June 10, 1947					Do.
27bc	do	6.1	3	GI	N	O	do	.7	7,534.1	5.49	June 11, 1947					Do.
32aa	do	5.3	3	GI	N	O	do	0	7,538.5	3.93	May 20, 1947					Do.
32bb	do	6.4	2	GI	N	O	do	.4		4.27	May 20, 1947					Do.
34da	do	5.9	2	GI	N	O	do	.6	7,535.9	4.85	June 11, 1947					Do.
35ab	do	9.7	3	GI	N	O	do	1.1	7,534.4	8.70	June 10, 1947					Do.
36bd	do	9.8	3	GI	N	O	do	1.5	7,534.1	9.50	June 11, 1947					Do.
36cc	do	7.4	3	GI	N	O	do	.1	7,531.6	8.90	June 10, 1947					Do.
43-7-12ab	Homer Dunlap, Jr.	43.2	16	GI	T, T	I, O	Top of casing, north side	.2	7,657.4	24.61	Nov. 23, 1946					
24aa	John and Earl Davey		3	I	F	S, I							300, E		57	
24ab1	do	180	3	I	F	S, D						June 16, 1949	120, M		60	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point			Distance to water level above (+) or below measuring point (feet)	Date of measurement of—		Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
							Description	Distance above or below (−) land surface (feet)	Heigth above sea level (feet)		Water level	Discharge				
43-7-24ab2	John and Earl Davey	134.2	3	I	F	S, I						June 17, 1949	100, M		61	
24ab3	do		3½	I	F	S, I							600, E		59	
24ab4	do	180	3½	I	F	S, I							300, E		58	
24da1	do		3	I	F	S, I						June 17, 1949	278, M		52	
24da2	do		3	I	F	S, I						June 16, 1949	220, M		54	
25ac	Earl Davey		3	I	F	I						June 17, 1948	214, M		57	
25bc1	do		3	I	F	I						June 17, 1948	199, M		61	
25bc2	do	73.9	3	I	F	I						June 17, 1948	100, M		59	
25cb	William Hagan	107.3	3	I	F	S, I						June 17, 1948	125, M		55	
25cc	do	122.7	3	I	F	S, I						June 17, 1948	43, M		57	
25cd	do	162.6	4	I	F	S, I							700, E		61	
25db	do		3	I	F	S, I						June 17, 1948	38, M		57	
26ad1	do	103.4	4	I	F	I						June 17, 1948	75, M		56	
26ad2	do	108.3	4	I	F	I						June 17, 1948	75, M		53	
26da1	E. L. Watkins	102.1	3	I	F	D, S						June 17, 1948	42, M		51	Sample.
26da2	do	117.3	4	I	F	D						June 17, 1948	48, M		51	
35ab	W. Mohland		3	I	F	S, I							4, E		58	
35ac	do		3	I	F	S							3, E		55	Unused domestic well.
35dd	O. G. Hastings		2	I	F	S						Oct. 9, 1947	7.5, M		51	
36cc1	Oscar Pyle	100.1	3	I	F	S						June 18, 1948	17, M		55	Sample.
36cc2	do		2	I	F	S							3, E		52	
43-8-1ab	State of Colorado	147.2	4	I	F	I						July 12, 1948	60, M		54	
1ad	do		2	I	F	D							20, E		55	Unused domestic well.
1bb1	do	143.3	3	I	F	S, I						July 9, 1948	60, M		54	
1bb2	do	147.3	3	I	F	S, I							5, E		54	

1bb3	do		2	I	F	I						July 9, 1948	25, M		54	
1cb	do	161.9	3	I	F	S, I						July 9, 1948	34, M		53	
1dd	Saguache County	5.2	2	GI	N	O	Top of pipe	0	7,479.6	4.20	Nov. 23, 1946					Bored well.
2aa	State of Colorado	150.6	2	I	F	S, I						July 9, 1948	13, M		53	
2ba	J. M. Alexander		3	I	F	S, I						July 9, 1948	12, M		55	
2cc1	L. O. Lemieux	200	6	I	F	I						July 9, 1948	50, E		55	
2cc2	do	120	3	I	F	I						July 12, 1948	29, M		56	
2cc3	do		3	I	F	D, S, I							5, R		54	
2da	J. M. Alexander		2	I	F	D, S, I						July 9, 1948	13, M		55	
3ab	do	132.2	4	I	F	S, I						July 9, 1948	50, M		53	
3bb1	J. A. Strauss	128.9	4	I	F	S, I						July 9, 1948	38, M		52	
3bb2	do	128.3	3	I	F	S, I						July 9, 1948	43, M		51	
3cb1	do		3	I	F	I						July 12, 1948	11.5, M		53	
3cb2	do	92.4	3	I	F	S, I						July 12, 1948	25, M		52	
3cb3	do		3	I	F	D, S						July 12, 1948	4.5, M		52	
4ab	R. E. Williams		4	I	F	S, I						July 12, 1948	29, M		48	
4cc	do	3.5	3	GI		O	Top of pipe	.1	7,602.5	2.67	May 20, 1947					Jetted well. Sample.
5da	John and Earl Davey		2	I	F	D, S						July 12, 1948	2.5, M		47	Water has odor of hydrogen sulfide.
5dd	do	127.4	4	I	F	I, S						July 12, 1948	13, M		47	
6cc	Saguache County	7.3	2	GI	N	O	Top of pipe	.4	7,638.2	7.30	May 20, 1948					Driven and bored well.
6db	Homer Dunlap, Jr.		2	GI	F	S						July 2, 1948	6.5, M		62	
8ba	Homer Dunlap		3	I	F	S						July 2, 1948	3.5, M		51	
8bb	James Werner	113.7	3	I	F	I						July 2, 1948	64, M		60	Water has odor of hydrogen sulfide.
10aa	Carl Smith	5.0	2	GI	N	O	Top of pipe	.1	7,591.0	4.51	Nov. 23, 1946					Bored well. Sample.
10ad	John and Earl Davey	185.5	6	I	F	S							1, E		54	
10bb1	F. Seyfried		3	I	F	I						July 2, 1948	16, M		56	
10bb2	do		3	I	F	D, S						June 8, 1948	6.5, M		55	
11bb1	L. O. Lemieux	113.3	3	I	F	S, I							5, E		55	
11bb2	do		3	I	F	S, I							5, E		58	
11bb3	do		2	I	F	D, S							2, R		54	
11bb4	do		3	I	F	S, I						July 8, 1948	25, M		56	
11bc	Carl Smith		2	I	F	D, S, I						July 8, 1948	18, M		51	
11bd1	do		3	I	F	S							5, E		53	
11bd2	do		3	I	F	S, I							2, E		51	
11bd3	do		2	I	F	S, I						July 8, 1948	19, M		51	
11bd4	do	176.6	3	I	F	D, S							1, E		51	
11cb	John and Earl Davey		2	I	F	S, I						July 8, 1948	5, M		51	
12ab	State of Colorado	138.0	3	I	F	S, I						July 8, 1948	30, M		54	
12bb1	do	223	3	I	F	D, S, I						July 8, 1948	20, M		54	
12bb2	do	81.9	4	I	F	S, I						July 8, 1948	23, M		55	
15ab1	W. J. Werner	500	5	I	F	I							300, E		55	
15ab2	do	200	2	I	F	S, I						July 9, 1948	11, M		52	

TABLE 10.—*Records of wells in part of San Luis Valley*—Continued

Well	Owner	Depth of well (feet)	Diameter of well (inches)	Type of casing	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (—) land surface (feet)	Measuring point: Height above sea level (feet)	Distance to water level above (+) or below measuring point (feet)	Date of measurement of—: Water level	Date of measurement of—: Discharge	Discharge (gpm)	Drawdown (feet)	Temperature (°F)	Remarks
43-8-15bb1	John and Earl Davey	138.0	3	I	F	S, I						June 16, 1948	60, M		51	
15bb2	do	307.8	3	I	F	S, I						June 16, 1948	60, M		55	
15bb3	do	142.9	3	I	F	I						June 16, 1948	22, M		51	
15cc1	do	180	2	I	F	D, I						June 16, 1948	27, M		50	Water has odor of hydrogen sulfide. Sample.
15cc2	do		3	I	F	D						June 16, 1948	46, M		53	
16ab	William Hagan	136.8	3	I	F	S, I						June 16, 1948	18, M		53	
16ad	do		2	I	F	D							1, E		50	
16bb	do	120.4	3	I	F	S, I						June 16, 1948	43, M		53	
16dd	do	10.5	3	GI	N	O	Top of pipe	0.3		1.50	June 8, 1950					Jetted well.
19aa	do	187.9	3½	I	F	S, I						June 15, 1948	104, M		53	
19ab1	do	82.2	3	I	F	S, I							1, E			
19ab2	do	183.4	3	I	F	S, I						June 15, 1948	100, M		62	
19bb1	John and Earl Davey	152.4	3	I	F	S, I						June 15, 1948	100, M		64	
19bb2	do	123.5	3	I	F	I						June 15, 1948	44, M		60	
19bb3	do	214.2	3	I	F	I						June 15, 1948	136.5, M		62	
19da	Saguache Country Club.	225.2	2½	I	F	F						June 18, 1948	40, M		54	
20bb1	C. C. Wetherill	120	4	I	F	I							20, E		48	Sample.
20bb2	do	163.3	4	I	F	F						June 15, 1948	60, M		50	
20bc	do	141.5	3	I	F	F						June 15, 1948	43, M		50	
20ca1	Saguache Country Club.		2	I	F	D						June 16, 1948	4, M		51	
20ca2	do		5	I	F	D						June 16, 1948	17, M		54	
20cd	do	200.3	2½	I	F	I						June 16, 1948	32, M		54	
21ab1	Leo Welton		2	I	F	I						June 16, 1948	60, M		51	
21ab2	do	138.0	3	I	F	I						June 16, 1948	29, M		50	

24ac	State of Colorado	300	2	I	F	D						June 25, 1948	18, M		55	
25aa	Saguache County	6.5	2	GI	N	O	Top of pipe	.1	7,563.0	5.83	May 24, 1947					Bored well.
31bb	L. Sheldon	250	3	I	F	I							250, E			
31bc1	do	185	3	I	F	S, I	Bottom of 3-inch elbow	1.3		+44.28	Sept. 3, 1950		6, M		52	Sample.
31bc2	do	290	3	I	F	I						Oct. 8, 1947	583, M		57	Do.
31bc3	do	180	4	I	F	I						Oct. 8, 1947	120, M		51	
31cc	A. B. Van De Winter	288	4	I	F	I							150, E			
31da	V. L. Crow		2	I	F	S										
31db	Saguache County	210.8	3	I	F	I							5, E		49	Water has odor of hydrogen sulfide.
31dc	V. L. Crow	378	2	I	F	I						Oct. 6, 1947	21, M		49	
32cc1	do	301	3	I	F	D, I						Oct. 6, 1947	100, M			
32cc2	do	185	2	I	F	S, I							50, E			
32dc	do	401	3	I	F	I							25, E		54	
33cc1	F. L. Bailey	505	2	I	F	D, S							40, E		52	
33cc2	do	491	2	I	F	D, S							30, E		52	
33dd	Saguache County	7.4	2	GI	N	O	Top of pipe	.3	7,573.9	5.37	Nov. 22, 1946					Bored well. Sample.
34cd	do		3	I	F	S							1, E		51	Water has odor of hydrogen sulfide.
35cc	William Hagan	209.1	3	I	F	S						June 15, 1948	60, M		50	
43-9-1dd	Saguache County	4.5	3	GI	N	O	Top of pipe	.1	7,558.8	2.43	May 20, 1947					Bored well.
3cd	State of Colorado		3	I	F	S						July 12, 1948	6.5, M		49	
3dd	do	7.7	2	GI	N	O	Top of pipe	.5	7,563.7	5.97	June 3, 1947					Do.
5dc	do	248.0	4	I	F	S						June 29, 1948	23, M		55	
5dd	Saguache County	7.1	2	GI	N	O	Top of pipe	0	7,570.8	6.92	Nov 23, 1946					Do.
6bc	State of Colorado	162.8	3	I	F	I						June 28, 1948	43, M		54	
6cb	do		3	I	F	D						June 28, 1948	43, M		54	
7bb1	do		2	I	F	I						June 28, 1948	50, M		57	
7bb2	do	180.6	3	I	F	S						June 28, 1948	37.5, M		55	
7da	do	188.1	3	I	F	S						June 28, 1948	20, M		55	
8ab	do		4	I	F	I						June 29, 1948	13.5, M		54	
9ab	do	185	2	I	F	S, I							5, E		51	
11aa1	do		2	I	F	S						July 12, 1948	14, M		53	Water has odor of hydrogen sulfide.
11aa2	do		3	I	F	D, S						July 12, 1948	6.5, M		53	
12aa	Albert Smith		2	I	F	D, S						July 12, 1948	6.5, M		53	
18ab	State of Colorado	112.4	3¼	I	F	S							25, E		54	
18ad	do		3	I	F	D						June 25, 1948	14, M		57	
18bc	do		3	I	F	S						June 25, 1948	15, M		54	
19aa	N. E. Hammerer	232.5	2	I	F	D							25, E		56	
19bb	Clara Straeter		3	I	F	S						June 25, 1948	4, M		55	
20ba	N. E. Hammerer	210.7	2	I	F	S							5, E		58	Well discharges inflammable gas.
21aa	Ivan McDonald	188.3	3	I	F	S							3, E		54	
21ab	do	233.7	3	I	F	I						June 30, 1948	9, M		56	Sample.
43-10-8bb		4.2	2	GI	N	O	Top of pipe	.2	7,558.2	3.65	May 20, 1947					Bored well.

LOGS OF WELLS AND TEST HOLES

Listed in the following pages are the logs of 290 wells and test holes, including 52 test holes and test wells drilled for the Geological Survey as a part of this investigation. The locations of the test holes and test wells used in constructing cross sections (pl. 11) are shown on plate 16. Logs entitled "sample logs" are those for which the well cuttings were collected and studied by the writer. The "drillers' logs" are written logs obtained from well drillers, and "reported logs" are logs obtained orally from drillers and well owners.

Sample logs of test wells and test holes in undifferentiated Recent deposits and the Alamosa formation

[Numbers correspond to well numbers on plate 16]

1. **Test well 1.** NW¼NW¼ sec. 6, T. 38 N., R. 10 E. Alamosa County. Surface altitude, 7,567.9 feet.

	Thickness (feet)	*Depth (feet)*
Sand, fine, to fine gravel	8	8
Sand, medium, to coarse gravel	18	26
Sand, fine, to medium gravel	9	35
Sand, medium, to coarse gravel	8	43
Clay, soft to hard, brown to greenish-blue; contains streaks of sand	10	53

2. **Test hole 2.** SW¼SW¼ sec. 8, T. 38 N., R. 11 E. Alamosa County. Surface altitude, 7,533.7 feet.

Sand, medium to coarse, and medium to coarse brown gravel; contains stringers of brown clay	5.0	5.0
Clay, compact, brown	1.5	6.5
Gravel, fine to coarse, brown; contains stringers of brown clay	4.5	11.0
Gravel, fine to very coarse, brown; contains very fine to coarse black sand	16.0	27.0
Clay, compact, gray	6.0	33.0
Sand, fine to coarse, black; contains medium to coarse black gravel	2.0	35.0
Clay, compact, gray	3.0	38.0
Sand, medium to coarse, black; contains medium to coarse black gravel	3.9	41.9
Clay, compact, green	12.6	54.5

3. **Test well 3.** NE¼NE¼ sec. 14, T. 38 N., R. 11 E. Alamosa County. Surface altitude, 7,520.9 feet.

Clay, compact, tan; contains lenses of fine brown sand	7.2	7.2
Sand, fine to very coarse, brown; contains very fine to medium brown gravel	25.0	32.2
Clay, soft to hard, brown	4.8	37.0
Sand, medium to very coarse, brown and black; contains very fine to coarse brown and black gravel	10.3	47.3
Clay, hard, tan to brown	23.4	70.7
Sand, very fine to medium, brown and black	6.0	76.7
Clay, compact, greenish-gray	18.1	94.8

4. **Test well 4.** NW¼NW¼ sec. 15, T. 38 N., R. 11 E. Alamosa County. Surface altitude, 7,526.42 feet.

Sand, fine to very coarse, brown; contains very fine to medium brown gravel	10.0	10.0
Clay, compact, brown	.5	10.5
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	8.1	18.6
Clay, compact, brown	.5	19.1
Sand, medium to coarse, brown; contains medium to coarse brown gravel	1.0	20.1
Clay, compact, brown	4.1	24.2
Sand, very fine to very coarse, brown; contains very fine to medium brown gravel	9.2	33.4

	Thickness (feet)	*Depth (feet)*
Clay, compact, bluish-gray to greenish-gray	5.0	38.4
Sand, very fine to medium, black	7.2	45.6
Clay, compact, green	3.0	48.6
Sand, very fine to medium, black and greenish-black	4.0	52.6
Clay, compact, green	11.4	64.0
Sand, very fine, greenish-gray to black	1.0	65.0

5. **Test well 5.** NW¼NW¼ sec. 25, T. 38 N., R. 11 E. Alamosa County. Surface altitude, 7,514.7 feet.

Clay, soft, brown; contains lenses of very fine brown sand	3.0	3.0
Sand, very fine to medium, brown	2.0	5.0
Sand, very fine to very coarse, and very fine to coarse gravel, black; contains stringers of brown clay	20.3	25.3
Clay, compact, brown to dark-gray	1.7	27.0
Sand, very fine to fine, brown	1.0	28.0
Clay, soft to compact, light-tan to white	7.0	35.0
Sand, fine, black	1.0	36.0
Clay, compact, green	9.0	45.0
Sand, fine, black; contains white snail shells	1.0	46.0
Clay, compact, brown	16.4	62.4
Sand, very fine to fine, brown	1.0	63.4

6. **Test hole 6.** SW¼SW¼ sec. 34, T. 38 N., R. 11 E. Alamosa County. Surface altitude, 7,532.5 feet.

Clay, compact, sandy, brown	8.7	8.7
Gravel, coarse, black and brown; contains medium to coarse black and brown sand	1.0	9.7
Clay, compact, brown	5.0	14.7
Sand, medium to very coarse, brown; contains very fine to coarse brown gravel and stringers of brown clay	8.3	23.0
Gravel, fine to coarse; contains coarse brown sand and brown clay	17.5	40.5
Clay, compact, brown	1.0	41.5
Gravel, medium to coarse, brown; contains stringers of brown clay	4.7	46.2
Clay, compact, brown	1.0	47.2
Gravel, coarse, brown	2.0	49.2
Clay, compact, green	10.5	59.7
Clay, compact, gray	4.7	64.4
Clay, compact, green; contains lenses of very fine black sand	11.1	75.5

7. **Test well 7.** SE¼SE¼ sec. 35, T. 38 N., R. 11 E. Alamosa County. Surface altitude, 7,528.7 feet.

Sand, very fine to coarse, brown	3.0	3.0
Clay, soft, light-red	1.0	4.0
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	16.0	20.0
Clay, compact, red	1.5	21.5
Sand, very fine to very coarse, light-brown; contains very fine to coarse light-brown gravel	13.5	35.0
Clay, brittle, white	4.0	39.0
Sand, very fine to very coarse, brown; contains very fine to medium brown gravel	3.9	42.9
Sand, very fine to fine, black	12.9	55.8
Clay, soft, sandy, brownish-gray	13.2	69.0
Clay, compact, light-brown	3.0	72.0
Sand, very fine, brown	2.0	74.0
Clay, compact, green	8.5	82.5

8. **Test hole 8.** SE¼NE¼ sec. 18, T. 38 N., R. 12 E. Alamosa County. Surface altitude, 7,515.4 feet.

Sand, fine to very coarse, brown, and very fine to medium brown gravel; contains stringers of brown clay	4.0	4.0
Sand, fine to very coarse, brown, and very fine to coarse brown gravel; contains stringers of brown clay	7.8	11.8

	Thickness (feet)	Depth (feet)
Sand, fine to very coarse, black; contains very fine to coarse brown gravel	5.3	17.1
Clay, compact, gray	.5	17.6
Sand, fine to very coarse, black; contains very fine to coarse brown gravel	9.7	27.3
Clay, compact, light-green	19.5	46.8
Sand, very fine, black	2.8	49.6
Clay, compact, green; contains lenses of very fine black sand	5.0	54.6

9. **Test well 9.** NE¼NE¼ sec. 24, T. 39 N., R. 9 E. Alamosa County. Surface altitude, 7,564.2 feet.

Sand, very fine, to gravel, coarse	10	10
Sand, very fine, interbedded with stringers of brown sandy clay; contains some coarse gravel	18	28
Sand, medium, brown, to coarse brown gravel	5	43
Clay, soft, sandy, brown	3	46
Clay, hard, tan	2	48

10. **Test hole 10.** SE¼NE¼ sec. 25, T. 39 N., R. 9 E. Alamosa County. Surface altitude, 7,000.0 feet.

Sand, fine to coarse	6	6
Clay, compact, blue	4	10
Gravel, medium to coarse; contains fine to coarse sand	16	26
Sand, fine to medium	5	31
Clay, soft, brown	1	32
Gravel, fine to medium; contains fine to medium sand	4	36
Clay, sandy, yellow	4	40
Clay, compact, yellow	5	45

11. **Test well 11.** NW¼NW¼ sec. 7, T. 39 N., R. 10 E. Alamosa County. Surface altitude, 7,572.5 feet.

Sand, fine to coarse, brown	5	5
Gravel, medium, brown, to medium brown sand	10	15
Sand, very fine to medium, brown; contains a little fine brown gravel	10	25
Sand, fine, brown, to coarse brown gravel	15	40
Sand, fine to coarse, brown; contains a little medium to coarse brown gravel	4	44
Clay, compact, hard, brown	1.5	45.5
Sand, fine, brown, to coarse brown gravel	2.5	48
Clay, compact, hard, brown	1	49
Sand, fine, brown, to coarse brown gravel	3	52

12. **Test well 12.** NW¼NW¼ sec. 3, T. 39 N., R. 11 E. Alamosa County. Surface altitude, 7,523.6 feet.

Sand, very fine to medium, brown; contains stringers of brown clay	4.0	4.0
Sand, very fine to medium, black	11.0	15.0
Sand, very fine to very coarse black; contains very fine to coarse black and green gravel	39.8	54.8
Clay, compact, gray	2.1	56.9
Sand, very fine to very coarse, black; contains very fine to medium black gravel	11.9	68.8
Clay, compact, dark-gray	2.6	71.4
Sand, very fine to medium, black; contains very fine to medium black gravel	11.1	82.5
Clay, compact, dark-gray	1.0	83.5
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	12.2	95.7
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	9.6	105.3
Clay, soft, gray	8.0	113.3
Clay, compact, greenish-gray	9.7	123.0
Sand, very fine, black	2.0	125.0
Sand, very fine to coarse, black; contains coarse black gravel	22.6	147.6

13. **Test well 13.** NW¼SW¼ sec. 13, T. 39 N., R. 11 E. Alamosa County. Surface altitude, 7,519.8 feet.

Sand, very fine to medium, brown and black; contains stringers of brown clay	5.0	5.0
Clay, gray; contains brown cemented sand grains	1.5	6.5
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	22.5	29.0

	Thickness (feet)	*Depth (feet)*
Clay, compact, gray	.5	29.5
Sand, fine to coarse, black; contains medium to coarse black gravel	15.6	45.1
Clay, compact, greenish-gray	2.0	47.1
Sand, fine to coarse, black	2.0	49.1
Clay, compact, gray	.5	49.6
Sand, fine to medium, black	11.1	60.7
Clay, compact, greenish-gray	2.5	63.2
Sand, fine to medium, black	13.6	76.8
Clay, compact, greenish-gray	6.0	82.8
Sand, very fine to medium, black	4.9	87.7
Clay, compact, greenish-gray	6.0	93.7
Sand, very fine to fine, black	5.0	98.7
Clay, compact, greenish-gray to gray	14.3	113.0
Sand, very fine, black	2.8	115.8

14. **Test well 14.** SE¼NE¼ sec. 16, T. 39 N., R. 11 E. Alamosa County. Surface altitude, 7,523.1 feet.

Sand, fine to very coarse, brown; contains very fine brown gravel	4.8	4.8
Clay, compact, brown	.5	5.3
Sand, very fine to very coarse, brown	.8	6.1
Clay, compact, brown	.5	6.6
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	8.1	14.7
Clay, compact, brown	1.0	15.7
Sand, fine to very coarse, brown and black; contains very fine to coarse brown and black gravel	6.3	22.0
Sand, very fine to very coarse, black; contains very fine to coarse brown gravel	10.9	32.9
Sand, very fine to medium, black; contains fine to coarse brown gravel and stringers of gray clay	13.1	46.0
Clay, compact, green	3.0	49.0
Sand, very fine to medium, black; contains medium black and brown gravel	19.5	68.5
Clay, compact, green	.5	69.0
Sand, very fine, black	3.0	72.0
Clay, compact, green	.4	72.4
Sand, very fine, black	5.3	77.7
Clay, compact, greenish-gray	4.0	81.7
Sand, very fine to medium, black	2.2	83.9
Clay, compact, green	.9	84.8

15. **Test well 15.** SE¼SE¼ sec. 23, T. 39 N., R. 11 E. Alamosa County. Surface altitude, 7,517.9 feet.

Sand, fine to coarse, brown	6.0	6.0
Clay, compact, brown	2.0	8.0
Sand, fine to very coarse, brown; contains very fine to medium brown gravel	3.0	11.0
Gravel, very fine to coarse, black; contains very coarse black sand	13.0	24.0
Sand, fine to very coarse, black, and very fine to coarse black gravel; contains thin stringers of dark-gray clay	23.1	47.1
Clay, compact, medium-gray	2.0	49.1
Sand, fine to very coarse, black; contains very fine to medium black gravel	3.3	52.4
Clay, soft, gray	1.0	53.4
Sand, very fine to medium, black	21.5	74.9
Clay, compact, greenish-gray	6.4	81.3
Sand, very fine, black	3.5	84.8
Clay, compact, greenish-gray	9.1	93.9

16. **Test well 16.** NW¼NW¼ sec. 29, T. 39 N., R. 11 E. Alamosa County. Surface altitude, 7,530.8 feet.

Gravel, coarse, brown; contains interbedded brown sandy clay	10.0	10.0
Sand, medium to coarse, brown; contains medium to coarse brown gravel	12.0	22.0
Clay, soft, brown	.5	22.5
Sand, medium to coarse, brown; contains medium to coarse brown gravel	6.5	29.0
Gravel, medium to coarse, black; contains medium brown sand	6.0	35.0
Clay, compact, green	.7	35.7

	Thickness (feet)	Depth (feet)
Sand, fine to very coarse, black and green; contains very fine to coarse black and green gravel	13.3	49.0
Clay, compact, green	8.0	57.0
Sand, medium to coarse, black and green; contains medium to coarse black and green gravel	3.0	60.0
Clay, compact, green	3.4	63.4

17. **Test hole 17.** SE¼SE¼ sec. 33, T. 39 N., R. 11 E. Alamosa County. Surface altitude, 7,523.8 feet.

	Thickness (feet)	Depth (feet)
Clay, compact, brown; contains lenses of coarse brown sand	6.0	6.0
Gravel, fine to coarse, brown; contains medium to coarse brown sand	5.8	11.8
Clay, compact, brown to greenish-gray	9.3	21.1
Sand, very fine to medium, black	4.0	25.1
Clay, compact, bluish-gray	4.9	30.0
Sand, very fine, black and greenish-black	1.0	31.0
Clay, compact, gray	2.3	33.3
Sand, very fine to very coarse, black, and very fine to coarse black gravel; contains stringers of green clay	16.0	49.3
Clay, compact, green	.7	50.0
Sand, fine to medium, black	4.1	54.1
Clay, compact, green; contains lenses of fine black sand	8.9	63.0
Sand, very fine, black	1.7	64.7

18. **Test well 18.** SE¼SE¼ sec. 35, T. 39 N., R. 11 E. Alamosa County. Surface altitude, 7,520.9 feet.

	Thickness (feet)	Depth (feet)
Sand, very fine to very coarse, brown; contains very fine to medium brown gravel	9.0	9.0
Clay, soft, brown	.5	9.5
Sand and gravel, fine to coarse, brown; contains cemented zones	9.7	19.2
Sand, very fine to very coarse, brown and black; contains very fine to coarse brown and black gravel	5.4	24.6
Clay, compact, gray	3.0	27.6
Sand and gravel, fine to coarse, black and brown	2.3	29.9
Clay, compact, gray	4.0	33.9
Clay, compact, greenish-gray	8.8	42.7
Sand, very fine to medium, brown and black; contains very fine brown and black gravel	9.5	52.2
Clay, compact, greenish-gray	4.0	56.2
Sand and gravel, fine to coarse, brown and black	6.5	62.7
Clay, compact, greenish-gray; contains lenses of fine black sand	22.2	84.9

19. **Test well 19.** NW¼NW¼ sec. 3, T. 39 N., R. 12 E. Alamosa County. Surface altitude, 7,585.9 feet.

	Thickness (feet)	Depth (feet)
Sand, very fine to medium, brown	5.0	5.0
Sand, very fine to medium, black	17.8	22.8
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	48.2	71.0
Clay, soft, pink to brown	2.0	73.0
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	11.0	84.0
Clay, soft, light-brown	.5	84.5
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	9.5	94.0
Clay, soft, brown	1.0	95.0
Sand, medium to very coarse, brown; contains very fine to coarse brown gravel	16.5	111.5
Clay, soft, brown	1.0	112.5
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	11.0	123.5
Clay, soft, brown	.5	124.0
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	3.9	127.9
Clay, compact, brown	4.1	132.0
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	.8	132.8

20. **Test well 20.** SE¼SW¼ sec. 7, T. 39 N., R. 12 E. Alamosa County. Surface altitude, 7,520.8 feet.

	Thickness (feet)	Depth (feet)
Clay, compact, brown; contains lenses of fine brown sand	6.0	6.0
Sand, fine to very coarse, black; contains very fine to coarse black gravel	19.0	25.0

	Thickness (feet)	Depth (feet)
Sand, very fine to coarse, black; contains medium to coarse black gravel	13.0	38.0
Clay, soft, dark-gray	.5	38.5
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	5.5	44.0
Clay, compact, gray	.6	44.6
Sand, fine to very coarse, black; contains very fine to coarse black gravel	2.4	47.0
Clay, compact, greenish-gray	.5	47.5
Sand, fine to very coarse, black; contains very fine to coarse black gravel	2.5	50.0
Clay, compact, greenish-gray; contains lenses of fine black sand	8.6	58.6
Sand, fine to very coarse, black; contains very fine to medium black gravel	4.0	62.6
Clay, compact, greenish-gray	1.0	63.6

21. **Test well 21.** SE¼SE¼ sec. 20, T. 39 N., R. 12 E. Alamosa County. Surface altitude, 7,531.9 feet.

	Thickness (feet)	Depth (feet)
Sand, very fine to medium, brown; contains stringers of brown clay	5.0	5.0
Sand, very fine to very coarse, black; contains green, black, and white very fine to coarse gravel	5.0	10.0
Gravel, fine to coarse, black, white, and green; contains fine black sand	10.0	20.0
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	10.0	30.0
Clay, compact, brown	.5	30.5
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	8.5	39.0
Clay, compact, brown	1.0	40.0
Sand, fine to very coarse, black; contains very fine to coarse brown and black gravel	9.3	49.3
Clay, compact, gray	3.3	52.6
Sand, fine to medium, black	1.0	53.6
Clay, compact, green	1.4	55.0
Sand, very fine to medium, black	8.0	63.0
Clay, compact, green	1.3	64.3
Sand, very fine to fine, black	1.7	66.0
Clay, compact, green	4.0	70.0
Sand, very fine to fine, black	4.8	74.8
Clay, compact, green	2.2	77.0
Sand, very fine to fine, black	2.0	79.0
Clay, compact; contains lenses of very fine black sand	6.3	85.3

22. **Test hole 22.** SE¼SE¼ sec. 20, T. 40 N., R. 6 E. Rio Grande County. Surface altitude, 7,869.9 feet.

	Thickness (feet)	Depth (feet)
Gravel, very fine to large cobbles; contains fine to very coarse sand	7	7
Sand, fine to very coarse; contains fine to very coarse gravel and a few large cobbles	10	17
Gravel, very fine to large cobbles; contains very fine to very coarse sand	11	28
Clay, sandy, brown	.5	28.5
Gravel, fine to small cobbles; contains medium to coarse sand	7.5	36
Sand, fine to very coarse; contains fine to very coarse gravel and some small cobbles	10	46
Clay, sandy, brown	1	47
Gravel, medium to large cobbles; contains medium to very coarse sand, and a little brown clay	11	58
Gravel, medium to small cobbles; contains medium to very coarse sand	6	64
Clay, sandy, yellow	5	69

23. **Test hole 23.** NE¼NE¼ sec. 25, T. 40 N., R. 6 E. Rio Grande County. Surface altitude, 7,784.4 feet.

	Thickness (feet)	Depth (feet)
Gravel, very fine to small cobbles; contains fine sand	14	14
Gravel, very coarse, to medium sand; contains small cobbles and some large cobbles	14	28
Gravel, medium to large cobbles; contains very fine to coarse sand	7	35
Gravel, medium to large cobbles; contains medium to coarse sand	7	42
Gravel, medium to large cobbles; contains medium to coarse sand and a little brown clay	7	49
Clay, firm, hard, brown	1	50

	Thickness (feet)	Depth (feet)
24. **Test hole 24.** NW¼NW¼ sec. 26, T. 40 N., R. 6 E. Rio Grande County. Surface altitude, 7,824.7 feet.		
Gravel, very fine to large cobbles; contains fine to very coarse sand	15	15
Sand, fine, to very coarse gravel; contains small cobbles	20	35
Sand, very fine, to very coarse gravel; contains small cobbles and a little brown clay	6	41
Clay, soft, brown	1	42
25. **Test hole 25.** NE¼NE¼ sec. 27, T. 40 N., R. 7 E. Rio Grande County. Surface altitude, 7,707.0 feet.		
Gravel, very coarse, to fine sand	14	14
Gravel, very coarse, to fine sand; contains small cobbles	4	18
Sand, fine, to very coarse gravel	5	23
Gravel, very coarse, to very fine sand; contains small cobbles	40	63
Gravel, very coarse, to very fine sand	10	73
Gravel, very coarse, to very fine sand; contains a little clay	10	83
Gravel, very coarse, to very fine sand	10	93
Gravel, coarse, to medium sand	2	95
Gravel, medium, to very fine sand	3	98
Sand, very fine to coarse	2	100
Clay, sandy, brown	1	101
26. **Test hole 26.** NE¼NE¼ sec. 28, T. 40 N., R. 7 E. Rio Grande County. Surface altitude, 7,726.7 feet.		
Gravel, medium to very coarse; contains fine to medium sand	5	5
Gravel, coarse to small cobbles; contains medium to coarse sand	10	15
Gravel, coarse to small cobbles; contains medium to coarse sand and a little clay	10	25
Gravel, fine to very coarse; contains fine to coarse sand and a little clay	20	45
Gravel, medium to very coarse; contains medium to very coarse sand	8.5	53.5
Clay, sandy, yellow	.5	54
Gravel, medium to very coarse; contains fine to very coarse sand	11	65
Gravel, medium to coarse; contains fine to coarse sand	8	73
Clay, sandy, yellow	.5	73.5
Gravel, medium to coarse; contains medium to coarse sand	10	83.5
Gravel, medium to coarse, interbedded with gray sandy clay	1	84.5
Gravel, medium to very coarse; contains coarse sand	2.5	87
Sand, fine to very coarse	8	95
Clay, firm, brown	1	96
27. **Test hole 27.** NE¼NE¼ sec. 29, T. 40 N., R. 7 E. Rio Grande County. Surface altitude, 7,704.9 feet.		
Gravel, very coarse, to medium sand; contains small cobbles	20	20
Gravel, very fine to small cobbles; contains very fine sand	11	31
Gravel, very fine to small cobbles; contains very fine to coarse sand	20	51
Clay, firm, grayish-brown	1	52
28. **Test hole 28.** SE¼SE¼ sec. 21, T. 40 N., R. 8 E. Rio Grande County. Surface altitude, 7,638.6 feet.		
Gravel, very coarse, to medium sand	23.5	23.5
Clay, fine sandy, brown	.5	24.0
Gravel, very coarse, to fine sand	10.0	34.0
Gravel, very coarse, to medium sand	7.0	41.0
Clay, fine sandy, brown to gray	.5	41.5
Gravel, very coarse, to fine sand	9.5	51.0
Gravel, very coarse, to medium sand; contains a little brown clay	2.0	53.0
Gravel, very coarse, to medium sand	18.0	71.0
Gravel, medium, to medium sand	8.0	79.0
Clay, sticky, brown	1.0	80.0

	Thickness (feet)	*Depth (feet)*
29. Test hole 29. SW¼SW¼ sec. 24, T. 40 N., R. 8 E. Rio Grande County. Surface altitude, 7,619.8 feet.		
Gravel, coarse; contains fine to medium sand	5	5
Gravel, very fine to fine; contains medium sand	9	14
Gravel, medium to small cobbles; contains medium sand	6	20
Gravel, coarse to small cobbles; contains medium to very coarse sand	8	28
Gravel, medium to coarse; contains medium sand	8	36
Sand, fine to medium; contains a little medium to very coarse gravel	3	39
Gravel, fine to medium; contains fine to coarse sand	21	60
Gravel, medium to coarse; contains medium to coarse sand	12	72
Clay, compact, brown	2	74
Sand, fine to very coarse; contains a little medium gravel	2	76
30. Test hole 30. NW¼NW¼ sec. 30, T. 40 N., R. 8 E. Rio Grande County. Surface altitude, 7,678.1 feet.		
Gravel, very coarse, to medium sand	5	5
Gravel, very coarse, to medium sand; contains some small cobbles	35	40
Sand, medium, to very coarse gravel; contains small cobbles	10	50
Gravel, very fine to medium; contains some fine to very coarse sand	15	65
Sand, fine to very coarse; contains some very fine to medium gravel	6	71
Sand, very fine to fine	13	84
Clay, sandy, micaceous, brown	1	85
31. Test hole 31. SW¼SW¼ sec. 20, T. 40 N., R. 9 E. Alamosa County. Surface altitude, 7,604.2 feet.		
Gravel, coarse, to medium sand	5	5
Gravel, coarse, to coarse sand	20	25
Gravel, coarse, to medium sand	5	30
Gravel, coarse	15	45
Sand, fine, to fine gravel	12	57
Clay, hard, brittle, brown	3	60
Sand, fine to medium	1	61
32. Test hole 32. SE¼SE¼ sec. 21, T. 40 N., R. 9 E. Alamosa County. Surface altitude, 7,589.7 feet.		
Gravel, coarse, brown, to medium brown sand	15	15
Gravel, coarse, brown, to very fine brown sand	11	26
Sand, fine, brown, to coarse brown gravel	4	30
Gravel, coarse, brown, to medium brown sand	1	31
Sand, very fine, brown, to coarse brown gravel	10	41
Gravel, coarse, brown, to very fine brown sand	4	45
Gravel, coarse, brown, to fine brown sand	7	52
Clay, soft, sandy, brown	3	55
Gravel, fine to coarse, brown; contains a little fine to medium brown sand	6	61
33. Test hole 33. SW¼SW¼ sec. 24, T. 40 N., R. 9 E. Alamosa County. Surface altitude, 7,575.2 feet.		
Sand, fine to medium, brown	5	5
Gravel, coarse, brown, to fine brown sand	11	16
Gravel, coarse, brown; contains medium brown sand	37	53
Clay, hard, brown	3	56
Gravel, coarse, brown; contains medium to coarse brown sand	5	61
34. Test well 34. SE¼SE¼ sec. 25, T. 40 N., R. 9 E. Alamosa County. Surface altitude, 7,571.5 feet.		
Sand, very fine to medium, brown; contains fine brown gravel	7.5	7.5
Gravel, coarse, brown, to fine brown sand	10	17.5
Gravel, coarse, brown, to very fine brown sand	10	27.5
Sand, very fine to coarse, brown	17.5	45
Gravel, medium to coarse, brown; contains coarse brown sand	10	55
Clay, brown	2	57
Sand, fine, brown, to coarse brown gravel	2	59
Clay, blocky, hard, blue	1	60

35. **Test well 35.** SW¼SW¼ sec. 2, T. 40 N., R. 10 E. Alamosa County. Surface altitude, 7,545.0 feet.

	Thickness (feet)	*Depth (feet)*
Sand, fine to very coarse, brown	8	8
Sand, fine to very coarse, tan to brown; contains very fine to coarse tan to brown gravel	24	32
Sand, medium to very coarse, brown; contains very fine to coarse brown gravel	20	52
Clay, sandy, blue-gray	3	55
Sand, very fine to very coarse, dark-blue; contains very fine to medium brown gravel	6	61
Sand, very fine to very coarse, brown; contains very fine to fine brown gravel	6	67
Clay, soft, sandy, gray to greenish-gray	1	68
Sand, very fine to coarse, brown, and brown silt; contains stringers of gray-brown clay	3	71
Gravel, very fine to coarse, brown	8	79
Sand, fine to very coarse, greenish-blue; contains very fine greenish-blue gravel	4	83
Gravel, fine to coarse, greenish-blue, and fine greenish-blue sand; contains stringers of clay	8	91
Sand, very fine to medium, greenish-blue	14	105
Gravel, very fine to coarse, dark-greenish-blue to black; contains fine to medium dark-greenish-blue to black sand	16	121
Clay, silty, gray and bluish-gray; contains lenses of fine black sand	8	129
Clay, sandy, light-gray	4	133
Clay, silty, greenish-gray to bluish-gray	5	138
Clay, sandy, green	4	142
Clay, bluish-gray	11	153
Sand, fine, brown; contains stringers of green sandy clay and snail shells	5	158
Clay, greenish-blue	6	164
Clay, dark-gray; contains lenses of green sandy clay	12	176
Sand, fine, brown and black; contains stringers of gray and green clay	9	185
Clay, gray; contains thin lenses of fine black sand	9	194
Sand, fine, black; contains stringers of blue and greenish-blue clay	17	211

36. **Test well 36.** SW¼SW¼ sec. 5, T. 40 N., R. 10 E. Alamosa County. Surface altitude, 7,566.1 feet.

Sand, fine to coarse, brown; contains stringers of brown clay	5.0	5.0
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	5.7	10.7
Clay, compact, brown	1.0	11.7
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	18.3	30.0
Gravel, fine to very coarse, brown; contains very fine to coarse brown sand	18.5	48.5
Clay, soft, brown	.5	49.0
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	23.5	72.5
Clay, compact, yellowish-brown	1.0	73.5
Sand, very fine to coarse, brown; contains stringers of yellow clay	7.5	81.0
Sand, very fine to coarse, black	3.5	84.5
Clay, compact, gray	1.0	85.5
Sand, very fine, black	3.1	88.6
Clay, compact, dark-gray; contains lenses of fine black sand	8.0	96.6
Sand, very fine to medium, black	9.0	105.6
Clay, compact, green	6.4	112.0

37. **Test well 37.** SW¼NW¼ sec. 20, T. 40 N., R. 10 E. Alamosa County. Surface altitude, 7,562.7 feet.

Sand, fine to very coarse, brown	9.8	9.8
Clay, compact, brown	.2	10.0
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	7.0	17.0
Sand, fine to very coarse, brown and black; contains very fine to coarse brown and black gravel	27.0	44.0
Clay, soft, brown	.8	44.8
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	4.2	49.0
Clay, compact, brown	1.5	50.5
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	4.3	54.8
Clay, compact, brown	.4	55.2

	Thickness (feet)	Depth (feet)
Sand, fine to coarse, brown	5.1	60.3
Clay, compact, brown	.4	60.7
Sand, fine to coarse, brown	4.3	65.0
Clay, compact, green	5.5	70.5

38. **Test well 38.** SE¼NE¼ sec. 21, T. 40 N., R. 10 E. Alamosa County. Surface altitude, 7,552.1 feet.

	Thickness (feet)	Depth (feet)
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	5.0	5.0
Gravel, very fine to coarse, brown; contains fine to very coarse brown sand	32.2	37.2
Clay, soft, brown	.4	37.6
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel and stringers of brown clay	16.8	54.4
Clay, compact, brown to yellowish-brown	4.1	58.5
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	8.4	66.9
Clay, compact, brown	.5	67.4
Sand, very fine to medium, black; contains stringers of dark-gray clay	7.8	75.2
Clay, compact, green	5.8	81.0
Sand, very fine to medium, black	2.0	83.0
Clay, compact, green	1.1	84.1

39. **Test well 39.** NE¼SE¼ sec. 1, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,553.1 feet.

	Thickness (feet)	Depth (feet)
Sand, medium to very coarse, brown	10.0	10.0
Sand, fine to coarse, brown	10.0	20.0
Sand, very fine to coarse, brown; contains medium to coarse brown gravel	32.0	52.0
Clay, soft, sandy, brown	2.5	54.5
Sand, very fine to coarse, brown; contains medium to coarse brown gravel	9.4	63.9
Sand, very fine to fine, brown	14.8	78.4
Clay, compact, brown	2.0	80.7
Sand, fine to very coarse, brown	19.3	100.0
Clay, compact, grayish-brown	2.0	102.0
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	1.4	103.4

40. **Test well 40.** SW¼SW¼ sec. 6, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,535.2 feet.

	Thickness (feet)	Depth (feet)
Sand, very fine to coarse, brown	.8	.8
Sand, fine to very coarse, brown; contains stringers of brown clay	8.7	9.5
Sand, fine to very coarse, brown; contains very fine to medium brown gravel	15.5	25.0
Sand, medium to very coarse, brown and black; contains very fine to medium brown and black gravel	7.0	32.0
Sand, very coarse, black and brown; contains very fine to medium black and brown gravel	17.6	49.6
Sand, very coarse, brown; contains very fine to very coarse brown gravel	12.3	61.9
Clay, soft, greenish-gray	.6	62.5
Sand, medium to very coarse, brown and bluish-black; contains very fine to medium brown and bluish-black gravel	.9	63.4
Clay, compact, greenish-gray	1.0	64.4
Sand, medium to coarse, black; contains medium to coarse brown gravel	3.6	68.0
Clay, compact, greenish-gray	1.0	69.0
Sand, medium to coarse, black; contains medium to coarse brown gravel	4.0	73.0
Clay, compact, bluish-gray	5.0	78.0
Gravel, medium to coarse, brown; contains fine black sand	4.0	82.0
Sand, fine to coarse, black; contains medium to coarse brown gravel	19.0	101.0
Clay, soft, green to greenish-gray	2.0	103.0
Sand, coarse, brown and black; contains medium to coarse brown and black gravel	2.0	105.0
Clay, soft, green	1.0	106.0
Gravel, medium to coarse, brown and black	2.0	108.0
Sand, fine to coarse, black and bluish-black	48.0	156.0
Clay, soft to compact, gray	7.0	163.0
Sand, very fine to coarse, black	3.0	166.0
Clay, compact, gray	12.0	178.0
Sand, fine to coarse, brown and black	1.5	179.5

	Thickness (feet)	*Depth (feet)*
41. Test well 41. NW¼NW¼ sec. 9, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,533.7 feet.		
Sand, very fine to medium, brown; contains stringers of brown clay	5.0	5.0
Sand, fine to very coarse, bluish-black; contains very fine bluish-black gravel	5.0	10.0
Sand, fine to very coarse, bluish-black; contains very fine to coarse bluish-black gravel	22.0	32.0
Sand, medium to very coarse, bluish-black; contains very fine to coarse bluish-black gravel	11.0	43.0
Sand, medium to very coarse, bluish-black; contains very fine to coarse bluish-black gravel	3.0	46.0
Sand, fine to very coarse, black; contains very fine black gravel	7.0	53.0
Sand, fine to very coarse, black; contains very fine to coarse black gravel	16.0	69.0
Clay, compact, gray	1.5	70.5
Sand, medium to coarse, black	5.5	76.0
Clay, compact, gray	3.0	79.0
Sand, medium to very coarse, black; contains very fine to coarse black gravel	2.0	81.0
Clay, compact, greenish-gray	6.0	87.0
Sand, fine to very coarse, brown and black; contains very fine to coarse brown and black gravel	29.0	116.0
Sand, very fine to coarse, brown and black	12.1	128.1
Clay, compact, greenish-gray	7.9	136.0
Sand, very fine to medium, brown and black	11.0	147.0
Clay, compact, greenish-gray	3.0	150.0
Sand, very fine, black	13.0	163.0
Clay, compact, greenish-gray	12.0	175.0
Sand, very fine to medium, black	3.0	178.0
Clay, compact, greenish-gray	15.6	193.6
Sand, very fine to medium, black	.6	194.2
42. Test well 42. NE¼NE¼ sec. 10, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,533.3 feet.		
Sand, very fine to medium, brown	20	20
Sand, very fine to medium, brown and black	18.0	33.0
Sand, fine to coarse, black	14.0	52.0
Sand, medium to very coarse, black	7.0	59.0
Sand, fine to medium, black	2.0	61.0
Sand, coarse to very coarse, black	9.0	70.0
Clay, soft, brown	1.0	71.0
Sand, fine to coarse, black; contains medium black gravel	1.0	72.0
Clay, compact, greenish-gray	3.1	75.1
Sand, fine to very coarse, black	14.9	90.0
Clay, compact, greenish-gray	1.8	91.8
Sand, very fine to coarse, black	32.4	124.2
Clay, soft, olive-green to greenish-gray	4.3	128.5
Sand, very fine to medium, black	16.5	145.0
Sand, medium to very coarse, black	28.7	173.7
Clay, compact, gray	2.0	175.7
Sand, fine to coarse, black	1.3	177.0
Clay, compact, green	3.1	180.1
Sand, fine to coarse, black	10.3	190.4
Clay, soft, green	.9	191.3
Sand, very fine to medium, black; contains fine black gravel	5.1	196.4
Clay, compact, gray	4.0	200.4
Sand, fine to medium, black	1.3	201.7
43. Test well 43. SW¼SE¼ sec. 15, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,528.7 feet.		
Sand, fine to coarse, brown	5.0	5.0
Sand, very fine to medium, black	21.0	26.0
Sand, fine to very coarse, black	17.0	43.0
Sand, fine to very coarse, black; contains very fine to medium black gravel	14.0	57.0
Clay, compact, gray	.5	57.5

	Thickness (feet)	Depth (feet)
Sand, fine to very coarse, black; contains very fine to coarse black gravel	7.4	64.9
Clay, compact, gray	2.0	66.9
Sand, coarse, black; contains coarse black gravel	14.6	81.5
Clay, compact, dark-gray	3.0	84.5
Sand, fine to coarse, black; contains coarse black gravel	21.1	105.6
Clay, compact, green to greenish-gray	7.0	112.6
Sand, medium to coarse, black	1.4	114.0
Clay, compact, light-gray to greenish-gray	9.0	123.0
Sand, fine to medium, black; contains coarse black gravel	.5	123.5

44. **Test well 44.** SW¼NW¼ sec. 19, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,537.8 feet.

	Thickness (feet)	Depth (feet)
Sand, very fine to very coarse, and very fine to coarse brown gravel; contains stringers of brown clay	33.2	33.2
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	12.9	46.1
Clay, compact, dark-gray	3.1	49.2
Gravel, fine to coarse, brown	2.0	51.2
Clay, compact, greenish-gray	3.2	54.4
Gravel, coarse, brown; contains fine brown sand	2.2	56.6
Clay, compact, gray	2.0	58.6
Gravel, fine to coarse, brown	3.9	62.5
Clay, compact, greenish-gray	5.2	67.7
Sand, fine to very coarse, black; contains very fine to coarse black gravel	8.0	75.7
Clay, compact, bright-green	5.0	80.7
Sand, very fine to medium, greenish-black to black	5.2	85.9

45. **Test well 45.** SE¼SE¼ sec. 22, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,525.9 feet.

	Thickness (feet)	Depth (feet)
Sand, fine, brown; contains stringers of brown clay	3.5	3.5
Sand, cemented hard, ferruginous, reddish-brown	3.5	7.0
Sand, very fine to very coarse, black; contains very fine to medium black gravel	16.0	23.0
Gravel, fine to very coarse, black; contains very fine to coarse black sand	27.6	50.6
Clay, soft to compact, dark-gray	3.2	53.8
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	4.6	58.4
Clay, compact, green	2.0	60.4
Sand, very fine to coarse, black; contains coarse black gravel	31.3	91.7
Clay, compact, green	1.0	92.7
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	3.5	96.2
Clay, compact, greenish-gray	4.1	100.3

46. **Test well 46.** SW¼SW¼ sec. 32, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,532.53 feet.

	Thickness (feet)	Depth (feet)
Sand, fine to very coarse, brown; contains very fine to coarse brown gravel	7.0	7.0
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	10.0	17.0
Clay, soft, brown; contains stringers of medium brown sand	1.0	18.0
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	21.0	39.0
Clay, compact, bluish-gray	.5	39.5
Sand, coarse, to very coarse, brown; contains very fine to coarse brown gravel	3.3	42.8
Sand, very fine to coarse, black; contains coarse black gravel	8.2	51.0
Clay, compact, bluish-gray	2.3	53.3
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	4.7	58.0
Clay, compact, greenish-gray	3.0	61.0
Sand, very fine to medium, black	4.0	65.0
Clay, compact, greenish-gray	2.0	67.0
Sand, fine to medium, black	3.0	70.0
Clay, compact, greenish-gray	2.0	72.0
Sand, very fine, black	11.0	83.0
Clay, compact, greenish-gray	3.9	86.9
Sand, very fine to medium, black	5.4	92.3
Clay, soft to compact, gray to greenish-gray; contains lenses of very fine black sand	7.7	100.0

47. **Test well 47.** SE¼SE¼ sec. 35, T. 40 N., R. 11 E. Alamosa County. Surface altitude, 7,523.3 feet.

	Thickness (feet)	*Depth (feet)*
Sand, fine to very coarse, brown	6.0	6.0
Sand, very fine to fine, black	4.0	10.0
Sand, fine to very coarse, black	16.0	26.0
Sand, fine to very coarse, black; contains very fine to coarse black gravel	22.2	48.2
Clay, soft, gray	.5	48.7
Sand, fine to very coarse, black; contains very fine to coarse black gravel	.9	49.6
Clay, compact, greenish-gray	1.3	50.9
Sand, fine to very coarse, black; contains very fine to coarse black gravel	13.1	64.0
Clay, compact, bluish-gray	3.0	67.0
Sand, medium to coarse, black; contains coarse black gravel	9.0	76.0
Clay, compact, brownish-gray	.5	76.5
Sand, medium to coarse, black; contains coarse black gravel	2.5	79.0
Clay, compact, greenish-gray	7.4	86.4
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	9.1	95.5

48. **Test well 48.** SW¼SW¼ sec. 32, T. 40 N., R. 12 E. Alamosa County. Surface altitude, 7,532.9 feet.

	Thickness (feet)	*Depth (feet)*
Sand, very fine to medium, brown	5.0	5.0
Sand, fine to coarse, black	5.0	10.0
Sand, fine to coarse, brown and black	11.6	21.6
Sand, fine to coarse, brown; contains lenses of fine black sand	24.9	46.5
Clay, compact, gray	2.0	48.5
Sand, very fine to medium, black	5.5	54.0
Clay, compact, green to greenish-gray	7.0	61.0
Sand, very fine to medium, black	2.3	63.3

49. **Test well 49.** NE¼NE¼ sec. 1, T. 41 N., R. 9 E. Saguache County. Surface altitude, 7,548.7 feet.

	Thickness (feet)	*Depth (feet)*
Sand, very fine, brown, to medium brown gravel interbedded with thin layers of brown sandy clay	18	18
Sand, very fine to coarse, brown	9	27
Sand, very fine, to coarse brown gravel	10	37
Sand, very fine to medium, brown; contains a little fine brown gravel	8	45
Sand, fine, to medium brown gravel	6	51
Gravel, coarse, to fine brown sand	11	62
Clay, compact, brown	2	64
Gravel, coarse, to fine brown sand	3	67

50. **Test well 50.** SW¼SW¼ sec. 7, T. 41 N., R. 10 E. Saguache County. Surface altitude, 7,553.6 feet.

	Thickness (feet)	*Depth (feet)*
Sand, fine to coarse; contains a little coarse gravel	3	3
Sand, very fine, to coarse brown gravel	14	17
Sand, very fine to medium, brown	10	27
Sand, very fine, to medium brown gravel	5	32
Gravel, very fine to coarse; contains some fine to medium sand	10	42
Sand, fine to coarse, brown; contains a little fine to medium brown gravel	5	47
Sand, very fine, to very fine brown gravel	7	54
Clay, sandy, soft, brown	2	56
Gravel, coarse, to very fine sand	6	62

51. **Test well 51.** SW¼NW¼ sec. 26, T. 41 N., R. 10 E. Saguache County. Surface altitude, 7,540.2 feet.

	Thickness (feet)	*Depth (feet)*
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	10.0	10.0
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	29.7	39.7
Sand, fine to very coarse, brown and black; contains very fine to coarse brown and black gravel	8.0	47.7
Clay, soft, dark-green	.6	48.3
Sand, fine to very coarse, black; contains very fine to coarse black gravel	12.5	60.8
Clay, soft, dark-gray	.1	60.9
Sand, very fine to coarse, black; contains coarse brown gravel	2.1	63.0

	Thickness (feet)	Depth (feet)
Clay, compact, dark-gray	4.8	67.8
Sand, very fine, black	4.0	71.8
Clay, compact, dark-gray; contains lenses of fine black sand	3.1	74.9
Sand, very fine to very coarse, black; contains very fine to coarse black gravel	20.2	95.1
Clay, compact, green	.7	95.8

52. **Test well 52.** NW¼NW¼ sec. 29, T. 41 N., R. 10 E. Saguache County. Surface altitude, 7,550.4 feet.

Sand, very fine to very coarse, brown	5.0	5.0
Sand, very fine to coarse, brown; contains fine to coarse brown gravel	22.0	27.0
Clay, compact, brown	.3	27.3
Gravel, very fine to coarse, brown; contains fine to very coarse brown sand	23.3	50.6
Clay, soft, brownish-gray	.3	50.9
Gravel, very fine to coarse, brown; contains fine to very coarse brown sand	15.4	66.3
Clay, compact, brown	3.0	69.3
Sand, very fine to very coarse, brown; contains very fine to coarse brown gravel	19.7	89.0
Clay, compact, brown; contains stringers of fine to coarse brown sand	7.8	96.8

Sample logs of wells that were sunk by the U. S. Bureau of Reclamation in Recent deposits

53. **Well 37–9–17aa.** Alamosa County. Jetted. Surface altitude, 7,572.6 feet.

Sand and gravel, fine	8	8
Clay, hard, brown	.2	8.2

54. **Well 37–9–22dd.** Alamosa County. Jetted. Surface altitude, 7,560.7 feet.

Sand, fine	3.8	3.8
Clay, sandy, yellow	5.3	9.1

55. **Well 37–9–32dd.** Alamosa County. Jetted. Surface altitude, 7,586.2 feet.

Sand, fine	1	1
Gravel, coarse; contains fine sand	7.5	8.5
Clay	.8	9.3

56. **Well 37–10–5db.** Alamosa County. Jetted. Surface altitude, 7,548.8 feet.

Sand, fine, clayey	8.3	8.3

57. **Well 37–10–8dd.** Alamosa County. Jetted. Surface altitude, 7,540.8 feet.

Sand, fine, clayey	10.2	10.2

58. **Well 37–10–14ca.** Alamosa County. Jetted. Surface altitude, 7,532.7 feet.

Sand, fine	9.5	9.5

59. **Well 37–10–19cc.** Alamosa County. Jetted. Surface altitude, 7,549.5 feet.

Clay, firm, brown	4	4
Sand, fine	4.7	8.7

60. **Well 37–11–3dd.** Alamosa County. Jetted. Surface altitude, 7,522.0 feet.

Clay, firm, hard, brown	4.5	4.5
Sand, fine, brown	4.7	9.2

61. **Well 37–12–6bb.** Alamosa County. Jetted. Surface altitude, 7,542.8 feet.

Sand, fine to very coarse, red	6.3	6.3

62. **Well 38–8–5da.** Rio Grande County. Jetted. Surface altitude, 7,639.4 feet.

Sand, fine	4	4
Gravel, coarse	4.1	8.1

63. **Well 38–8–17dd.** Rio Grande County. Jetted. Surface altitude, 7,627.4 feet.

Clay, hard, brown	6	6
Sand, fine, clayey	4.3	10.3

64. **Well 38–8–25dd.** Rio Grande County. Jetted. Surface altitude, 7,591.8 feet.

Clay	3	3
Sand and gravel, coarse	6.7	9.7

	Thickness (feet)	*Depth (feet)*
65. Well 38-9-28aa. Alamosa County. Jetted. Surface altitude, 7,578.6 feet.		
Clay, hard, brown	2.5	2.5
Sand, fine, gray	4.7	7.2
66. Well 38-10-9cc. Alamosa County. Jetted.		
Clay, firm, brown	4	4
Sand and gravel, fine to medium, brown	4.2	8.2
67. Well 38-10-35cc. Alamosa County. Jetted. Surface altitude, 7,540.0 feet.		
Clay, loam, black	5	5
Sand, fine, gray	4.2	9.2
68. Well 38-11-1cc. Alamosa County. Bored. Surface altitude, 7,518.1 feet.		
Clay, sandy	8.5	8.5
Sand, fine to coarse	2	10.5
69. Well 38-11-1dd. Alamosa County. Surface altitude, 7,515.4 feet.		
Clay, sandy	8	8
Sand, coarse	2	10
70. Well 38-11-2cc. Alamosa County. Bored. Surface altitude, 7,522.1 feet.		
Clay, sandy	10.5	10.5
Sand, coarse	2	12.5
71. Well 38-11-4aa. Alamosa County. Bored. Surface altitude, 7,524.5 feet.		
Sand, fine to medium	2	2
Sand, fine, clayey	6	8
Sand, fine to coarse	4.6	12.6
72. Well 38-11-10dd. Alamosa County. Bored. Surface altitude, 7,523.6 feet.		
Clay, sandy	9	9
Sand, coarse	1.3	10.3
73. Well 38-11-12dd. Alamosa County. Bored. Surface altitude, 7,523.3 feet.		
Clay, sandy	12	12
Sand, coarse	4.2	16.2
74. Well 38-11-14cc. Alamosa County. Bored. Surface altitude, 7,524.7 feet.		
Clay, sandy	8	8
Sand, coarse	3.8	11.8
75. Well 38-11-26bb. Alamosa County. Bored. Surface altitude, 7,521.8 feet.		
Clay, gray	5.5	5.5
Sand, coarse	3.1	8.6
76. Well 38-11-31cc. Alamosa County. Jetted. Surface altitude, 7,533.0 feet.		
Sand, fine, brown	10	10
77. Well 38-11-33cc. Alamosa County. Jetted. Surface altitude, 7,525.0 feet.		
Sand, fine	7.3	7.3
78. Well 38-11-35bb. Alamosa County. Bored. Surface altitude, 7,521.4 feet.		
Clay, sandy	8	8
Sand, coarse, red	3	11
79. Well 39-7-25da. Rio Grande County. Jetted.		
Clay	3	3
Gravel, coarse; contains fine black sand	4.2	7.2
80. Well 39-9-1dd. Alamosa County. Jetted. Surface altitude, 7,572.9 feet.		
Sand, fine	2.1	2.1
Sand and gravel, coarse	7.3	9.4
81. Well 39-9-2aa. Alamosa County. Jetted. Surface altitude, 7,578.7 feet.		
Soil, sandy	1.3	1.3
Sand and gravel, coarse	8	9.3

	Thickness (feet)	Depth (feet)
82. Well 39-9-3bb. Alamosa County. Jetted. Surface altitude, 7,589.5 feet.		
Clay, sandy	1.7	1.7
Sand and gravel	7.9	9.6
83. Well 39-9-3dd. Alamosa County. Jetted. Surface altitude, 7,583.4 feet.		
Soil, sandy	2.8	2.8
Sand and gravel, coarse	7.1	9.9
84. Well 39-9-4dd. Alamosa County. Jetted. Surface altitude, 7,590.2 feet.		
Soil, sandy	2.8	2.8
Sand and gravel, coarse	6.9	9.7
85. Well 39-9-10cc. Alamosa County. Jetted. Surface altitude, 7,588.4 feet.		
Clay, hard, brown	1.9	1.9
Sand and gravel, fine	7.9	9.8
86. Well 39-9-10dd. Alamosa County. Jetted. Surface altitude, 7,580.9 feet.		
Clay, hard, brown	3	3
Sand and gravel, fine	6.9	9.9
87. Well 39-9-11dd. Alamosa County. Jetted. Surface altitude, 7,574.7 feet.		
Clay, sandy	3	3
Sand and gravel, fine	6	9
88. Well 39-9-12dd. Alamosa County. Jetted. Surface altitude, 7,568.6 feet.		
Clay, hard, brown	2.5	2.5
Sand and gravel, fine	7.4	9.9
89. Well 39-9-20aa. Alamosa County. Jetted. Surface altitude, 7,593.4 feet.		
Clay, hard, brown	1.9	1.9
Sand and gravel, fine	8	9.9
90. Well 39-9-20bb. Alamosa County. Jetted. Surface altitude, 7,600.1 feet.		
Clay, sandy	1.9	1.9
Sand and gravel, fine	7.7	9.6
91. Well 39-9-21cc. Alamosa County. Jetted. Surface altitude, 7,594.4 feet.		
Clay, sandy	8	8
Sand and gravel, coarse	1.9	9.9
92. Well 39-9-22cc. Alamosa County. Jetted. Surface altitude, 7,587.5 feet.		
Clay, sandy	2.5	2.5
Sand, fine	2	4.5
Clay	.5	5
Sand and gravel, coarse	4.9	9.9
93. Well 39-9-23cc. Alamosa County. Jetted. Surface altitude, 7,580.0 feet.		
Clay, sandy	4.5	4.5
Sand and gravel, fine	5.4	9.9
94. Well 39-9-24cc. Alamosa County. Jetted. Surface altitude, 7,571.7 feet.		
Clay, sandy	3.5	3.5
Sand and gravel, coarse	6.4	9.9
95. Well 39-9-24dd. Alamosa County. Jetted. Surface altitude, 7,567.1 feet.		
Clay, sandy	4.8	4.8
Sand and gravel, coarse	4.2	9
96. Well 39-10-32dd. Alamosa County. Jetted. Surface altitude, 7,551.1 feet.		
Clay, brown	2	2
Sand, fine to coarse, brown; contains fine to coarse brown gravel	6.7	8.7
97. Well 39-10-36aa. Alamosa County. Jetted. Surface altitude, 7,536.8 feet.		
Sand, fine to medium	1	1
Clay, brown	.5	1.5
Sand, fine to coarse; contains fine to very coarse gravel	8.5	10

	Thickness (feet)	Depth (feet)
98. **Well 39-11-1dd.** Alamosa County. Jetted. Surface altitude, 7,522.6 feet.		
Clay, sandy, brown	4	4
Clay, gray	2	6
Sand, coarse, gray and black; contains medium gray and black gravel	3.8	9.8
99. **Well 39-11-4cc.** Alamosa County. Jetted. Surface altitude, 7,526.3 feet.		
Sand, medium; contains fine to coarse gravel	10	10
100. **Well 39-11-9aa.** Alamosa County. Jetted. Surface altitude, 7,521.9 feet.		
Sand, medium, to coarse gravel; contains some clay	9.5	9.5
101. **Well 39-11-9dd.** Alamosa County. Jetted. Surface altitude, 7,521.9 feet.		
Sand, medium, to medium gravel	9.4	9.4
102. **Well 39-11-10aa.** Alamosa County. Jetted. Surface altitude, 7,522.6 feet.		
Clay, sandy	8	8
Clay, gray	2	10
Sand, coarse, gray and black, to medium gray and black gravel	1.5	11.5
103. **Well 39-11-11bd.** Alamosa County. Jetted. Surface altitude, 7,521.7 feet.		
Clay, soft; contains lenses of medium sand	10.4	10.4
104. **Well 39-11-12cc.** Alamosa County. Jetted. Surface altitude, 7,522.2 feet.		
Sand, very fine	2	2
Sand, fine	5.8	7.8
105. **Well 39-11-13cc.** Alamosa County. Bored. Surface altitude, 7,519.5 feet.		
Clay, sandy	3	3
Sand, fine	7	10
106. **Well 39-11-14cc.** Alamosa County. Bored. Surface altitude, 7,519.8 feet.		
Clay, sandy	1	1
Sand, fine, clayey	7	8
107. **Well 39-11-15aa.** Alamosa County. Jetted. Surface altitude, 7,521.7 feet.		
Clay, brown	6	6
Sand, fine to coarse	3.9	9.9
108. **Well 39-11-15cc.** Alamosa County. Jetted. Surface altitude, 7,521.9 feet.		
Sand, fine to medium, brown to black	10	10
109. **Well 39-11-21cc.** Alamosa County. Jetted. Surface altitude, 7,527.2 feet.		
Sand, fine to coarse; contains fine to very coarse gravel	10	10
110. **Well 39-11-25cc.** Alamosa County. Bored. Surface altitude, 7,515.9 feet.		
Silt to sand, very fine	5	5
Sand, fine	4.4	9.4
111. **Well 39-11-32ba.** Alamosa County. Jetted. Surface altitude, 7,529.7 feet.		
Clay, firm, brown	5.6	5.6
Sand, fine to medium, brown	4.4	10
Clay, firm, brown	.2	10.2
112. **Well 39-11-32bb.** Alamosa County. Jetted. Surface altitude, 7,531.5 feet.		
Clay, firm; contains layers of fine to medium sand	13	13
Sand, fine to medium, brown	4	17
113. **Well 39-12-2bb.** Alamosa County. Bored. Surface altitude, 7,608.1 feet.		
Sand, black and brown	3.2	3.2
Sand, medium, black	1	4.2
114. **Well 39-12-6dd.** Alamosa County. Jetted. Surface altitude, 7,526.7 feet.		
Sand and clay	1.5	1.5
Sand, coarse, gray and black	8	9.5

	Thickness (feet)	*Depth (feet)*
115. **Well 39-12-18bb.** Alamosa County. Jetted. Surface altitude, 7,523.0 feet.		
Sand and clay	2.5	2.5
Sand, coarse, brown to black; contains fine brown to black gravel	7	9.5
116. **Well 39-12-19ad.** Alamosa County. Jetted. Surface altitude, 7,523.2 feet.		
Sand and clay, gray	3	3
Sand, fine to medium	6.5	9.5
117. **Well 39-12-19bb.** Alamosa County. Jetted. Surface altitude, 7,518.1 feet.		
Sand, medium to coarse, brown and black	8.7	8.7
118. **Well 39-12-29bd.** Alamosa County. Bored. Surface altitude, 7,524.2 feet.		
Sand, coarse, clayey	8.8	8.8
119. **Well 39-12-31cc.** Alamosa County. Bored. Surface altitude, 7,516.9 feet.		
Clay, sandy	4	4
Sand, coarse	9.3	13.3
120. **Well 39-12-32ca.** Alamosa County. Bored. Surface altitude, 7,520.6 feet.		
Sand, fine	9.3	9.3
121. **Well 40-8-1dd.** Rio Grande County. Jetted. Surface altitude, 7,606.5 feet.		
Soil	2.5	2.5
Sand and gravel, coarse	6.9	9.4
122. **Well 40-9-1aa.** Alamosa County. Jetted. Surface altitude, 7,571.4 feet.		
Sand and gravel, coarse	16.6	16.6
123. **Well 40-9-6dd.** Alamosa County. Jetted. Surface altitude, 7,598.9 feet.		
Soil, sandy	2.8	2.8
Sand and gravel, coarse	7.1	9.9
124. **Well 40-9-10aa.** Alamosa County. Jetted. Surface altitude, 7,582.3 feet.		
Clay, sandy	7.5	7.5
Sand and gravel, coarse	2.4	9.9
125. **Well 40-9-10cc.** Alamosa County. Jetted. Surface altitude, 7,591.6 feet.		
Soil, sandy, fine	8	8
Sand and gravel, coarse	1.6	9.6
126. **Well 40-9-11cc.** Alamosa County. Jetted. Surface altitude, 7,584.8 feet.		
Soil, sandy	4	4
Clay, sandy, brown	4.9	8.9
127. **Well 40-9-11dd.** Alamosa County. Jetted. Surface altitude, 7,577.9 feet.		
Soil, sandy	7	7
Clay	.5	7.5
Sand and gravel	.5	8
128. **Well 40-9-12dd.** Alamosa County. Jetted. Surface altitude, 7,567.9 feet.		
Sand, very fine to medium, brown	5	5
Clay, firm, brown	.5	5.5
Sand, fine to coarse, brown	4.5	10
129. **Well 40-9-14dd.** Alamosa County. Jetted. Surface altitude, 7,573.9 feet.		
Clay, hard, brown	3	3
Sand and gravel, coarse	6.8	9.8
130. **Well 40-6-16dd.** Alamosa County. Jetted. Surface altitude, 7,587.7 feet.		
Clay, hard, brown	4.8	4.8
Sand and gravel, coarse	4.3	9.1
131. **Well 40-9-17dd.** Alamosa County. Jetted. Surface altitude, 7,595.4 feet.		
Soil, sandy	2.8	2.8
Sand and gravel, coarse	6.5	9.3

	Thickness (feet)	*Depth (feet)*
132. **Well 40-9-19cc.** Alamosa County. Jetted. Surface altitude, 7,612.4 feet.		
Sand and gravel, fine	9.6	9.6
133. **Well 40-9-19dd.** Alamosa County. Jetted. Surface altitude, 7,604.4 feet.		
Soil, sandy	2.5	2.5
Sand and gravel, coarse	7.4	9.9
134. **Well 40-9-20dd.** Alamosa County. Jetted. Surface altitude, 7,597.2 feet.		
Soil, sandy	4.5	4.5
Sand and gravel, coarse	5.1	9.6
135. **Well 40-9-21dd.** Alamosa County. Jetted. Surface altitude, 7,589.6 feet.		
Clay, firm, brown	2.5	2.5
Sand and gravel, coarse	7.4	9.9
136. **Well 40-9-25bb.** Alamosa County. Jetted. Surface altitude, 7,574.9 feet.		
Clay, hard, brown	2.3	2.3
Sand and gravel, coarse	7	9.3
137. **Well 40-9-25dd.** Alamosa County. Jetted. Surface altitude, 7,573.2 feet.		
Sand, fine	9	9
Sand and gravel, coarse	.9	9.9
138. **Well 40-9-26bb.** Alamosa County. Jetted. Surface altitude, 7,581.8 feet.		
Clay, hard, brown	2.4	2.4
Sand and gravel, coarse	6.8	9.2
139. **Well 40-9-26dd.** Alamosa County. Jetted. Surface altitude, 7,576.9 feet.		
Sand, fine	4.5	4.5
Sand and gravel, coarse	5.1	9.6
140. **Well 40-9-27cc.** Alamosa County. Jetted. Surface altitude, 7,589.3 feet.		
Clay, sandy, brown	7	7
Sand and gravel, coarse	2.8	9.8
141. **Well 40-9-27dd.** Alamosa County. Jetted. Surface altitude, 7,582.8 feet.		
Sand, fine	7.5	7.5
Sand and gravel, coarse	2	9.5
142. **Well 40-9-32bb.** Alamosa County. Jetted. Surface altitude, 7,604.3 feet.		
Clay, sandy	3.2	3.2
Sand and gravel, coarse	6.7	9.9
143. **Well 40-9-32cc.** Alamosa County. Jetted. Surface altitude, 7,604.1 feet.		
Sand, fine	2.2	2.2
Sand and gravel, coarse	6.7	8.9
144. **Well 40-9-32dd.** Alamosa County. Jetted. Surface altitude, 7,596.7 feet.		
Clay, sandy	2.8	2.8
Sand and gravel, coarse	7.1	9.9
145. **Well 40-9-35cc.** Alamosa County. Jetted. Surface altitude, 7,583.8 feet.		
Soil, sandy	1.7	1.7
Sand and gravel, coarse	7.6	9.3
146. **Well 40-10-1cd.** Alamosa County. Bored. Surface altitude, 7,536.4 feet.		
Soil, sandy	.5	.5
Clay	.5	1
Sand, fine	5.6	6.6
147. **Well 40-10-1dc.** Alamosa County. Bored. Surface altitude, 7,535.2 feet.		
Sand, fine, clayey	.7	.7
Sand, medium; contains fine gravel	5.3	6
148. **Well 40-10-1dd.** Alamosa County. Bored. Surface altitude, 7,534.6 feet.		
Soil, sandy	1	1

	Thickness (feet)	Depth (feet)
Clay	.7	1.7
Sand, fine	5.3	7
149. Well 40-10-3cc. Alamosa County. Bored. Surface altitude, 7,554.8 feet.		
Sand, very fine to fine, brown; contains some fine brown gravel	5	5
Sand, fine to medium; contains fine gravel	2.3	7.3
Sand, medium to coarse; contains fine gravel	1	8.3
150. Well 40-10-6aa. Alamosa County. Bored. Surface altitude, 7,562.9 feet.		
Sand, very fine to medium, brown; contains some coarse brown gravel	2	2
Sand, fine to coarse; contains fine to very coarse gravel	9.6	11.6
151. Well 40-10-9cc. Alamosa County. Jetted. Surface altitude, 7,560.1 feet.		
Sand, fine, brown; contains fine brown gravel	.5	.5
Sand, very fine, brown; contains some fine to medium brown gravel	2.5	3
Sand, fine to coarse, brown; contains fine to very coarse brown gravel	5	8
Clay, firm, brown	.5	8.5
Sand, fine to coarse, brown; contains fine to very coarse brown gravel	1.3	9.8
152. Well 40-10-11aa. Alamosa County. Bored. Surface altitude, 7,540.8 feet.		
Soil, sandy, coarse	3	3
Sand, coarse; contains fine gravel	1	4
Gravel, fine to medium	1.5	5.5
Sand, coarse; contains fine gravel	2.2	7.7
153. Well 40-10-13dd. Alamosa County. Bored. Surface altitude, 7,539.1 feet.		
Soil, sandy	.5	.5
Sand, coarse, to fine gravel	6.5	7
Gravel, fine to coarse	1	8
154. Well 40-10-14dd. Alamosa County. Bored. Surface altitude, 7,542.9 feet.		
Soil, sandy, brown	0.5	0.5
Sand, fine to coarse, brown; contains medium to coarse brown gravel	3.8	4.3
Sand, very fine to coarse, brown; contains medium to coarse brown gravel	.7	5
Sand, coarse, to coarse gravel	5	10
155. Well 40-10-16cc. Alamosa County. Jetted. Surface altitude, 7,556.7 feet.		
Sand, very fine to medium, brown; contains coarse brown gravel	2	2
Clay, firm, brown	.5	2.5
Sand, fine to coarse, brown; contains coarse brown gravel	7.6	10.1
156. Well 40-10-19aa. Alamosa County. Jetted. Surface altitude, 7,563.9 feet.		
Sand, fine to coarse, brown; contains fine to coarse brown gravel	10	10
157. Well 40-10-23dd. Alamosa County. Bored. Surface altitude, 7,542.9 feet.		
Sand, fine to medium	3.5	3.5
Sand, coarse; contains medium gravel	.5	4
Sand, coarse; contains very coarse gravel	1.1	5.1
158. Well 40-10-26dd. Alamosa County. Jetted. Surface altitude, 7,543.0 feet.		
Sand, very fine to medium, brown	1	1
Sand, fine to coarse, brown; contains fine to very coarse brown gravel	8.9	9.9
159. Well 40-10-30bb. Alamosa County. Jetted.		
Sand, very fine to medium, brown	2	2
Sand, fine to coarse, brown	4	6
Sand, fine to coarse; contains fine to very coarse gravel	1.8	7.8
160. Well 40-10-36aa. Alamosa County. Jetted. Surface altitude, 7,538.1 feet.		
Loam, sandy	0.5	0.5
Sand, fine to medium; contains fine to coarse gravel	5.5	6
Sand and gravel, coarse; contains some clay	3.9	9.9
161. Well 40-11-2cc. Alamosa County. Bored. Surface altitude, 7,534.6 feet.		
Sand, very fine; contains some fine gravel	6.4	6.4

	Thickness (feet)	Depth (feet)
162. Well 40-11-2dc. Alamosa County. Bored. Surface altitude, 7,537.8 feet.		
Soil, sandy	0.8	0.8
Sand, coarse; contains fine to medium gravel	1.2	2
Sand, coarse; contains fine gravel	4.7	6.7
163. Well 40-11-3ad. Alamosa County. Bored. Surface altitude, 7,543.8 feet.		
Sand, medium, brown	3	3
Sand, medium to coarse, dark-brown	1	4
Sand, fine to medium, black	3	7
164. Well 40-11-5aa. Alamosa County. Bored. Surface altitude, 7,535.2 feet.		
Soil, sandy	0.2	0.2
Sand, very fine to fine, clayey	4.4	4.6
Sand, fine to coarse, dark-brown	.8	5.4
165. Well 40-11-6bd. Alamosa County. Jetted. Surface altitude, 7,529.2 feet.		
Soil	2	2
Gravel, medium to coarse; contains very fine to fine sand	6.1	8.1
166. Well 40-11-7aa. Alamosa County. Bored. Surface altitude, 7,533.7 feet.		
Sand, fine to medium, gray	0.2	0.2
Sand, very fine to fine; contains some fine gravel	1.8	2
Sand, fine to coarse; contains fine to coarse gravel	1.5	3.5
Gravel, fine to coarse; contains fine to coarse sand	5.9	9.4
167. Well 40-11-7cc. Alamosa County. Bored. Surface altitude, 7,538.3 feet.		
Sand, fine	1.3	1.3
Sand, coarse; contains fine gravel	8.7	10
168. Well 40-11-8dc. Alamosa County. Bored. Surface altitude, 7,528.7 feet.		
Sand, medium, clayey	1.5	1.5
Clay, brown	1.5	3
Sand, medium, clayey	.5	3.5
Sand, medium to coarse, gray	1	4.5
Sand, fine to medium, gray; contains some blue clay	.5	5
Sand, medium to coarse, gray	2	7
Sand, coarse, black; contains some clay	1.8	8.8
169. Well 40-11-14aa. Alamosa County. Bored. Surface altitude, 7,530.7 feet.		
Soil, sandy	1	1
Gravel, fine to medium, slightly clayey	.5	1.5
Gravel, medium, gray	1.5	3
Gravel, fine to medium; contains coarse black sand	1	4
Sand, medium, gray	.5	4.5
Sand, coarse; contains fine gravel	1.2	5.7
170. Well 40-11-14cc. Alamosa County. Bored. Surface altitude, 7,524.9 feet.		
Sand, coarse, gray	2.5	2.5
171. Well 40-11-14dc. Alamosa County. Bored. Surface altitude, 7,526.0 feet.		
Sand, medium, clayey	0.5	0.5
Sand, fine to medium, clayey	2	2.5
Sand, medium, clayey	.5	3
Sand, medium, brown; contains some clay	1.5	4.5
Sand, medium to coarse, gray	2.5	7
172. Well 40-11-15bb. Alamosa County. Jetted. Surface altitude, 7,526.5 feet.		
Soil	1	1
Sand, coarse, gray	1	2
Clay, gray	1	3
Sand, coarse, brown and black	1	4
Sand, coarse, clayey, gray	3.6	7.6
173. Well 40-11-15dd. Alamosa County. Bored. Surface altitude, 7,529.4 feet.		
Sand, fine, clayey	1.5	1.5
Sand, fine; contains some clay	1.5	3
Sand, medium; contains some coarse gravel	1	4

	Thickness (feet)	*Depth (feet)*
Sand, medium, clayey	2	6
Sand, coarse, gray	1.8	7.8

174. **Well 40–11–17bb.** Alamosa County. Bored. Surface altitude, 7,535.4 feet.

Soil, sandy	1	1
Sand, medium; contains fine gravel	5	6
Sand, medium to coarse, gray	.5	6.5
Sand, coarse	2	8.5

175. **Well 40–11–18bd.** Alamosa County. Bored. Surface altitude, 7,536.5 feet.

Sand, fine; contains some clay	9.5	9.5

176. **Well 40–11–20dd.** Alamosa County. Bored. Surface altitude, 7,527.4 feet.

Soil, sandy	0.5	0.5
Sand, very fine to medium; contains fine to coarse gravel	.5	1
Sand and gravel, fine to coarse	1	2
Sand, coarse; contains coarse gravel	3.4	5.4

177. **Well 40–11–25ba.** Alamosa County. Bored. Surface altitude, 7,529.1 feet.

Soil, sandy, gray	1	1
Clay, sandy, gray	5.5	6.5
Sand, medium, gray	3.3	9.8

178. **Well 40–11–26db.** Alamosa County. Jetted. Surface altitude, 7,523.6 feet.

Sand, fine to coarse, brown	7.7	7.7

179. **Well 40–11–27aa.** Alamosa County. Bored. Surface altitude, 7,526.9 feet.

Sand, fine, clayey, gray	1	1
Sand, medium, black; contains some clay	4	5
Sand, medium to coarse; contains some clay	1.7	6.7

180. **Well 40–11–27cb.** Alamosa County. Bored. Surface altitude, 7,526.9 feet.

Clay, gray	3	3
Sand, coarse, gray; contains some gray clay	1	4
Clay, gray	1	5
Sand, coarse, to fine gravel	.6	5.6

181. **Well 40–11–29dd.** Alamosa County. Bored. Surface altitude, 7,527.9 feet.

Clay, brown	1	1
Clay, sandy, gray	1	2
Sand, coarse, gray and black, to coarse gray and black gravel	1	3
Sand, medium to coarse	.5	3.5
Sand and gravel, coarse	1	4.5

182. **Well 40–11–30bb.** Alamosa County. Bored. Surface altitude, 7,537.9 feet.

Soil, sandy	1	1
Sand, fine to coarse	3	4
Sand, medium to coarse	6	10

183. **Well 40–11–30dd.** Alamosa County. Bored. Surface altitude, 7,531.9 feet.

Sand, very fine to medium; contains some coarse gravel	4	4
Clay, sandy, light-gray	.5	4.5
Sand, coarse; contains coarse gravel	1.7	6.2

184. **Well 40–12–7dd.** Alamosa County. Bored. Surface altitude, 7,544.3 feet.

Soil	2	2
Sand, medium, black; contains some clay	4.8	6.8

185. **Well 40–12–18bb.** Alamosa County. Bored. Surface altitude, 7,534.5 feet.

Sand, fine to medium, black; contains some clay	5	5
Clay, blue	1.9	6.9

186. **Well 40–12–20ba.** Alamosa County. Bored. Surface altitude, 7,545.5 feet.

Sand, medium, brown; contains some clay	1	1
Sand, medium to coarse, gray	3	4

	Thickness (feet)	Depth (feet)
187. **Well 40–12–29dc.** Alamosa County. Bored. Surface altitude, 7,537.8 feet.		
Clay, sandy, gray	1.5	1.5
Sand, coarse, black and gray	4.3	5.8
188. **Well 40–12–30aa.** Alamosa County. Bored. Surface altitude, 7,532.9 feet.		
Soil, sandy, clayey	1	1
Sand, fine, brown and gray, to coarse brown and gray gravel	5.4	6.4
189. **Well 40–12–31ab.** Alamosa County. Bored. Surface altitude, 7,528.5 feet.		
Clay, sandy, gray	1	1
Clay, sandy, brown	1.5	2.5
Sand, coarse, black; contains some clay	4	6.5
190. **Well 40–12–33cc.** Alamosa County. Bored. Surface altitude, 7,550.0 feet.		
Sand, medium to coarse, gray	7	7
191. **Well 41–8–3aa.** Saguache County. Jetted. Surface altitude, 7,593.5 feet.		
Clay, sandy	1	1
Sand and gravel, coarse	8.9	9.9
192. **Well 41–8–6cc.** Saguache County. Jetted. Surface altitude, 7,632.3 feet.		
Sand, fine	6	6
Gravel, coarse; contains some fine sand	.2	6.2
193. **Well 41–8–7dd.** Saguache County. Jetted. Surface altitude, 7,630.9 feet.		
Soil, sandy	1.9	1.9
Sand and gravel, coarse	8.1	10
194. **Well 41–8–13aa.** Saguache County. Jetted. Surface altitude, 7,586.8 feet.		
Clay, sandy	2	2
Sand and gravel, coarse	7.7	9.7
195. **Well 41–8–15aa.** Saguache County. Jetted. Surface altitude, 7,603.9 feet.		
Clay, sandy	1.7	1.7
Sand and gravel, coarse	8.2	9.9
196. **Well 41–8–16bb.** Saguache County. Jetted. Surface altitude, 7,621.9 feet.		
Soil, sandy	1.5	1.5
Sand and gravel, coarse	6	7.5
197. **Well 41–8–20aa.** Saguache County. Jetted. Surface altitude, 7,576.3 feet.		
Clay, hard, brown	2	2
Sand and gravel, coarse	8	10
198. **Well 41–8–21dd.** Saguache County. Jetted. Surface altitude, 7,622.8 feet.		
Soil, sandy	1.7	1.7
Sand and gravel, coarse	8.2	9.9
199. **Well 41–8–22aa.** Saguache County. Jetted. Surface altitude, 7,608.9 feet.		
Soil, sandy	1.3	1.3
Sand and gravel, coarse	8.6	9.9
200. **Well 41–8–24aa.** Saguache County. Jetted. Surface altitude, 7,588.9 feet.		
Sand and gravel, fine	9.9	9.9
201. **Well 41–8–26cc.** Saguache County. Jetted. Surface altitude, 7,630.4 feet.		
Soil, sandy	2.5	2.5
Sand and gravel, coarse	7.4	9.9
202. **Well 41–8–26dd.** Saguache County. Jetted. Surface altitude, 7,609.3 feet.		
Soil, sandy	2.1	2.1
Sand and gravel, coarse	7.8	9.9
203. **Well 41–9–1aa.** Saguache County. Jetted. Surface altitude, 7,549.4 feet.		
Clay	1	1
Sand and gravel, coarse	3	4

	Thickness (feet)	Depth (feet)
Clay	.5	4.5
Sand and gravel, coarse	5.4	9.9

204. **Well 41–9–2bb.** Saguache County. Jetted. Surface altitude, 7,556.8 feet.

Clay, hard, brown	0.6	0.6
Sand and gravel	9.2	9.8

205. **Well 41–9–6aa.** Saguache County. Jetted. Surface altitude, 7,570.8 feet.

Clay, sandy	7.5	7.5
Sand and gravel, fine	2.5	10

206. **Well 41–9–6dd.** Saguache County. Jetted. Surface altitude, 7,574.9 feet.

Clay, sandy	1.7	1.7
Sand and gravel, coarse	6.3	8

207. **Well 41–9–11bb.** Saguache County. Jetted. Surface altitude, 7,560.3 feet.

Soil, sandy, fine	1.5	1.5
Sand and gravel, coarse	7	8.5

208. **Well 41–9–12aa.** Saguache County. Jetted. Surface altitude, 7,550.5 feet.

Clay, sandy, hard	4.5	4.5
Sand and gravel, coarse	5.4	9.9

209. **Well 41–9–13cc.** Saguache County. Jetted. Surface altitude, 7,560.6 feet.

Soil, sandy	1.9	1.9
Sand and gravel, coarse	8	9.9

210. **Well 41–9–14bb.** Saguache County. Jetted. Surface altitude, 7,562.3 feet.

Sand, fine	1.8	1.8
Sand and gravel, coarse	8.1	9.9

211. **Well 41–9–16aa.** Saguache County. Jetted. Surface altitude, 7,565.0 feet.

Clay, hard, brown	1.5	1.5
Sand and gravel, coarse	8.4	9.9

212. **Well 41–9–16bb.** Saguache County. Jetted. Surface altitude, 7,570.6 feet.

Clay, hard, brown	1.9	1.9
Sand and gravel, coarse	7.1	9

213. **Well 41–9–18aa.** Saguache County. Jetted. Surface altitude, 7,577.7 feet.

Clay, hard, brown	2.3	2.3
Sand and gravel, coarse	5.5	7.8

214. **Well 41–9–19aa.** Saguache County. Jetted. Surface altitude, 7,582.5 feet.

Clay, firm, brown	1.8	1.8
Sand and gravel, coarse	8.2	10

215. **Well 41–9–19cc.** Saguache County. Jetted. Surface altitude, 7,595.7 feet.

Sand and gravel, fine	9.9	9.9

216. **Well 41–9–20cc.** Saguache County. Jetted. Surface altitude, 7,588.3 feet.

Clay, firm, brown	2	2
Sand and gravel, coarse	7.9	9.9

217. **Well 41–9–20dd.** Saguache County. Jetted. Surface altitude, 7,581.0 feet.

Clay, firm, brown	1.5	1.5
Sand and gravel, coarse	8.4	9.9

218. **Well 41–9–22dd.** Saguache County. Jetted. Surface altitude, 7,568.8 feet.

Soil, sandy	2	2
Sand and gravel	7.9	9.9

219. **Well 41–9–23bb.** Saguache County. Jetted. Surface altitude, 7,566.8 feet.

Sand and gravel, fine	1.9	1.9
Sand and gravel, coarse	8	9.9

	Thickness (feet)	*Depth (feet)*
220. Well 41–9–29cc. Saguache County. Jetted. Surface altitude, 7,591.6 feet.		
Soil, sandy	4.8	4.8
Clay, soft, brown	.5	5.3
Sand and gravel	4.6	9.9
221. Well 41–9–30cc. Saguache County. Jetted. Surface altitude, 7,599.8 feet.		
Clay, sandy	6.5	6.5
Sand and gravel, coarse	3.3	9.8
222. Well 41–9–31cc. Saguache County. Jetted. Surface altitude, 7,602.9 feet.		
Soil, sandy	4.9	4.9
Sand and gravel, coarse	5	9.9
223. Well 41–9–32cc. Saguache County. Jetted. Surface altitude, 7,595.0 feet.		
Soil, sandy	2.8	2.8
Soil and gravel, coarse	7.1	9.9
224. Well 41–9–35dd. Saguache County. Jetted. Surface altitude, 7,570.8 feet.		
Sand and gravel, fine	9.8	9.8
225. Well 41–10–11 cc. Saguache County. Bored. Surface altitude, 7,533.3 feet.		
Clay, firm, brown	2.5	2.5
Clay, sandy	1.5	4
Sand, fine to coarse	2.2	6.2
226. Well 41–10–13aa. Saguache County. Bored. Surface altitude, 7,529.9 feet.		
Clay	4	4
Sand, fine to medium, black	2.9	6.9
227. Well 41–10–13cb. Saguache County. Jetted. Surface altitude, 7,531.3 feet.		
Clay, firm, brown	7	7
Sand, fine to coarse, black; contains fine to medium black gravel	17	24
228. Well 41–10–13dd. Saguache County. Bored. Surface altitude, 7,530.5 feet.		
Clay, sandy	4.6	4.6
Sand, fine, green	2.7	7.3
229. Well 41–10–25aa. Saguache County. Bored. Surface altitude, 7,529.8 feet.		
Clay, firm	5.5	5.5
Clay, sandy	1.5	7
Sand	2.5	9.5
230. Well 41–10–27dd. Saguache County. Bored. Surface altitude, 7,540.3 feet.		
Sand, fine to coarse, brown	3.5	3.5
Sand, fine to coarse; contains fine to coarse gravel	7.9	11.4
231. Well 41–10–33dd. Saguache County. Jetted. Surface altitude, 7,548.0 feet.		
Sand, very fine to coarse, brown	8	8
Clay, firm, brown	1	9
Sand, fine to coarse; contains fine to medium gravel	.9	9.9
232. Well 41–11–18dd. Saguache County. Bored. Surface altitude, 7,532.7 feet.		
Soil	2	2
Clay, sandy	4	6
Sand, fine to coarse	3.9	9.9
238. Well 41–11–29bb. Saguache County. Bored. Surface altitude, 7,537.3 feet.		
Sand, fine, brown	6.5	6.5
Sand, fine to coarse, black	3.4	9.9
234. Well 41–11–31cd. Saguache County. Bored. Surface altitude, 7,528.1 feet.		
Clay, firm, brown	1.5	1.5
Clay, sandy	.5	2
Clay, dark-brown; contains lenses of fine to medium dark-brown sand	3.5	5.5

	Thickness (feet)	Depth (feet)
235. **Well 41–11–32ba.** Saguache County. Bored. Surface altitude, 7,534.7 feet.		
Soil, sandy	4	4
Sand, fine, black	5.7	9.7
236. **Well 42–7–36dd.** Saguache County. Jetted. Surface altitude, 7,627.7 feet.		
Clay, firm, brown	4	4
Sand and gravel, fine to very coarse	8.9	12.9
237. **Well 42–8–32cc.** Saguache County. Jetted. Surface altitude, 7,619.8 feet.		
Clay, firm, brown	2	2
Sand and gravel, fine	7.8	9.8
238. **Well 42–9–32dd.** Saguache County. Jetted. Surface altitude, 7,564.5 feet.		
Clay, sandy	1.4	1.4
Sand and gravel, fine	8.6	10
239. **Well 42–10–8dd.** Saguache County. Bored. Surface altitude, 7,539.7 feet.		
Clay, sandy	3.5	3.5
Sand, coarse	6.2	9.7
240. **Well 42–10–16aa.** Saguache County. Bored. Surface altitude, 7,536.8 feet.		
Soil	2.5	2.5
Sand, fine, brown	2	4.5
Sand, fine, black	2.1	6.6
241. **Well 42–10–17da.** Saguache County. Bored. Surface altitude, 7,537.5 feet.		
Clay, black	3	3
Sand, coarse, black	6	9
242. **Well 42–10–20aa.** Saguache County. Bored. Surface altitude, 7,539.3 feet.		
Clay	2.5	2.5
Sand, coarse	7.4	9.9
243. **Well 42–10–22bb.** Saguache County. Bored. Surface altitude, 7,536.3 feet.		
Clay, sandy	2.5	2.5
Sand and gravel, coarse	7.4	9.9
244. **Well 42–10–25ca.** Saguache County. Bored. Surface altitude, 7,532.9 feet.		
Clay, sandy	5.5	5.5
Sand, black	4.3	9.8
245. **Well 42–10–27aa.** Saguache County. Bored. Surface altitude, 7,532.8 feet.		
Sand, fine	3	3
Clay	1	4
Sand, coarse	5.8	9.8
246. **Well 42–10–27bc.** Saguache County. Bored. Surface altitude, 7,533.4 feet.		
Clay, sandy	2	2
Sand, fine to coarse	4.1	6.1
247. **Well 42–10–34da.** Saguache County. Bored. Surface altitude, 7,535.3 feet.		
Clay	2.5	2.5
Gravel, fine; contains fine to coarse sand	3.4	5.9
248. **Well 42–10–35ab.** Saguache County. Bored. Surface altitude, 7,533.3 feet.		
Clay	7	7
Sand, fine to coarse	2.7	9.7
249. **Well 42–10–36bd.** Saguache County. Bored. Surface altitude, 7,532.6 feet.		
Clay	7.3	7.3
Sand	2.5	9.8
250. **Well 42–10–36cc.** Saguache County. Bored. Surface altitude, 7,531.5 feet.		
Clay, sandy	4.5	4.5
Sand and gravel, coarse	2.9	7.4

Logs of wells and test holes drilled into indicated rock units

251. **Well 35–9–4bc.** Conejos County. Drilled by Howard Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Clay, brown	24	24
Clay, blue	16	40
Clay, blue, interbedded with layers of sand	101	141
Clay, brown, interbedded with layers of sand	127	268
Gravel, loose	10	278
Santa Fe formation:		
Lava rock; contains layers of sand	54	332
Ash	11	343
Lava rock; contains layers of sand	49	392
Gravel, cemented; contains layers of loose sand and gravel	173	565

252. **Well 36–8–26cb.** Conejos County. Drilled by H. A. Dewey. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Top soil and gravel	55	55
Gravel and clay (contains some water at 56 feet)	30	85
Clay	41	126
Clay and gravel, cemented	4	130
Clay	18	148
Clay and gravel, cemented	23	171
Clay	1	172
Clay and gravel	39	211
Gravel (contains water)	3	214
Clay and gravel	32	246
Gravel (contains water)	4	250
Clay and boulders	20	270
Clay, sandy	15	285
Santa Fe formation:		
Lava rock	33	318
Clay	3	321
Gravel and stringers of clay	19	340
Clay	12	352
Gravel and boulders	19	371
Clay	37	408
Boulders (contains some water)	3	411
Boulders and gravel (contains some water)	8	419
Clay, sandy (contains some water)	40	459
Boulders	6	465
Clay, sandy	3	468
Boulders, large	4	472
Sand (contains water)	23	495

253. **Well 36–8–36ac.** Conejos County. Drilled by Jack Sanford. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Silt and fine sand	12	12
Gravel, coarse; contains some boulders	24	36
Sand, coarse, black	14	50
Clay, hard, blocky, blue	58	108
Boulders, interbedded with layers of clay	70	178
Gravel and coarse sand	8	186
Clay, red	8	194
Sand, fine, black	4	198
Clay, red	29	227
Undifferentiated Recent deposits and Alamosa formation—Con.:		
Gravel, coarse, to large boulders	4	231
Clay, red	4	235
Santa Fe formation:		
Rock, hard, black, basalt	46	281
Clay, red	6	287
Rock, hard, porous, red	23	310
Talc, pink (?)	2	312
Gravel, small; contains fine black sand	16	328
Clay, red	4	332
Gravel, coarse; contains coarse sand	58	390

254. **Well 36–9–1bc.** Alamosa County. Drilled by Mahres Well Service. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Sand	21	21
Sand and clay	38	59
Clay	91	150
Sand and clay	150	300
Sand	50	350
Sand and clay	139	489
Boulders	6	495
Sand and clay	17	512
Clay	23	535
Santa Fe formation:		
Rock, hard	92	627
Clay and gravel	85	712
Rock, hard	46	758
Clay, gravel, and boulders	46	804
Boulders and gravel	134	938
Santa Fe formation—Con.:		
Sand, gravel, and boulders	115	1,053
Rock, hard	138	1,191
Rock and sand	135	1,326
Rock and sand	89	1,415
Sand	40	1,455
Sand and clay	35	1,490
Clay	10	1,500
Clay and sand	20	1,520
Hard sand and clay	50	1,570
Sand and rock	35	1,605
Sand and clay	90	1,695
Hard sand	25	1,720
Sand, clay, and boulders	140	1,860
Rock	20	1,880
Sand and boulders	95	1,975

255. **Well 36–9–3bc.** Alamosa County. Drilled by Mr. Robinson. Reported log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Top soil	2	2
Gravel	2	4
Clay, yellow	43	47
Clay, blue	64	110
Clay, interbedded with layers of sand	347	457

256. **Well 36–9–6bc.** Alamosa County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Gravel, tight	35	35
Rock, tight, interbedded with layers of clay	14	49
Rock, interbedded with layers of clay	7	56
Clay, hard, brown	34	90
Clay, hard, blue	18	108
Soapstone	9	117
Clay	13	130
Sand, brown	3	133
Gravel, interbedded with layers of clay	7	140
Gravel, loose	20	160

257. **Well 36–9–6cc.** Alamosa County. Drilled by H. A. Dewey. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Gravel	40	40
Shale, green	20	60
Shale, sandy, pink	65	125
Sand (contains water)	5	130
Shale, sandy	110	240
Sand, coarse	10	250
Sand and shale	60	310
Gravel, cemented	8	318
Sand (contains water)	4	322
Gravel, cemented	8	330
Shale and gravel	30	360
Gravel, cemented	25	385
Sand (contains water)	5	390
Gravel, cemented	9	399
Shale	2	401
Santa Fe formation:		
Rock, brown	57	458
Rock, red	21	479
Shale, red	21	500
Shale, yellow	12	512
Lava rock, hard	5	517
Shale	8	525
Shale and gravel (contains water)	32	557
Shale	8	565
Shale and gravel	20	585
Sand and gravel (contains water)	5	590
Shale and gravel	38	628
Lava rock, hard	3	631
Shale, sandy (caving)	14	645
Gravel (contains water)	5	650
Shale and gravel	32	682

258. Well 36-9-18dc. Alamosa County. Reported log.

	Thickness (feet)	*Depth (feet)*
Undifferentiated Recent deposits and Alamosa formation:		
Top soil	16	16
Clay	2	18
Sand and gravel	22	40
Sand, interbedded with layers of clay	350	390
Santa Fe formation:		
Rock, solid, black	70	460
Clay, blue	75	535
Sand, gray	45	580
Sand, coarse; contains large boulders	22	602

259. Well 36-9-19ac. Alamosa County. Drilled by H. A. Dewey. Driller's log.

	Thickness (feet)	*Depth (feet)*
Undifferentiated Recent deposits and Alamosa formation:		
No log	226	226
Clay	14	240
Clay and sand	18	258
Clay and rock	17	275
Clay	25	300
Clay and gravel	30	330
Clay	15	345
Clay and gravel	12	357
Clay	8	365
Santa Fe formation:		
Lava	35	400
Clay	12	412
Gravel (contains water)	3	415
Lava (contains water)	28	443
Santa Fe formation—Con.:		
Clay and sand	12	455
Clay	5	460
Clay, sandy	30	490
Hardpan	6	496
Clay, sandy	9	505
Hardpan	9	514
Clay	16	530
Boulders and clay	4	534
Clay	11	545
Clay and gravel	5	550
Clay	3	553
Gravel and boulders (contains water)	9	562
Sand and clay	18	580
Sand (contains water)	23	603

260. Well 36-9-19dc. Alamosa County. Drilled by H. A. Dewey. Driller's log.

	Thickness (feet)	*Depth (feet)*
Undifferentiated Recent deposits and Alamosa formation:		
No log	23	23
Clay	92	115
Clay and gravel	11	126
Clay	9	135
Clay and gravel	9	144
Clay	28	172
Clay and gravel	11	183
Clay	34	217
Clay and gravel	7	224
Clay	11	235
Clay and boulders	10	245
Clay	8	253
Clay and gravel	16	269
Clay	15	284
Clay and boulders	13	297
Clay	3	300
Undifferentiated Recent deposits and Alamosa formation—Con.:		
Clay and gravel	32	332
Santa Fe formation:		
Rock	38	370
Sand, clay, and gravel (contains water)	11	381
Rock	35	416
Clay and boulders	24	440
Sand and clay (contains water)	6	446
Clay and boulders (contains water)	6	452
Sand and gravel	16	468
Clay	12	480
Clay and boulders	13	493
Clay	2	495
Sand and gravel (contains water)	32	527

261. **Well 37-10-11cc.** Alamosa County. Drilled by Harold P. Doty. Sample log.[1]

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Soil	4	4
Sand	25	29
Clay, blue	43	72
Sand and clay	93	165
Clay	92	257
Clay, sand, and shale	31	288
Sand, medium, tan, to fine tan gravel	32	320
Sand, medium, to fine gravel; contains some clay	10	330
Sand, very fine to very coarse; contains some very fine gravel and a little clay	10	340
Clay, firm, blocky, bluish-gray; contains layers of fine to coarse bluish-gray sand	30	370
Clay, hard, blocky, bluish-gray; contains layers of very fine to coarse bluish-gray sand	10	380
Clay, hard, bluish-gray; contains a little very fine to fine bluish-gray sand	20	400
Clay, sandy, bluish-gray	70	470
Clay, hard, blocky, blue	68	538
Clay, hard, blocky, interbedded with thin layers of very fine sand	32	570
Clay, hard, blocky, blue to greenish-blue	105	675
Clay, blocky, blue, interbedded with thin layers of very fine to fine sand	5	680
Clay, soft, slightly sandy, interbedded with very fine to medium sand	60	740
Sand, coarse, to fine gravel; contains some blue clay	20	760
Clay, hard, slightly sandy, greenish-gray to brown	10	770
Sand, coarse to very coarse, brown to black	10	780
Sand, coarse to very coarse, brown to black; contains some clay	45	825
Sand, medium to coarse, brown to black; contains very fine brown to black gravel	15	840
Sand, very coarse; contains fine gravel	10	850
Gravel, very fine to fine; contains very coarse sand	5	855
Gravel, very fine to fine; contains coarse to very coarse sand	40	895
Gravel, very fine to fine; contains a little brown clay	15	910
Gravel, very fine to fine; contains medium to very coarse sand and some clay	10	920
Sand, coarse to very coarse; contains very fine to fine gravel and some brown clay	50	970
Sand, medium to very coarse; contains very fine gravel and some clay	45	1,015
Sand, medium to very coarse; contains brown clay	25	1,040
Sand, medium to very coarse; contains some fine gravel and brown clay	60	1,100
Sand, medium to very coarse, interbedded with layers of brown clay	75	1,175
Clay, hard, brown, interbedded with medium to coarse sand	485	1,660
Sand, very fine to medium, interbedded with layers of brown and blue clay	40	1,700
Sand, very fine to coarse, interbedded with layers of hard clay	65	1,765
Sand, very fine to medium, black and brown, interbedded with layers of hard clay	37	1,802

262. **Well 38-11-34dc.** Alamosa County. Surface altitude, 7,526.6 feet. Reported log.

	Thickness (feet)	Depth (feet)
Recent deposits:		
Clay, firm; contains lenses of fine to medium sand	13	13
Sand, fine to coarse; contains fine to coarse gravel	5	18
Sand, fine to medium, brown; contains some clay	17	35

263. **Well 39-7-10dc.** Rio Grande County. Drilled by Floyd Oliver. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Sand, fine to very coarse; contains medium to very coarse gravel and some small cobbles	28	28
Gravel, very coarse, to fine sand; contains some small cobbles	10	38

[1] Cuttings were collected by the driller at intervals of 5 feet; hence, the depths shown for changes in material may be in error by as much as 5 feet. The well cuttings above 288 feet were examined and described by the driller.

	Thickness (feet)	Depth (feet)
Sand, fine to very coarse, tan	6	44
Gravel, very coarse, brown, to fine brown sand	9	53
Sand, medium to very coarse, brown	22	75
Clay, soft, brown	22	97
Gravel, medium to very coarse; contains medium to very coarse sand	13	110

264. **Well 39-7-11bb.** Rio Grande County. Drilled by Ora Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:		
Gravel	36	36
Gravel, fine; contains sand	13	49
Sand, tight	14	63
Boulders, large	6	69
Sand; contains interbedded clay layers	34	103

265. **Well 39-8-31ca.** Rio Grande County. Drilled by V. Wheeler. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:		
Sand and gravel	45	45
Clay, blue	65	110
Clay and boulders	120	230
Clay, brown, and boulders	90	320
Sand and boulders	34	354
Rock	10	364
Sand and gravel	18	382
Santa Fe formation:		
Lava rock	38	420
Sand and boulders	40	460
Sand	15	475

266. **Well 40-6-14cc.** Rio Grande County. Drilled by Ora Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:		
Gravel, coarse	43	43
Rock, interbedded with thin layers of clay (?)	52	95
Clay	4	99
Rock, tight (?)	5	104

267. **Well 40-6-22dc.** Rio Grande County. Drilled by Ora Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:		
Sand, coarse; contains large boulders	46	46
Sand, well graded	1	47
Clay; contains gravel	33	80
Sand, fine, black	10	90
Sand, interbedded with layers of soft clay	15	105
Sand, well graded; contains small cobbles	20	125

268. **Well 40-6-23cc.** Rio Grande County. Drilled by Ora Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:		
Sand, fine; contains small gravel	30	30
Clay	1	31
Sand, coarse; contains cobbles	8	39
Gravel, interbedded with layers of clay	24	63
Gravel and sand, interbedded with layers of clay	7	70
Sand, fine	6	76
Sand, fine; contains gravel	41	117
Sand, coarse; contains large cobbles	6	123

269. **Well 40-7-28ac.** Rio Grande County. Drilled by Ora Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:		
Gravel, coarse, and large rock	32	32
Clay	2	34
Rock, large, interbedded with layers of clay	31	65
Clay	1	66
Rock, interbedded with layers of clay	4	70
Sand, tight	15	85
Gravel, loose	5	90

	Thickness (feet)	Depth (feet)
Gravel, good	21	111
Sand, fine	4	115
Rock, coarse	17	132

270. **Well 40-7-36ac.** Rio Grande County. Drilled by Ora Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:

	Thickness (feet)	Depth (feet)
Gravel, tight	52	52
Clay	3	55
Gravel, small	10	65
Gravel, small; contains fine sand	9	74
Sand, fine	6	80
Clay	.5	80.5

271. **Well 40-8-26cb.** Rio Grande County. Drilled by Elmer Crown. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:

	Thickness (feet)	Depth (feet)
Sand, fine; contains some fine gravel	70	70
Clay, hard, blue	3	73

272. **Well 40-10-4db.** Alamosa County. Drilled by Ora Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:

	Thickness (feet)	Depth (feet)
Sand, medium to coarse, gray	18	18
Clay, brown	3	21
Sand, medium to coarse, brown	24	45
Clay, blue	5	50
Sand, medium to coarse, brown	20	70
Clay, blue	5	75
Sand, medium to coarse, brown	4	79
Clay, blue	7	86
Sand, fine, black	11	97
Clay, blue	10	107
Sand, fine to medium, black	5	112
Clay, blue	6	118
Sand, fine to medium, black	6	124
Clay, blue	5	129
Sand, fine to medium, black	6	135
Clay, blue	5	140
Sand, fine to medium, black	6	146
Clay, blue	5	151
Sand, fine to medium, black	5	156
Clay, blue	6	162
Sand, fine to medium, black	3	165
Clay, blue	1	166
Sand, fine to medium, black	4	170
Clay, hard, blocky, blue	1	171

273. **Well 40-10-5bc.** Alamosa County. Drilled by Howard Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:

	Thickness (feet)	Depth (feet)
No information	117	117
Clay, blue	20	137
Sand, fine to medium, blue	1	138
Clay, blue	12	150
Sand, fine to medium, black	23	173
Clay, blue	100	273
Sand, fine to medium	4	277
Clay, blue	15	292
Sand, fine to medium, black	5	297
Sand, interbedded with thin layers of clay	13	310
Sand, fine to medium, black	6	316
Clay, soft to hard, blue	19	335

274. **Well 40-10-30dc.** Alamosa County. Drilled by Howard Platz. Driller's log.

Undifferentiated Recent deposits and Alamosa formation:

	Thickness (feet)	Depth (feet)
Sand, coarse; contains gravel	30	30
Sand, fine to medium	5	35
Clay, brown, interbedded with thin layers of medium to coarse gravel	28	63
Clay, blue	91	154
Sand, fine to medium, blue	1	155
Clay, blue	2	157
Sand, fine to medium, blue	3	160

	Thickness (feet)	Depth (feet)
Sand, fine to medium, blue, interbedded with thin layers of blue clay	28	188
Clay, hard, blue	22	210
Sand, fine to medium, blue, interbedded with thin layers of blue clay	30	240
Sand, fine to medium, blue	1	241
Clay, hard, blue	69	310
Sand, fine to medium, blue, interbedded with thin layers of blue clay	87	397

275. **Well 41-7-4ab.** Saguache County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Gravel and sand, loose	22	22
Gravel	63	85
Sand	25	110
Clay	2	112

276. **Well 41-7-24ac.** Saguache County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Gravel	45	45
Clay	.5	45.5
Sand and gravel, small	15.5	61
Sandstone (?)	14	75
Sand, black	6.6	81.6
Clay, black	10.4	92
Sand, black	4	96
Clay, black	1	97
Sand, black	8	105
Clay, black	3	108
Sand, interbedded with thin layers of clay	6	114

277. **Well 41-7-25cc.** Saguache County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Recent deposits:		
Gravel	60	60
Sand, fine	27	87

278. **Well 41-7-25dc.** Saguache County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Recent deposits:		
Gravel	35	35
Sand, fine	12	47
Gravel	4	51

279. Well 41-7-28cc. Saguache County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Gravel and small cobbles	33	33
Gravel, interbedded with layers of clay	52	85
Clay	6	91
Gravel, small; contains sand interbedded with layers of clay	19	110
Clay	4	114
Sand, interbedded with layers of clay	14	128
Gravel, small, interbedded with layers of clay	15	143
Sand	2	145
Rock (?)	14	159

280. **Well 41-7-34ac.** Saguache County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Gravel, coarse	25	25
Gravel, small, tight	30	55
Sand and gravel, loose	8	63
Clay; contains interbedded layers of gravel	12	75
Clay	1	76
Sand, tight	6	32
Sand, black; contains interbedded layers of clay	6	88

281. **Well 41-7-34bc.** Saguache County. Drilled by Ora Platz. Driller's log.

	Thickness (feet)	Depth (feet)
Undifferentiated Recent deposits and Alamosa formation:		
Gravel, tight	18	18

	Thickness (feet)	*Depth (feet)*
Clay	2	20
Gravel, tight	40	60
Gravel, loose	10	70
Sand, fine, interbedded with layers of clay	23	93
Rock (?)	2	95
Clay, brown	7	102

282. **Test hole 41–8–10bc.** Saguache County. Drilled by **M. F. Smith. Driller's log.**

Undifferentiated Recent deposits and Alamosa formation:		
Gravel, medium to coarse; contains fine to medium sand	40	40
Sand, fine to medium, brown	4	44
Clay, brown; contains lenses of fine sand	31	75
Sand, very fine, brown	7	82
Clay, blue	12	94
Clay, white	6	100
Clay, hard, blue	87	187
Sand, fine, interbedded with thin layers of clay	18	205

283. **Well 41–8–10ca.** Saguache County. Drilled by D. W. Spencer. Sample log.[3]

Undifferentiated Recent deposits and Alamosa formation:		
Gravel, medium to coarse; contains medium to coarse sand and a little sandy clay	33	33
Gravel, fine to coarse; contains fine to coarse sand	9	42
Gravel, medium to coarse; contains fine to coarse sand	5	47
Clay, sandy, brown	3	50

284. **Test hole 41–8–10ca.** Saguache County. Drilled by D. W. Spencer. Sample log.[3]

Undifferentiated Recent deposits and Alamosa formation:		
Silt to very fine to coarse sand	15	15
Sand, fine to coarse; contains very fine to coarse gravel	15	30
Gravel, fine to coarse; contains fine to coarse sand	15	45
Silt, brown, to medium brown sand	3	48
Sand, fine to medium, brown	10	58
Sand, very fine to coarse, brown; contains a little fine brown gravel	11	69
Gravel, fine to coarse, brown; contains very fine to coarse brown gravel	14	83
Clay, hard, greenish-blue	20	103

285. **Well 41–8–10cc.** Saguache County. Drilled by Ora Platz. Driller's log.

Recent deposits:		
Sand and gravel, loose	43	43
Clay	1	44
Sand, interbedded with layers of clay	21	65
Gravel, small	65	85

286. **Well 41–8–33bc.** Saguache County. Drilled by Ora Platz. Driller's log.

Recent deposits:		
Gravel	36	36
Gravel, interbedded with layers of clay	31	67

287. **Well 41–8–36ac.** Saguache County. Drilled by Ora Platz. Driller's log.

Recent deposits:		
Gravel	64	64
Clay	.5	64.5
Gravel, interbedded with layers of clay	10.5	75

[3] Cuttings were collected by the driller at intervals of 5 feet; hence, the depths shown for changes in material may be in error by as much as 5 feet.

288. **Oil test hole 39–11–11bb.** Alamosa County. Drilled by Mr. Layne. Driller's log.

	Thickness (feet)	*Depth (feet)*
Undifferentiated Recent deposits and Alamosa formation:		
Sand, gray	60	60
Sand, black	60	120
Sand and clay	155	275
Sand	57	332
Sand, coarse (show of gas)	18	350
Gumbo	150	500
Shale, blue	50	550
Gumbo	221	771
Sand, fine, black	9	780
Shale, blue	104	884
Gumbo	252	1,136
Shale, blue	32	1,168
Gumbo	25	1,193
Shale, hard	21	1,214
Sand	21	1,235
Shale	62	1,297
Gumbo	12	1,309
Sand, very hard	4	1,313
Sand, coarse, hard	14	1,327
Gumbo	36	1,363
Sand, coarse	20	1,383
Shale	14	1,397
Sand	20	1,417
Gumbo	4	1,421
Sand	19	1,440
Sand, coarse	16	1,456
Shale, sandy	45	1,501
Gumbo	22	1,523
Gumbo and shale	277	1,800
Gumbo, hard, and shale	42	1,842
Sand and gravel	5	1,847
Shale	11	1,858
Sand and gravel	22	1,880
Undifferentiated Recent deposits and Alamosa formation—Con.:		
Shale	54	1,934
Sand and gravel	16	1,950
Santa Fe formation:		
Sand and black rock	10	1,960
Gravel and shale; contains boulders	33	1,993
Gumbo	40	2,033
Shale and boulders	43	2,076
Sand, boulders, and green shale	37	2,113
Shale, boulders, and gumbo	9	2,122
Boulders and gumbo	65	2,187
Sand, shale, and boulders[4]	33	2,220
Shale and gumbo sand (probably blue sand)	34	2,254
Sand, brown, with streaks of shale	21	2,275
Sand, boulders, and shale	56	2,331
Clay, yellow	10	2,341
Sand, brown	11	2,352
Clay, red	20	2,372
Sand, blue	12	2,384
Gumbo	11	2,395
Shale, red, sand, and clay	96	2,491
Clay, red	9	2,500
Sand and boulders	100	2,600
Rock	4	2,604
Sand	13	2,617
Rock	7	2,624
Sand	21	2,645
Rock	10	2,655

239. **Oil test hole 41–10–27aa.** Saguache County. Drilled by J. H. Rush and J. V. Calvert. Driller's log.

Undifferentiated Tertiary and Quaternary deposits:		
Sand and clay	40	40
Sand and shale	20	60
Gravel	2	62
Sand and shale	48	110
Sand, coarse	50	160
Shale, green	20	180
Shale, sticky	50	230
Shale and gumbo	50	280
Gumbo	18	298
Gumbo, sticky	19	317
Shale, sticky	9	326
Shale, hard	9	335
Shale, sticky	15	350
Shale, hard, blue	9	359
Shale	9	368
Shale, sticky, blue	24	392
Shale, hard, blue	10	402
Gumbo, hard	38	440
Gumbo, blue	5	445
Shale, sandy, brown	17	462
Gumbo, blue, containing gypsum	15	477
Gumbo	7	484
Shale	28	512
Shale, sandy	53	565
Gumbo, hard	8	573
Shale, sticky, blue and white	29	602
Shale, sandy, brown	32	635
Gumbo, hard	20	655

[4] Strong artesian flow of about 350 barrels an hour that persisted to 2,655 feet. Temperature of the water was reported to be about 140° F.

	Thickness (feet)	Depth (feet)
Gumbo and shale	25	680
Shale, sandy	55	735
Shale, blue	23	758
Limestone, hard (?)	2	760
Shale, loose	20	780
Sand, gray	25	805
Gumbo, sticky	56.5	861.5
Sand, packed	8.5	870
Shale, sandy	35	905
Gumbo, hard, blue	9	914
Shale	34	948
Sand, packed	15	963
Gumbo, hard	17	980
Shale, sticky	28	1,008
Sand, hard	18	1,026
Sand, loose	12	1,038
Gumbo, hard	10	1,048
Shale, sticky, interbedded with layers of gumbo	21	1,069
Gumbo, hard	30	1,099
Shale, sticky	50	1,149
Gumbo, sticky	12	1,161
Shale, interbedded with layers of sand	31	1,192
Gumbo, hard	40	1,232
Gravel	15	1,247
Gypsum	15	1,262
Shale, sandy, hard	33	1,295
Gumbo, hard	10	1,305
Gumbo, sandy	20	1,325
Shale	10	1,335
Sand, packed, light-gray	15	1,350
Gypsum	20	1,370
Gumbo, hard	22	1,392
Gravel, interbedded with layers of hard sand	7	1,399
Shale, blue, and gumbo	46	1,445
Gumbo, hard	7	1,452
Sand, hard	15	1,467
Shale, hard, blue	15	1,482
Gumbo, hard, interbedded with layers of sand	20	1,502
Gumbo, sandy	20	1,522
Shale, sandy	20	1,542
Sand, gray	11	1,553
Shale, sandy	16	1,569
Gravel	43	1,612
Sand and gravel	46	1,658
Shale, loose	40	1,698
Sand, packed	40	1,738
Gravel	62	1,800
Sand, hard	1	1,801
Sand, packed	18	1,819
Shale, sandy	12	1,831
Sand, hard	19	1,850
Shale, sandy	9	1,959
Sand and gravel	19	1,978
Shale, interbedded with layers of blue sand	36	2,014

	Thickness (feet)	Depth (feet)
Shale, sandy	17	2,031
Shale	13	2,044
Shale, interbedded with layers of blue sand	13	2,057
Shale, interbedded with layers of packed sand	19	2,076
Shale, brown	12	2,088
Shale, soft, pink	25	2,113
Shale, sandy, pink	18	2,131
Clay, yellow	8	2,139
Rock, hard, sandy (?)	7	2,146
Sand, hard	1	2,147
Limestone (?)	11	2,158
Sand and lime (?)	4	2,162
Sand, hard	8	2,170
Shale, containing coal (?)	7	2,177
Shale, brown	6	2,183
Gravel, containing black sand	19	2,202
Sand, gray, and shale	13	2,215
Sand, gray	11	2,226
Shale, soft, brown	13	2,239
Gumbo, hard, blue	9	2,248
Shale, blue	12	2,260
Sand, black	27	2,287
Shale, black	16	2,303
Shale, yellow	9	2,312
Sand, loose, containing gravel	9	2,321
Sand and shale	15	2,336
Shale, yellow	13	2,349
Shale	35	2,384
Sand, hard	6	2,390
Sand and shale	22.5	2,412.5
Sand lime rock (?)	2.5	2,415
Sandy lime	1.5	2,416.5
Shale, hard, brown	10.5	2,427
Shale, brown	9	2,436
Sand, hard, gray	6	2,442
Shale, soft	30	2,472
Shale, blue	7	2,479
Sand rock	6	2,485
Sandstone, gray (?)	4	2,489
Shale, blue and gray	21	2,510
Gumbo	7	2,517
Shale, yellow	27	2,544
Gumbo	2	2,546
Shale, soft, black	10	2,556
Shale, gray	35.5	2,591.5
Sandstone, greenish-gray	6.5	2,598
Sandstone, gray	2	2,600
Shale	3	2,603
Quartzite sandstone	8	2,611
Shale, reddish-brown	20	2,631
Shale, red	11	2,642
Sand rock, red	7	2,649
Shale, sandy, red	15	2,664
Shale, brown and yellow	14	2,678
Shale, brown	18	2,696
Shale, brown and black	13	2,709

	Thickness (feet)	Depth (feet)
Shale	7	2,716
Gumbo, hard	7	2,723
Gumbo	3	2,726
Sand rock, coarse	9	2,735
Shale, sandy	25	2,760
Sandstone, gray (?)	14	2,774
Shale, red	19	2,793
Sand rock, gray	11	2,804
Shale, black	13	2,817
Gumbo	12	2,829
Sand, grayish-brown, containing boulders	26	2,855
Shale, blue	37	2,892
Gumbo	3	2,895
Gumbo, sandy	9	2,904
Sand, black	3	2,907
Gumbo, red	7	2,914
Shale	16	2,930
Shale, sandy	7	2,937
Shale, red	20	2,957
Gravel, coarse, black	7	2,964
Shale, blue, and hard brown sand	25	2,989
Sand, hard, brown	5	2,994
Gumbo, sandy, red	7	3,001
Gumbo	4	3,005
Shale	5	3,010
Shale, gray	17	3,027
Shale, sandy, gray	8	3,035
Shale, blue	22	3,057
Gravel, coarse, black	12	3,069
Shale, sticky, red	16	3,085
Shale, red	14	3,099
Shale, grayish-brown	5	3,104
Sand, brown	9	3,113
Shale, sandy, brown	5	3,118
Sand, brown and gray	12	3,130
Sand, gray, containing shale	14	3,144
Sand, gray	1	3,145
Shale, red	34	3,179
Sandstone, gray (?)	5	3,184
Shale, sandy, gray	5	3,189
Sand, hard, gray and brown	14	3,203
Shale, sandy, soft	16	3,219
Shale, blue	8	3,227
Lime, bluish-gray (?)	10	3,237
Shale	3	3,240
Shale, blue	9	3,249
Sand, hard, brown	6	3,255
Sandrock (?)	7	3,262
Shale, sandy, red	6	3,268
Shale, red	12	3,280
Sand, gray	26	3,306
Shale, blue	15	3,321
Shale, red	8	3,329
Shale, sandy, red	21	3,350
Shale, gray	10	3,360
Sand, hard	7	3,367
Gumbo	10	3,377
Shale, sandy	32	3,409
Gumbo	12	3,421
Shale, gray	8	3,429
Gumbo	17	3,446
Shale, red	19	3,465
Sand, blue and gray	33	3,498
Shale, blue and gray	6	3,504
Gumbo	10	3,514
Gumbo and blue shale	9	3,523
Shale, sandy	5	3,528
Gumbo and gray shale	15	3,543
Gumbo	2	3,545
Shale, gray	19	3,564
Shale	28	3,592
Shale, gray	20	3,612
Shale, blue and gray	13	3,625
Shale, sandy	3	3,628
Shale, red	26	3,654
Shale, sandy, red	11	3,665
Shale	6	3,671
Sand, packed	9	3,680
Shale, sandy	7	3,687
Sand and shale	29	3,716
Sand, packed	13	3,729
Shale, sandy	13	3,742
Shale, red	13	3,755
Shale	30	3,785
Sand	4	3,789
Sand and shale	12	3,801
Lime, sandy (?) (showing of gas)	4	3,805
Sand	7	3,812
Sand and shale	21	3,833
Shale	7	3,840
Sand and shale	16	3,856
Sand, hard, and shale	6	3,862
Shale and gumbo	19	3,881
Shale, sticky	21	3,902
Sand and shale	20	3,922
Shale, sticky	5	3,927
Shale and sand	12	3,939
Sand	6	3,945
Sand and yellow clay	16	3,961
Sand	21	3,982
Shale, sticky	8	3,990
Clay	3	3,993
Clay, sticky	7	4,000
Clay	3	4,003
Lime and shale (?)	3	4,006
Sand and shale (showing of gas)	9	4,015
Shale, sandy	5	4,020
Shale, sticky, blue	5	4,025
Sand and shale	23	4,048
Shale, sticky, blue	10	4,058
Shale	10	4,068
Shell and lime (?)	2	4,070
Sand	4	4,074
Sand and shale	10	4,084
Shale, blue and gray	6	4,090
Sand and shale	12	4,102
Shale	2	4,104
Shale, blue and gray	15	4,119
Shale, blue	32	4,151
Gumbo	12	4,163

	Thickness (feet)	Depth (feet)
Chalky lime (?)	6	4,169
Lime, black (?)	9.5	4,178.5
Shale, sandy	12.5	4,191
Gumbo	8	4,199
Shale and gumbo	13	4,212
Sand, hard	4	4,216
Sand	7	4,223
Sand, hard	12	4,235
Shale	9	4,244
Shale, sticky	29	4,273
Sand, hard	12	4,285
Shale, sticky	11	4,296
Slate (?)	12	4,308

290. Orrin Tucker and others–Thomas well 1, 41–8–13aa. Saguache County. Sampled by the Denver Sample Log Co.

Santa Fe formation:

Top (based on electric log) at depth of 885 ft.

	Thickness (feet)	Depth (feet)
No samples	1,480	1,480
Debris, arkosic and igneous, containing angular quartz	20	1,500
No samples	125	1,625
Conglomerate, arkosic, containing lava and basic igneous debris with subangular to subrounded pebbles. Considerable clay and a trace of black shale below 1,650	60	1,685
Conglomerate, containing quartz, feldspar, mica, and some basic debris; weathered, subangular to subrounded and fine-grained. Predominantly arkosic conglomerate consisting of fine-textured granite below 1,720. Unit contains subangular to subrounded grains below 1,790	145	1,830
Conglomerate, arkosic, fine to very coarse, angular to subrounded, containing a trace of basic debris and some olivine	70	1,900
No samples	105	2,005
Conglomerate, arkosic, fine- to medium-grained, with some very coarse angular to subangular grains and containing abundant quartz. Unit contains basic debris below 2,060. Unit is fine- to coarse-grained and contains about 50 percent angular to subangular grains of quartz below 2,120. Material is fine- to very coarse-grained containing large granite pebbles with a little clay below 2,150. A trace of basic debris and some olivine crystals below 2,180. Unit contains grains of basic material with a trace of olivine below 2,220	225	2,230
Conglomerate, arkosic, coarse-grained, containing basic debris and a trace of vesicular lava. Unit contains fine- to coarse-grained material with considerable angular quartz below 2,242, and basic debris with grains showing a considerable amount of weathering below 2,300 and feldspar that has weathered to clay below 2,320. Contains abundant grains of olivine and quartz below 2,350	170	2,400
Conglomerate, arkosic, fine to coarse, angular to subangular, containing basic debris and abundant quartz. Unit is weathered to fine fragments of feldspar and granite below 2,420. Pebbles and grains appear to be unconsolidated but probably had clay matrix which disappeared in mud. Unit contains very coarse subrounded to subangular pebbles of weathered granite below 2,520 and very coarse slightly weathered pebbles of granite, feldspar, quartz, augite and olivine below 2,530	140	2,540
Conglomerate, arkosic, fine to coarse, angular to subangular, containing 60 percent quartz. Unit is weathered and contains some clay below 2,570 and very coarse pebbles below 2,580	60	2,600
Conglomerate, arkosic, fine to very coarse, deeply weathered, containing clay and basic debris. Material is slightly weathered below 2,620 and contains very coarse subrounded pebbles between 2,630 and 2,640 (appear to be water worn). Considerable pink to buff sandy and silty clay with very fine to coarse grains of quartz interbedded below 2,660. Material is gray and tan clay below 2,720 and medium- to very coarse-grained with some pebbles of angular to subangular quartz below 2,730. Most of feldspar is weathered below 2,740. Trace of black shale below 2,760. Material is fine- to coarse-grained containing about 50 percent angular quartz with some clay below 2,790	210	2,810
Conglomerate, arkosic, fine- to very coarse-grained, angular to subangular; containing quartz, pink feldspar, mica, and pink to buff clay. Sixty percent of grains below 2,830 feet are quartz. Unit contains a trace of basic debris below 2,850	50	2,860

	Thickness (feet)	Depth (feet)
Conglomerate, consisting of very coarse pebbles of granitic and basic rock, weathered, subangular to subrounded and containing a trace of clay below 2,880	80	2,940
Conglomerate, consisting of fine-textured granitic and basic rocks; in part porphyritic; contains some clay. Trace of basic rocks below 2,990. Unit contains abundant pink to buff clay interbedded with grains of quartz and flakes of mica below 2,990	60	3,000
Conglomerate, deeply weathered, varicolored, containing very coarse pebbles and abundant clay. Contains less clay below 3,010 and abundant clay below 3,030	60	3,060
Clay, orange-buff, containing fine to coarse angular to subrounded grains of quartz	10	3,070
Conglomerate, deeply weathered, subangular to subrounded, containing very coarse pebbles, and a trace of vesicular lava. Slightly to deeply weathered subangular to subrounded pebbles below 3,120. Trace of clay and pebbles of deeply weathered granite below 3,130	70	3,140
Conglomerate, derived from fine to coarse textured acidic rocks. Material deeply weathered with a trace of vesicular lava below 3,160. Considerable clay below 3,170. Considerable fine to coarse subangular to subrounded grains of olivine below 3,180. Fresh-water ostracod at about 3,190	60	3,200
Conglomerate, fine to very coarse, slightly to deeply weathered, with angular to subrounded fragments of basic rocks. Considerable clay and deeply weathered water-worn pebbles below 3,220. Considerable granitic material and a trace of vesicular basaltic lava below 3,250. Abundant clay derived from decomposed feldspar below 3,260. Weathered basic material and olivine below 3,270. Abundant clay and a trace of lava below 3,280	90	3,290
Clay, light-orange to buff, containing abundant quartz and mica with some pebbles. Considerable very coarse subangular to subrounded pebbles below 3,310. Unit contains a trace of gray shale and abundant coarse pebbles below 3,320 and medium to coarse angular to subangular grains of quartz below 3,330. A few very silicious clay pebbles below 3,340. Trace of weathered red vesicular lava below 3,350	70	3,360
Conglomerate, containing very coarse grains of weathered granitic and basic material. Unit contains clay below 3,380. Material is deeply weathered below 3,390. Unit contains abundant clay below 3,400 and some basic debris below 3,450 and a trace of lava below 3,460	110	3,470
Clay, very silty, buff, containing grains of coarse conglomerate. Unit contains deeply weathered pebbles below 3,490	30	3,500
Conglomerate, very coarse, containing abundant clay and subangular to subrounded pebbles. Unit contains very coarse deeply weathered pebbles below 3,530 and a trace of clay below 3,540	50	3,550
Conglomerate, deeply weathered, containing clay. Unit contains a trace of basic debris below 3,570 and deeply weathered pebbles below 3,590	50	3,600
Conglomerate, medium to very coarse, containing clay and grains of basic material. Unit contains pebbles composed of loosely consolidated very fine to medium angular grains of quartz. First lava flow at 3,645. Lava is deeply weathered and vesicular. Unit contains pinkish-buff, silicious clay and flakes of mica and quartz pebbles below 3,670	100	3,700
Clay, very silicious, buff, containing coarse grains of quartz and flakes of mica. Unit contains trace of pyrite and cemented conglomerate below 3,710 and very coarse secondary calcareous crystalline limestone below 3,720 and slightly weathered grains of feldspar porphyry below 3,750	60	3,760
Conglomerate, subangular, containing granite debris	10	3,770
Granite and basic debris; pinkish-red (boulder)	10	3,780
Conglomerate, granular, pinkish-red, containing arkosic debris; slightly weathered	10	3,790
Granite, fine- to medium-textured, slightly weathered, red, containing some basic debris	10	3,800
Granite wash and basic debris. Partly weathered below 3,820. Silicious clay containing conglomerate and subrounded pebbles below 3,830	40	3,840

	Thickness (feet)	*Depth (feet)*
Conglomerate, deeply weathered, fine- to very coarse-grained, containing clay. Partly weathered very coarse fragments of feldspar below 3,850. Very coarse (as much as 18 mm in diameter) angular to subangular pebbles below 3,860. Material is deeply weathered below 3,870. Abundant angular to subrounded basic debris below 3,890	60	3,900
Conglomerate, deeply weathered, very coarse-grained; contains some basic material. Unit appears to be derived from coarse-textured light-colored igneous rocks below 3,910. Weathered granite wash below 3,930. Basic debris below 3,950	60	3,960
Conglomerate, fine- to very coarse-grained, angular to subangular, containing basic debris. Unit contains deeply weathered granite wash below 3,970	20	3,980
Granite wash, deeply weathered, pinkish-buff, contains a trace of basic debris below 3,990, and clay below 4,000 and subangular to subrounded basic pebbles below 4,040	70	4,050
Granite wash and conglomerate; contains basic debris. Basic debris principally olivine below 4,080	50	4,100
Granite wash and conglomerate; deeply weathered; containing basic debris. Abundant coarse subangular basic pebbles below 4,120. Conglomerate is medium to very coarse grained below 4,140	50	4,150
Conglomerate, very coarse-grained, containing granite wash and basic debris. Abundant basic debris below 4,210. Unit contains buff clay below 4,220	80	4,230
Granite wash, deeply weathered, containing coarse subangular to subrounded pebbles. Unit contains basic material below 4,240 and sandy conglomerate with clay below 4,250	30	4,260
Granite wash, deeply weathered, containing basic pebbles	10	4,270
Clay, siliceous, pink to buff and tan, containing coarse pebbles	20	4,290
Clay, buff and tan, containing coarse pebbles, basic material and a little granite wash	30	4,320
Conglomerate, deeply weathered, containing clay, coarse pebbles of granite, lava, and granite wash. Material is fine to coarse grained below 4,330. Unit contains basic debris below 4,340	40	4,360
Clay, siliceous, pink to pale-green and buff, containing pebbles and a trace of weathered granite wash. Unit contains abundant pebbles below 4,370 and weathered basic debris below 4,380	40	4,400
Clay, sandy, pale-green, with interbedded grains of basic material. Unit contains siliceous pebbles below 4,420	30	4,430
Conglomerate, coarse-textured, containing granite wash and basic debris. Lava is deeply weathered below, 4,440. Material is derived from basic rocks below 4,450. Unit contains buff, tan, and pale-green siliceous clay below 4,470 and contains coarse pebbles derived from basic rocks below 4,480. Pebbles are derived from basic and acidic igneous rocks below 4,500	80	4,510
Clay, siliceous, pale-green and buff, containing angular to subangular grains of quartz. Material consists of basic rock below 4,530. Weathered granite wash below 4,540	40	4,550
Conglomerate, fine- to coarse-grained, varicolored, containing basic and acidic debris. Unit contains weathered lava below 4,560. Material is deeply weathered and contains granite wash below 4,580. Sampled section from 4,522 to 4,605 may be deeply weathered lava flow or material derived from lava	80	4,630
Clay, pale-green, buff, tan, in part siliceous, containing fine to coarse pebbles and a little clay. Clay is sandy below 4,650 and siliceous below 4,660. Material is deeply weathered below 4,690	70	4,700
Congomerate, varicolored, containing medium to very coarse basic pebbles and a few grains of quartz. Unit contains abundant grains of nephelite(?) below 4,710. Unit is primarily a basic breccia below 4,720. Material is weathered below 4,730. Unit contains a trace of buff to pale-green clay below 4,740, considerable clay below 4,760, and a trace of siliceous clay below 4,770	90	4,790
Conglomerate and breccia; basic. Unit is weathered and contains siliceous		

	Thickness (feet)	Depth (feet)
clay below 4,800. Unit contains buff siliceous clay and pink granite wash below 4,810, siliceous and sandy clay with fragments of conglomerate and breccia below 4,820, and abundant pink, buff, tan, and pale-green siliceous clay with some pebbles below 4,840	80	4,870
Conglomerate, containing very coarse pebbles	10	4,880
Breccia, basic, containing pebbles. Material is weathered below 4,890	20	4,900
Conglomerate and breccia; basic; deeply weathered	10	4,910
Clay and andesitic breccia; contains clay and pebbles below 4,920 and is in part weathered to siliceous clay below 4,940	40	4,950
Clay, siliceous, buff, pink, and tan, containing a trace of conglomerate and breccia. Unit contains mica and very fine to fine angular to subangular grains of quartz below 4,960. Material is decomposed below 4,970. Unit contains coarse-textured basic breccia and conglomerate below 5,010 and deeply weathered pebbles in clay matrix below 5,020	140	5,090
Clay, siliceous, drab-gray, containing conglomerate with coarse pebbles	10	5,100
Clay, micaceous, siliceous, varicolored, containing some basic pebbles. Unit contains basic breccia below 5,140, weathered basic debris below 5,160, very coarse subrounded pebbles below 5,190, and water-worn pebbles below 5,200	110	5,210
Undifferentiated Miocene(?) rocks:		
Breccia, basic, containing clay	20	5,230
Conglomerate and breccia; very coarse; varicolored; containing clay. Material is deeply weathered and contains considerable siliceous clay below 5,280 and a small amount of clay below 5,290	70	5,300
Breccia, basic, weathered, containing clay. Unit contains coarse pebbles below 5,310, very coarse breccia below 5,320	60	5,360
Lava, felsitic, containing a trace of hornblende and mica phenocrysts	20	5,380
Clay, siliceous, pink to yellow and yellowish-buff, containing some conglomerate	10	5,390
Conglomerate, coarse, varicolored, containing some lava and siliceous clay. Unit contains felsitic lava below 5,400	20	5,410
Conglomerate and breccia; basic; deeply weathered; containing clay	10	5,420
Clay, siliceous, pink to yellow and yellowish-buff, containing conglomerate. Unit contains very coarse basic breccia below 5,430	20	5,440
Lava, felsitic, slightly weathered, red. Unit contains very coarse pebbles below 5,450 and andesitic breccia below 5,460	30	5,470
Breccia, basic, containing diorite and andesite. Unit contains clay and a few pebbles below 5,500, siliceous clay and green, red, and brown conglomerate below 5,520. Slightly weathered basic breccia below 5,530	70	5,540
Lava (?), basic, felsitic (?)	10	5,550
Conglomerate and breccia; basic	20	5,570
Lava, slightly weathered, andesitic, greenish-black. Contains slightly weathered and slightly conglomeratic basic breccia below 5,580	30	5,600
Breccia, basic, slightly conglomeratic, varicolored. Unit contains conglomerate with green, tan, and buff siliceous clay below 5,610	20	5,620
Lava, slightly weathered, containing breccia	30	5,650
No samples	10	5,660
Conglomerate, varicolored, containing coarse pebbles and some clay. Material is coarse to very coarse grained and contains basic debris below 5,670	20	5,680
Clay, siliceous and sandy, varicolored, containing some deeply weathered conglomerate	10	5,690
Conglomerate and breccia; mostly basic; weathered	20	5,710
Lava, basic, weathered, brecciated, red, green and brown, containing coarse pebbles below 5,720 and very coarse basic conglomerate below 5,730	30	5,740
Conglomerate and breccia; consisting mainly of basic rocks. Contains lava breccia below 5,750 and some weathered conglomerate below 5,770. Unit is deeply weathered and contains some clay below 5,800 and basic breccia below 5,810	90	5,830
Lava, basaltic, slightly porphyritic, weathered. Unit contains andesite below 5,850	30	5,860

	Thickness (feet)	*Depth (feet)*
Conglomerate and breccia; weathered; containing basic rocks. Unit contains considerable andesite below 5,970	140	6,000
Conglomerate and breccia; basic; deeply weathered	10	6,010
Clay	10	6,020
Breccia, andesitic and basaltic	10	6,030
Conglomerate, consisting of very coarse pebbles of basic and acidic rocks. Material is slightly weathered below 6,060	40	6,070
Conglomerate and breccia; mostly basic; deeply weathered. Material is slightly weathered below 6,080	30	6,100
Conglomerate and breccia; mostly basic; slightly weathered. Unit contains considerable lava below 6,110, contains very glassy material below 6,150, is mostly breccia below 6,160 and contains considerable lava-derived material below 6,180	100	6,200
Breccia, basic, red to light-gray, containing feldspar. Unit contains conglomerate below 6,210. Second lava flow encountered at 6,218. Considerable glassy-textured material and a little clay below 6,220. Material is light colored, red, and gray and is in part weathered below 6,230	40	6,240
Breccia, varicolored, containing porphyritic rock with flaky groundmass. Unit contains siliceous clay with dark basic material and conglomerate below 6,260. Unit contains a little siliceous clay below 6,270. Entire rock is similar to felsite porphyry but may be too glassy. Section from 6,218 to 6,340 may be slightly weathered lava flow	100	6,340
Conglomerate and breccia; deeply weathered; containing pebbles that are very coarse and mostly basic. Unit contains green and grayish-green clay below 6,370, green basic rocks below 6,380, and a little clay below 6,420	90	6,430
Breccia or slightly weathered felsitic flow	10	6,440
Conglomerate and breccia; slightly weathered. Unit contains very coarse to coarse pebbles below 6,450. Most of the breccia consists of basic rocks, with considerable weathering below 6,470. Unit contains a trace of red vesicular lava below 6,490	60	6,500
Conglomerate and breccia; basic; slightly weathered; containing clay. Material is deeply weathered below 6,510, contains clay and dark breccia below 6,560, contains fragments of vesicular lava below 6,570, contains dark basic breccia below 6,600, and is slightly weathered below 6,610. Unit contains light-colored, felsitic, slightly weathered, brecciated, porphyritic lava flow (third flow) at 6,630. Phenocrysts in lava flow are mica and hornblende. Unit contains pebbles below 6,710	340	6,840
Conglomerate and breccia; deeply weathered; containing clay. Unit contains light-colored felsitic lava below 6,850	40	6,880
Conglomerate and breccia; deeply weathered; containing abundant clay. Unit contains mostly basic rocks below 6,920, is glassy and light-colored and has a trace of granular quartzitic rock below 6,940, is deeply weathered and contains conglomerate below 6,950, and contains basic breccia below 6,970	120	7,000
Breccia, basic; containing fragments of lava. Unit is deeply weathered and contains some pebbles below 7,010, contains very coarse pebbles between 7,030 and 7,040, and contains only a trace of pebbles below 7,040	100	7,100
Breccia, basic, containing fragments of lava and a few pebbles	20	7,120
Lava, basic, slightly weathered, brecciated, green and red. Material is deeply weathered below 7,130	20	7,140
Conglomerate and breccia; basic; green and grayish-green. Material is slightly weathered below 7,180 and deeply weathered below 7,190	60	7,200
Conglomerate and breccia; very deeply weathered; containing some clay	20	7,220
Breccia, basic, weathered; containing fragments of lava. Unit is slightly weathered and contains considerable andesitic debris below 7,230, contains pebbles below 7,240, contains clay, conglomerate, and breccia below 7,250, contains considerable clay below 7,270, contains abundant coarse pebbles below 7,280, and contains conglomerate and clay below 7,290	80	7,300
Conglomerate, containing very coarse pebbles and clay	10	7,310
Conglomerate and breccia; mostly basic; containing some clay. Unit contains fragments of lava below 7,320. Material is deeply weathered below 7,330	30	7,340

	Thickness (feet)	Depth (feet)
Breccia, basic, slightly weathered, containing fragments of lava. Unit contains a few pebbles below 7,370 and a little clay below 7,380	50	7,390
Breccia, slightly weathered, containing a little clay	10	7,400
Conglomerate and breccia; partly weathered; containing fragments of granitic rocks	20	7,420
Breccia, arkosic, deeply weathered, containing fragments of porphyritic granite. Unit contains a trace of basic debris below 7,440 and basic lava below 7,450	40	7,460
Breccia, basic, containing fragments of lava. Material is considerably weathered and contains a few coarse pebbles below 7,480	30	7,490
Conglomerate, very coarse, containing some basic breccia	10	7,500
Conglomerate and breccia; very coarse; containing fragments of lava. Unit contains considerable breccia below 7,510	30	7,530
Breccia, very dark-colored, containing fragments of lava	10	7,540
Conglomerate and breccia; dark-colored. Material is weathered below 7,550	20	7,560
Conglomerate and breccia; containing fragments of fine- to coarse-textured acid and basic rocks. Material is very deeply weathered below 7,590	50	7,610
Conglomerate and breccia; containing fragments of acid and basic debris	20	7,630
Breccia, pink to white, containing weathered felsitic lava. Unit contains considerable conglomerate below 7,640	20	7,650
Conglomerate and breccia	30	7,680
Conglomerate, varicolored, containing very coarse pebbles. Material is deeply weathered and contains clay below 7,720	60	7,740
Breccia, deeply weathered, light-colored, contains fragments of basic rocks	10	7,750
Breccia, deeply weathered, light-colored, containing fragments of lava	20	7,770
Lava, pale-purple to red, in part weathered (felsitic flow?). Unit contains fragments of lava below 7,790	30	7,800
Breccia, containing some andesitic or basaltic material. Unit contains conglomerate below 7,810	20	7,820
Conglomerate and breccia; basic; orange-buff to green. Unit contains fragments of lava below 7,830	30	7,850
Conglomerate, light-colored; containing considerable leached and weathered rocks. Unit contains considerable clay below 7,910, is deeply weathered below 7,930, and is pale-purple to red and green and contains considerable clay below 7,960	150	8,000
Conglomerate, pale-purple, red and green, containing fragments of granite, mica, and weathered igneous rocks. Unit contains considerable clay below 8,010	23	8,023

NOTE.—There probably are many thin lava flows in addition to the three that are indicated in the log.

SELECTED BIBLIOGRAPHY

Bayard, K. O., and Ahrens, T. P., 1943, A wartime facilities plan for the west slope of the San Luis Valley, Saguache, Alamosa, and Rio Grande Counties, Colo.: U. S. Dept. Agriculture Bur. Agr. Economics, mimeo. report, 26 p.

Bennison, E. W., 1947, Ground water, its development, uses, and conservation: St. Paul, Minn., Edward E. Johnson, Inc., p. 123–282.

Bryan, Kirk, 1938, Geology and ground-water conditions of the Rio Grande depression in Colorado and New Mexico, Regional planning, pt. 6, upper Rio Grande: Nat. Res. Comm., Washington, D. C., p. 197–225.

Burbank, W. S., and Goddard, E. N., 1937, Thrusting in Huerfano Park, Colo., and related problems of orogeny in the Sangre de Cristo Mountains: Geol. Soc. America Bull., v. 48, no. 7, p. 931–976.

Carpenter, L. G., 1891, Artesian wells of Colorado and their relation to irrigation: Colo. Agr. Coll. Expt. Sta. Bull. 16, p. 17–27.

Code, W. E., 1952, Underground water resources of Colorado, *in* A hundred years of irrigation in Colorado: Colo. Water Conserv. Board and Colo. Agr. Mech. Coll., p. 49–55.

Cope, E. D., 1874, Notes on the Santa Fe marls, and some of the contained vertebrate fossils: Phila. Acad. Nat. Sci. Proc. 1874, p. 147–152.

Cross, Whitman, and Larsen, E. S., 1935, A brief review of the geology of the San Juan region of southwestern Colorado: U. S. Geol. Survey Bull. 843.

Davison, M. H., 1939, Irrigation pumping plants—construction and costs: Kans. State Board Agriculture, Div. Water Res., v. 58, no. 231–C, p. 1–52.

Dean, H. T., 1936, Chronic endemic dental fluorosis: Am. Med. Assoc. Jour., v. 107, p. 1269–1272.

Denny, C. S., 1938, Santa Fe formation [abs.]: Geol. Soc. America Bull., v. 49, no. 12, pt. 2, p. 1877.

Frick, Childs, 1933, New remains of trilophodont-tetrabelodont mastodons: Am. Mus. Nat. History Bull., v. 59, art. 9, p. 505–652.

Jacob, C. E., 1944, Notes on determining permeability by pumping tests under water-table conditions, *in* [in part] Cooper, H. H., Jr., and Jacob, C. E., 1946, A generalized graphical method for evaluating formation constants and summarizing well-field history: Am. Geophys. Union Trans., v. 27, no. 4, p. 526–534.

Jacob, C. E., and Lohman, S. W., 1952, Nonsteady flow to a well of constant drawdown in an extensive aquifer: Am. Geophys. Union Trans., v. 33, no. 4, p. 559–569.

Johnson, J. H., 1929, Contributions to the geology of the Sangre de Cristo Mountains of Colorado: Colo. Sci. Soc. Proc., v. 12, p. 3–21.

Lowry, R. L., and Johnson, A. F., 1942, Consumptive use of water for agriculture: Am. Soc. Civil Engineers Trans., v. 107, p. 1243.

Meinzer, O. E., 1923a, The occurrence of ground water in the United States, with a discussion of principles: U. S. Geol. Survey Water-Supply Paper 489, 321 p.

——— 1923b, Outline of ground-water hydrology, with definitions: U. S. Geol. Survey Water-Supply Paper 494, 71 p.

Meinzer, O. E., and Wenzel, L. K., 1942, Hydrology: New York, McGraw-Hill Book Co., Inc., p. 385–477.

Richards, L. A., 1954, Diagnosis and improvement of saline and alkali soils: U. S. Dept. Agriculture, Agr. Handb. no. 60, p. 69–82.

Robinson, T. W., and Waite, H. A., 1938, Ground water in the San Luis Valley, Colo., Regional planning, pt. 6, upper Rio Grande: Nat. Res. Comm., Washington, D. C., p. 226–267.

Rohwer, Carl, 1940, Putting down and developing wells for irrigation: U. S. Dept. Agriculture Circ. 546, p. 1–86.

Siebenthal, C. E., 1910, Geology and water resources of the San Luis Valley, Colo.: U. S. Geol. Survey Water-Supply Paper 240, 228 p.

Stearns, N. D., 1927, Laboratory tests on physical properties of water-bearing materials: U. S. Geol. Survey Water-Supply Paper 596–F, p. 121–176.

Theis, C. V., 1935, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage: Am. Geophys. Union Trans., 16th Ann. Mtg., pt. 2, p. 519–524.

Thiessen, A. H., 1911, Precipitation averages for large areas: Monthly Weather Rev., July, p. 1082.

Tipton, R. J., 1939, San Luis Valley project, Wagon Wheel Gap Reservoir, Platoro Reservoir, Mogote Reservoir, Closed Basin Drain: Colo. Water Conserv. Board, v. 1, 166 p.

Tipton, R. J., and Hart, F. C., 1931, Consumptive use determinations, evaporation experiments, drainage measurements: Office State Engineer, Denver, Colo., Ms. copy in open file.

Upson, J. E., 1939, Physiographic subdivisions of the San Luis Valley, southern Colorado: Jour. Geology, v. 47, no. 7, p. 721–736.

Wenzel, L. K., 1942, Methods for determining permeability of water-bearing materials: U. S. Geol. Survey Water-Supply Paper 887, p. 1–92.

White, W. N., 1916, The San Luis Valley, Colo., Irrigation from artesian wells and general irrigation and drainage problems involved in land classification: Ground Water Branch, U. S. Geol. Survey, Denver, Colo., Ms. copy in open file.

——— 1932, A method of estimating ground-water supplies based on discharge by plants and evaporation from soil; results of investigations in Escalante Valley, Utah: U. S. Geol. Survey Water-Supply Paper 659–A, p. 24–86.

Wilcox, L. V., 1948, The quality of water for irrigation use: U. S. Dept. Agriculture Tech. Bull. 962, 40 p.

INDEX

☆ U. S. GOVERNMENT PRINTING OFFICE: 1957—428468