Ground-Water Resources of the Middle Loup Division of the Lower Platte River Basin Nebraska

By DELBERT W. BROWN

With a section on

CHEMICAL QUALITY OF THE GROUND WATER

By FRANK H. RAINWATER

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GROUND-WATER RESOURCES OF THE MIDDLE LOUP DIVISION OF THE LOWER PLATTE RIVER BASIN NEBRASKA

By Delbert W. Brown

ABSTRACT

The Middle Loup division of the lower Platte River basin is an area of 650 square miles which includes the Middle Loup River valley from the confluence of the Middle and North Loup Rivers in Howard County, Nebr., to the site of the diversion dam that the U. S. Bureau of Reclamation proposes to construct in Blaine County near Milburn, Nebr. It also includes land in Howard and Sherman Counties designated by the Bureau of Reclamation as the Farwell unit. Irrigable land in this division is present on both sides of the Middle Loup River and along its tributaries. Most of the Middle Loup River valley is already irrigated by the Middle Loup Public Power and Irrigation District, which is strictly an irrigation enterprise. The uplands are not irrigated.

Loess, dune sand, gravel, silt, and clay of Pleistocene or Recent age are exposed in the report area. These unconsolidated sediments rest on bedrock consisting of alternating layers of shale, mudstone, sandstone, and limestone, which are essentially flat lying or slightly warped. The Ogallala formation, of Tertiary (Pliocene) age, immediately underlies the Pleistocene sediments and rests on the Pierre shale of Cretaceous age. Belts of alluvium occupy the Middle Loup River valley and the valleys of the principal streams in the area. The soils, dune sand, and terrace deposits are the most recent deposits.

The Ogallala formation is water bearing and is the source of supply for some domestic and livestock wells. The saturated part of the sand and gravel formations of Pleistocene age, which yields water freely to wells, is the most important aquifer in the Middle Loup division. The water generally is under water-table conditions. The yields of properly constructed wells range from a few gallons per minute (gpm) to as much as 1,800 gpm. Some wells tap water in both the sand and gravel of Pleistocene age and in the underlying Ogallala formation. No wells are known to penetrate into formations older than the Ogallala.

Fluctuations of the water table indicate changes in the amount of ground water stored in the water-bearing formations. The principal factors controlling the rise of the water table are the amount of precipitation within the area, the quantity of water coming into the area as underflow from the west and northwest, seepage from the Middle Loup River at times when the water surface in the river is higher than the adjoining water table, and the infiltration of irrigation water not utilized by vegetation or lost by runoff or evaporation. The principal factors controlling the decline of the water table are the discharge as effluent seepage into the Middle Loup River and its tributaries, the amount of water pumped from wells, evapotranspiration losses, and the amount of water leaving the area as underflow.

Periodic water-level measurements were made in a total of 241 observation wells during the period 1948–50. Hydrographs of three observation wells having a longer period of record (1934–50) indicate that the water table rose slightly from 1934 until 1950 and that it remained nearly constant during the 1950 water year.

The configuration of the water table in the Middle Loup division shows that, except north and northwest of Sargent, the Middle Loup River is an effluent, or gaining, stream throughout its entire length in this area. Thus any rise or fall in the ground-water level will increase or decrease the discharge of the river. The river recharges the ground-water reservoir only during periods when it is at flood stage.

The depth to the water table from the land surface is governed largely by irregularities in topography. The depth to water is less than 10 feet near the river and increases to as much as 60 feet near the valley margins and the bordering intermediate slopes. In the Farwell unit the depth to water is more than 100 feet and in some parts more than 150 feet. Ground water pumped from wells is the source of supply for the principal municipalities in the Middle Loup River valley and in the Farwell unit.

Ground water in the lower Middle Loup River valley is of the calcium bicarbonate type and contains high concentrations of silica. Although the water is hard, it is otherwise satisfactory for general domestic use. Two samples contain concentrations of nitrate above the permissible limits recommended for infant feeding. Because the mineral content, percent sodium, and boron concentration are low, the water is exceptionally well suited for use in irrigation.

Little change in chemical quality of the ground water should result from the proposed irrigation practices, except in those areas where the water table may be raised to a level that would bring the capillary zone in contact with either the soil surface or the root zone.

INTRODUCTION

LOCATION AND EXTENT OF THE AREA

The area covered by this report is the floor of the Middle Loup River valley in Nebraska from the confluence of the Middle and North Loup Rivers in Howard County to the proposed Milburn diversion dam site of the U. S. Bureau of Reclamation in Blaine County. The area includes also those lands designated by the Bureau of Reclamation as the Farwell unit in Howard and Sherman Counties. The entire area encompasses approximately 650 square miles and comprises parts of the following counties: Howard, Sherman, Valley, Custer, and Blaine. (See figs. 1 and 2 for location of the

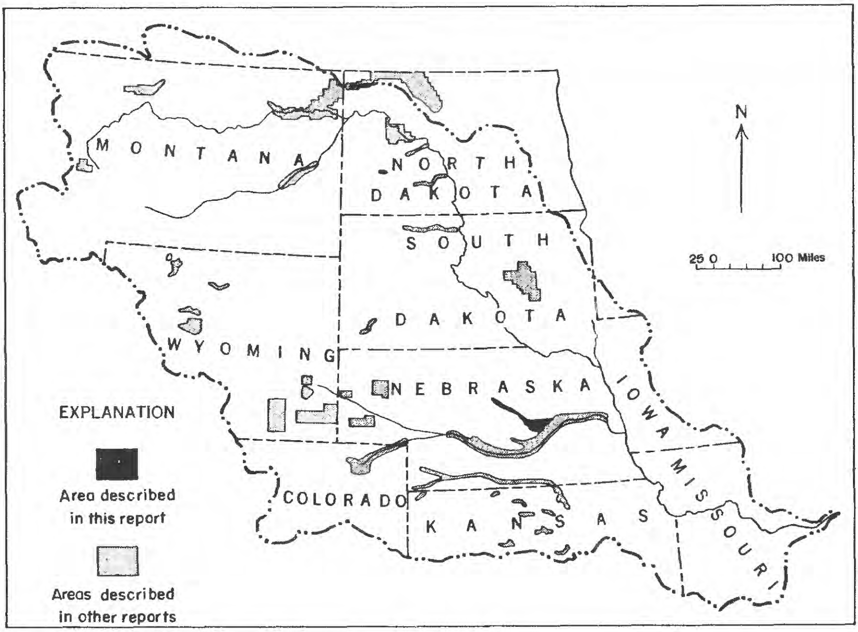

Figure 1. — Map of the Missouri River basin showing areas in which ground-water studies have been made under the Missouri River basin program.

area.) It is part of the Middle Loup division of the lower Platte River basin for which the Bureau of Reclamation has proposed a plan for the full development of the water resources.

The region is gently rolling. It has low relief; flat, wide, stream valleys; and low intervening upland divide areas mantled with loess or dune sand. The loess hills area is mantled with silty soil or loess and is therefore an area where the precipitation runs off rapidly into the intermittent gulleylike tributaries. The sand hills area is mantled with dune sand, a more pervious material, and consequently it is an area having little surface runoff. The part of

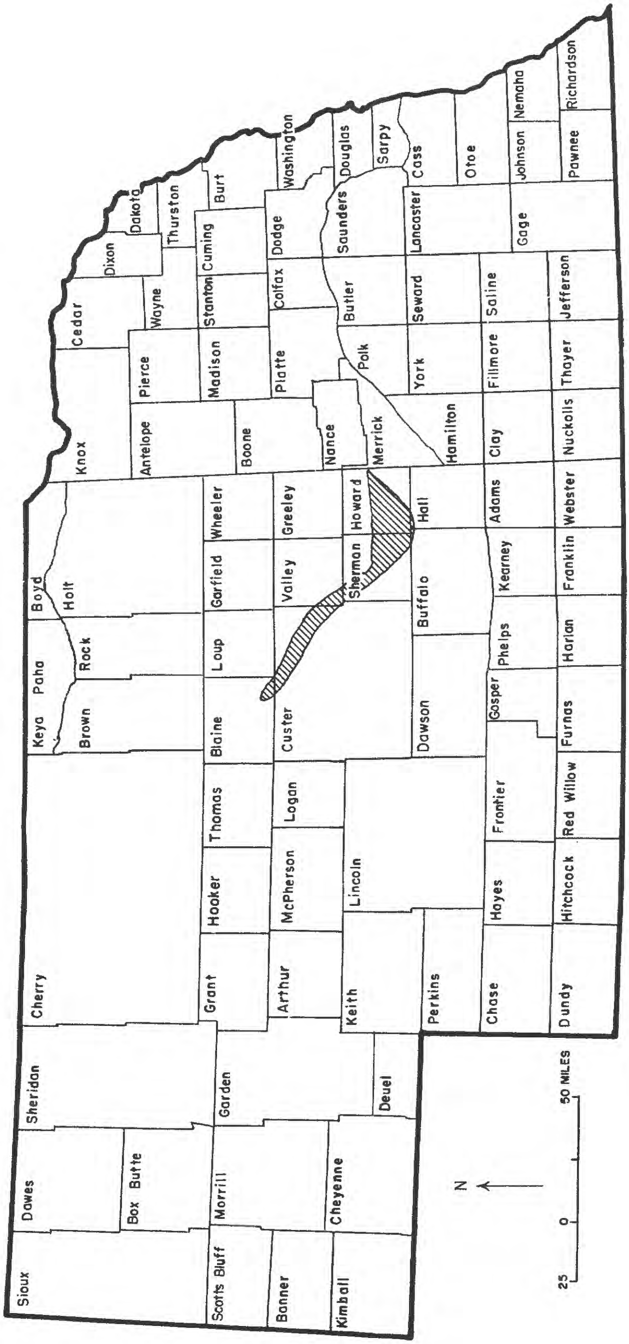

Figure 2. —Map of Nebraska showing, by ruling, the area covered by this report.

the Middle Loup River valley described in this report is about 112 miles long, and the valley floor ranges in width from about 1 to 2.5 miles. The river from St. Paul to its headwater has about 7,720 square miles in its watershed and, of this total, about 3,200 square miles contributes directly to surface-water runoff. The western boundary of the area is near the transitional boundary of the loess plains of central Nebraska and the great Sand Hills region of west-central Nebraska.

PREVIOUS INVESTIGATIONS

There has been no previous detailed investigation of the ground-water resources of the area. A report by Lugn and Wenzel (1938) did, however, include a very brief reference to the extreme south-eastern part.

Relatively long-term water-level records are available for three observation wells, 19–18–9aa near Sargent, 13–12–29ba near Boelus, and 14–10–14bb near St. Paul. These wells were selected in 1934 in connection with a statewide observation-well program carried on jointly by the Conservation and Survey Division of the University of Nebraska and the Ground Water Branch of the U. S. Geological Survey.

THE PRESENT INVESTIGATION

The investigation, on which this report is based, is one of several ground-water studies being made in connection with the Department of the Interior's program for the development of the Missouri River basin. The ground-water resources of Nebraska have been cooperatively investigated since July 1, 1930, by the U. S. Geological Survey and the Conservation and Survey Division of the University of Nebraska. Beginning in 1945, the scope of ground-water investigations in Nebraska was greatly expanded as part of a comprehensive program in the Missouri River basin. The work was undertaken jointly by the U. S. Geological Survey and the U. S. Bureau of Reclamation with the continued cooperation of the Conservation and Survey Division, University of Nebraska. These expanded studies included the Middle Loup River basin described in this report.

The field work for this report was begun in November 1949 and was concluded in October 1950. Previous to November 1949 other field work had been done in the area but it was on a very small scale and was restricted largely to the expansion of the observation-well program in the valley. This report is based on the following:

(1) Installation of 122 3/4-inch diameter observation wells. Of these, 99 were installed by jetting methods and 23 were hand augered or driven.

(2) Inventory of 119 existing irrigation and domestic wells selected as desirable control points necessary for the construction of maps showing the depth to water and configuration of the water table. Information on all observation wells are included in the table of well descriptions at the end of this report.

(3) Inventory of the public-supply wells of the principal towns in the area. The records of these public-supply wells are given in the table of municipal wells.

(4) Collection of ground-water samples for chemical analysis from 20 representative wells.

(5) Determination of the altitude of the measuring points at all observation and inventory wells by a Bureau of Reclamation level party. The altitudes, minus the depth to water in the observation wells, served as controls for the construction of the water-table contour map of the area.

(6) Construction of maps showing the configuration of the water table by means of contour lines.

(7) Construction of maps showing the depth to the water table from the land surface.

(8) Preparation of hydrographs showing the changes in water level in 15 observation wells during their respective periods of record.

Many of the observation wells installed by the Geological Survey were for the purpose of ascertaining the effects on the ground-water conditions in the area caused by the operation of existing and proposed surface-water irrigation projects, These wells were installed near existing irrigation structures and those planned for the Sargent and Farwell projects where the present position of the water table has already been determined.

Other observation wells were installed to obtain coverage of the entire area.

WELL-NUMBERING SYSTEM

The well-numbering system used in this report was adopted in Nebraska at the beginning of Missouri River basin ground-water studies. (See fig. 3.) In the well-location number the first set of

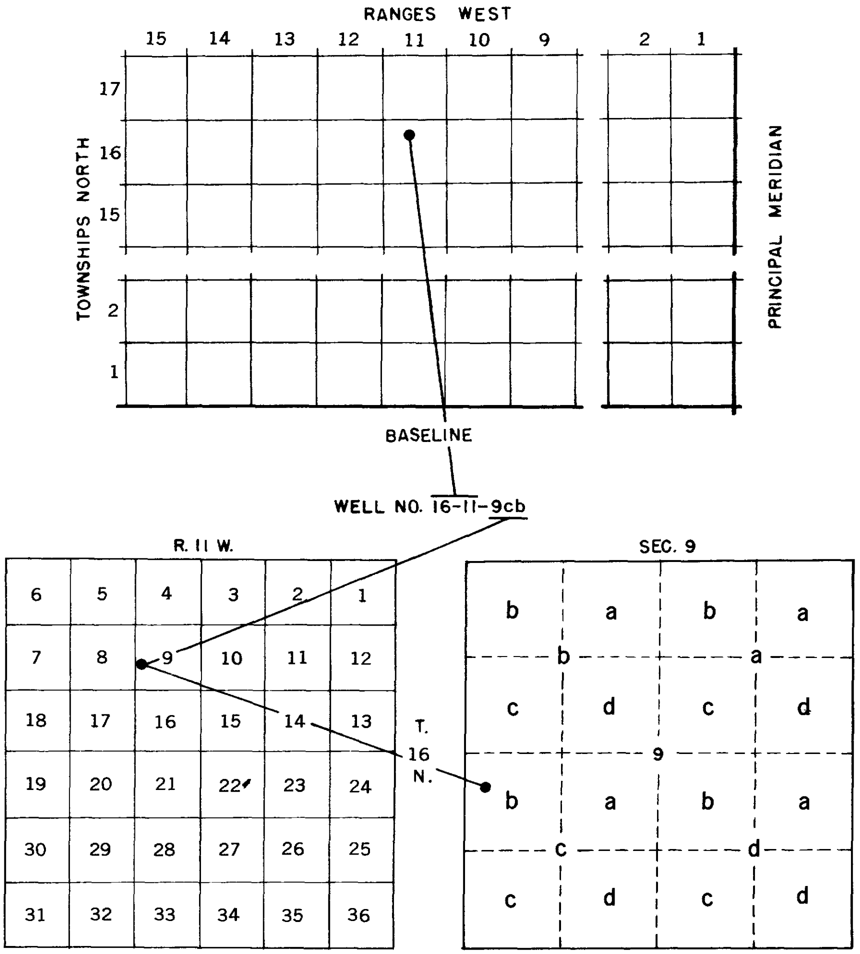

Figure 3.—Sketch showing system of well identification.

figures indicates the township, the second the range, and the third the section. The lowercase letters that follow the section number indicate the position of the well within the section, the first letter indicating the quarter section and the second letter the quarter-quarter section. The letters a, b, c, and d are applied in a counter-clockwise direction, beginning with the letter a in the northeast quadrant. A figure following the last letter indicates the number of the well within the tract of land indicated, but if only one well is situated within that tract no number is shown.

PERSONNEL

The investigation in the Middle Loup division was carried on under the general supervision of A. N. Sayre, chief of the Ground Water Branch of the U. S. Geological Survey, and G. H. Taylor, regional engineer in charge of the Missouri River basin ground-water investigations. The study was under the direct supervision of H. A. Waite, district geologist in charge of ground-water investigations in Nebraska. The quality-of-water studies were under the general supervision of S. K. Love, chief of the Quality of Water Branch, and P. C. Benedict, regional engineer in charge of Missouri River basin water quality investigations.

ACKNOWLEDGMENTS

Appreciation is expressed to the U. S. Bureau of Reclamation for establishing mean sea-level altitudes of the measuring points on all the observation wells in the area. The personnel of that agency were very cooperative and helpful at all times. The author is indebted also to the many residents of the area who gave permission for the measurement of water levels in their wells and who freely supplied information regarding them.

GEOGRAPHY

AGRICULTURE

The chief industry of the Middle Loup division is agriculture. The upper part of the valley is devoted almost entirely to grazing and hay production; the lower part, to general farming. The earliest agricultural activity in the area by the white man was cattle raising. This was begun in the years 1869-70 and consisted only of grazing cattle on the open range. Grain farming began to replace open-range ranching about 1872 or 1873, the first homesteads established in the area being in the Middle Loup River valley where an abundance of wood for fuel and water for domestic use could be obtained. The early agricultural development was slow and it was not until after 1900 that the population began to increase significantly. Soon after 1900 also, a better understanding of the climate and soil requirements began to show a favorable effect on the economy of the area.

Under the present agricultural system the valley lands and the more nearly level tablelands are held in comparatively small farms of 160 to 320 acres. The need for supplemental water for irrigation became apparent during the 1930's because of the drought in that period. As a result, the Middle Loup Public Power and Irrigation District was formed and the irrigation system constructed; consequently the farmers in the district have surface water available for irrigation. Some farmers who are not in the district have installed irrigation wells. The availability of irrigation water has resulted in a tendency for large ranches to be replaced by smaller, irrigated farms. According to the U. S. Census of Agriculture: 1950, the principal farm crops are corn, wheat, oats, wild hay, alfalfa, rye, and barley, ranking in acreage in the order named.

TRANSPORTATION

Most of the area is served by good transportation facilities. A spur of the Union Pacific Railroad from St. Paul, Nebr., extends southwest through Dannebrog and Boelus to Loup City. The Chicago, Burlington & Quincy Railroad has a branch line from Central City, Nebr., which traverses the Farwell unit and services the towns of St. Paul, Farwell, Ashton, and Loup City; this branch continues up the Middle Loup River valley to Sargent, Nebr., where it terminates.

State and Federal highways extend up the valley to Sargent. The towns of St. Paul, Farwell, Ashton, and Loup City are on hard-surfaced highways. The rest of the towns are served by good gravel-surfaced highways. Throughout most of the area the secondary roads follow section lines but in the Sand Hills region they conform to the topography and usually follow the valleys. The farm products, consisting principally of wheat, corn, cattle, and hogs, are transported out of the area by truck or train and are marketed chiefly in Omaha, Nebr.

CLIMATE

Precipitation.—Precipitation gages at St. Paul, Loup City, Arcadia, and Sargent, Nebr., are maintained by the U. S. Weather Bureau. The stations have different lengths of record, but St. Paul has the longest continuous record, extending from 1895 to the present time.

Most of the precipitation falls during the growing season, from March to October, the most intense precipitation usually accompanying local thunderstorms in summer. The average growing season at Loup City, from the last killing frost in the spring to the first killing frost in the fall, is 148 days and at St. Paul it is 150 days. The rainy season usually occurs in late spring and early summer and it favors the rapid growth of winter wheat and spring-planted small grains. The summer precipitation distribution is usually less favorable to crop growth, and during August and

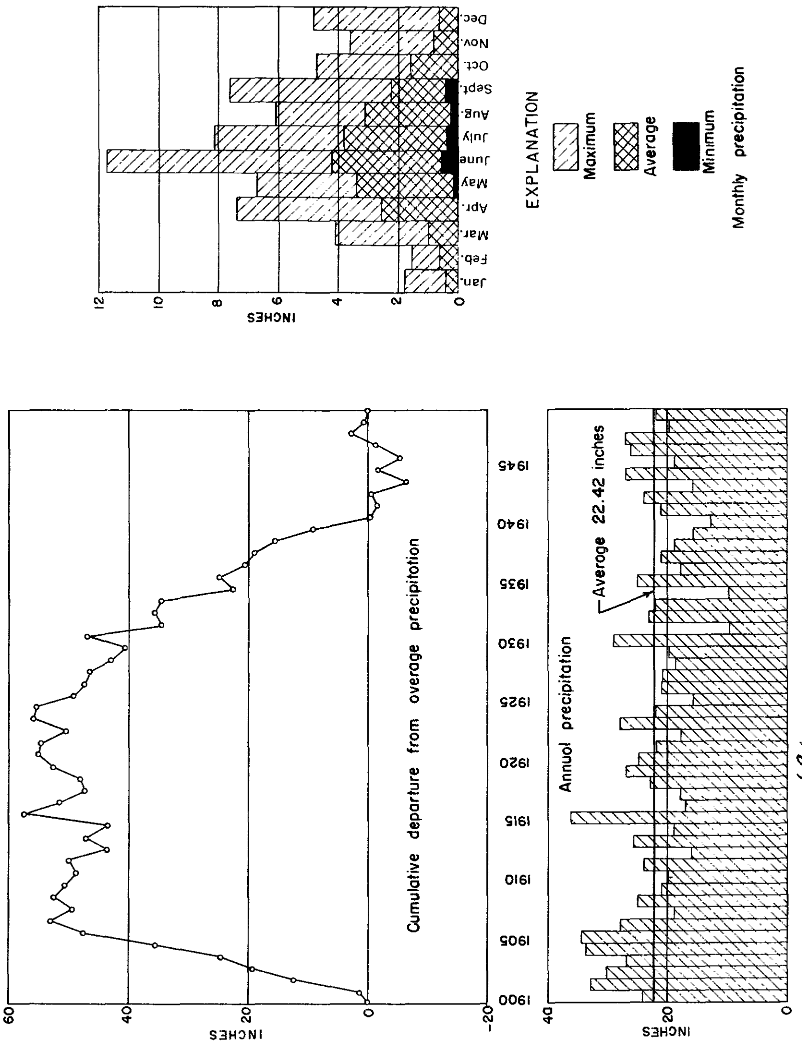

Figure 4. —Precipitation records at Arcadia, Nebr., 1900–49.

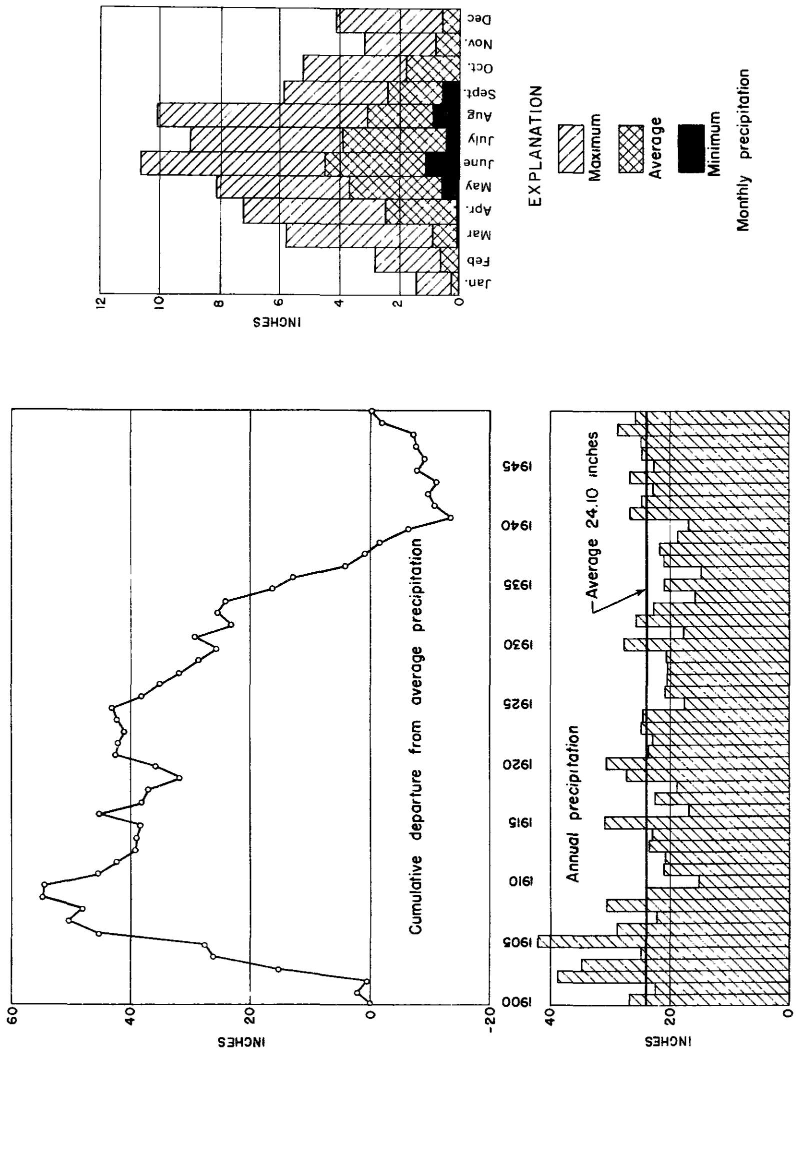

Figure 5. —Precipitation records at St. Paul, Nebr., 1900–49.

September long periods of drought occasionally cause reduced yields of grain. Crop failures, however, are rare because most of the soils are retentive of moisture when properly cultivated.

The precipitation records since 1900, which include the maximum, minimum, and average precipitation at St. Paul and Arcadia, Nebr., for the period of record, and the cumulative departure from average precipitation at St. Paul and Arcadia for the period 1900-49, are shown in figures 4 and 5.

Temperature.—Summer months frequently have daily temperatures above 100° F and in winter the temperatures often drop below zero. The mean temperature of the area for a year is about 50° F, the approximate average range being from 23° F in January to 76° F in July.

The prevailing winds are from the south in the summer and from the northwest in the winter but changes in direction are frequent. The winds are usually moderate to strong and tornadoes occur infrequently. The winds in the summer are often accompanied by high temperature and low relative humidity, a condition which causes rapid evaporation of the soil moisture.

The temperature records of St. Paul and Loup City are shown in table 1. This table also includes the prevailing wind directions and frost data.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

The geologic formations exposed at the surface in the Middle Loup division are unconsolidated sediments of Pleistocene or Recent age. These unconsolidated sediments, or mantle rock, include loess, dune sand, gravel, silt, and clay. They rest on bedrock of Cretaceous or Tertiary age, consisting of alternating layers of shale, mudstone, sandstone, and limestone, which are essentially flat lying or slightly warped.

The named geologic formations that constitute the mantle rock and the underlying bedrock in the area are listed in table 2, which gives their range in thickness, lithologic character, and importance as sources of water supply.

The bedrock formations in contact with the basal unconsolidated Pleistocene sediments that mantle the area are of Cretaceous and Tertiary age. The Ogallala formation, of Pliocene age, immediately underlies the Pleistocene sediments. It rests on the Pierre shale of Cretaceous age, which rests on the Niobrara formation, also of Cretaceous age.

Table 1.—*Temperature, prevailing wind direction, and occurrence of frost at St. Paul and Loup City for periods of record prior to 1950*

Stations	Record (years)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temperature, in degrees Fahrenheit														
St. Paul														
Average	34	24.0	27.0	38.4	50.4	60.7	70.4	76.1	74.6	65.8	53.4	39.0	26.6	50.5
Maximum		35.8	39.0	51.4	64.0	74.1	83.4	89.9	88.4	79.7	67.5	51.6	38.1	63.6
Minimum		12.2	14.9	25.3	36.9	47.3	57.3	62.3	60.8	51.8	39.2	26.4	15.0	37.4
Highest	36	72	78	89	98	102	110	111	111	103	94	84	75	111
Lowest		-30	-32	-12	10	22	37	44	36	22	5	-8	-25	-32
Loup City														
Average	30	22.8	26.4	36.8	49.4	59.4	68.4	74.0	72.8	63.4	51.4	37.8	25.2	49.0
Maximum		34.8	38.8	50.0	63.3	73.0	81.3	86.8	86.1	77.0	65.6	50.9	37.1	62.1
Minimum		10.7	14.0	23.6	35.4	45.8	55.6	61.1	59.5	49.8	37.3	24.6	13.3	35.9
Highest	34	72	76	90	98	97	102	106	104	104	97	88	72	106
Lowest		-39	-32	-15	8	20	34	40	36	21	4	-10	-26	-39
Prevailing wind direction														
St Paul	34	NW	NW	NW	NW	SE	SE	SE	SE	SE	NW	NW	NW	NW
Loup City	32	NW	NW	NW	NW	NW	SE	SE	SE	S	NW	NW	NW	NW

Occurrence of frost

Stations	Record (years)	Average growing season (days)	Dates of killing frosts: Averages, Last in spring	Dates of killing frosts: Averages, First in autumn	Dates of killing frosts: Extremes, Last in spring	Dates of killing frosts: Extremes, First in autumn
St. Paul	35	150	May 26	Oct. 4	May 7	Sept. 12
Loup City	35	148	May 27	Oct. 2	May 7	Sept. 12

Table 2.—*Generalized geologic section, Middle Loup division of the lower Platte River basin, Nebraska*

System	Series	Subdivision (Nebraska Geol. Survey)	Thickness (feet)	Character and distribution	Water supply
Quaternary.	Recent.	Superficial alluvium, loess, dune sand, topsoil.	0-10	Reworked sand and gravel in the river channel and its flood plain; isolated wind deposits of clay, silt, and sand; widespread soils.	Significant only as transmitting agent in recharge to ground water.
		Bignell loess.	0-20	Wind deposits of locally derived grayish silt on terraces and upland border of valley.	Significant only as transmitting agent in recharge to ground water.
		Unconformity			
	Pleistocene.	Peorian loess.	30-45	Wind deposits of silty clay (loess), massive, yellow to buff, widespread on upland surfaces and on terraces in the valley; some dune sand.	In upland areas significant only as a transmitting agent in recharge to ground water; occurs below water table in parts of the valley but does not yield watet readily.
		Todd Valley sand.	0-50	Fine gray sand and gravel deposited essentially as valley fill; present in places in the valley.	May yield water to wells where present below the water table.
		Loveland formation.	20-60	Stratified silt and clay with laminae of fine sand in valley phase of deposition; massive reddish-brown silt and clay loess in upland phase; capped by persistent old soil.	In upland areas significant only as transmitting agent in recharge to ground water; occurs below water table in parts of the valley but does not yield water readily.
		Crete formation.	0-30	Channel-fill deposit of sand and gravel modified by locally derived materials; present in places under bottom lands of tributary valleys.	May yield water to wells where present below the water table.
		Unconformity			
		Sappa formation.	5-50	Greenish silty clay of aqueous-eolian deposition, capped by old soil; generally present at high levels in valley sides.	Not a source.
		Grand Island formation.	0-60	Stream-deposited sand and gravel; upper part underlies valley side slopes, lower part is below valley floor.	Yields abundant supplies where present below water table.
		Unconformity			
		Fullerton formation.	5-30	Silt and calcareous clay grading locally into fine sand; of fluvial-eolian origin; capped with peat in some places.	Not a source.
		Holdrege formation.	0-15	Stream-deposited sand and gravel; underlies much of the valley.	Yields abundant supplies.
		Unconformity			

Tertiary.	Pliocene.	Ogallala formation.	150-350	Stream-deposited interlaminated gravel, sand, silt and clay; some beds lime-cemented.	Not a known source in this area but excellent in parts of Nebraska.
		Unconformity			
Cretaceous.		Pierre shale.	150-400	Dark clay shale and some shaly chalk, limestone, and thin sandstone where not removed by post-Cretaceous erosion.	Not a source.
		Niobrara formation.	350-400	Lead-gray andyellow shaly chalk in upper part (Smoky Hill chalk member); massive gray to yellowish-gray limestone in lower part (Fort Hays limestone member).	Not a source.

CRETACEOUS SYSTEM

UPPER CRETACEOUS SERIES

Niobrara formation.—The Niobrara formation is subdivided into two members, the Fort Hays limestone member, or lower member, and the overlying Smoky Hill chalk member. The Fort Hays consists of gray to yellowish-gray massive limestone and is 40 to 60 feet thick. The upper Smoky Hill chalk member consists of lead-gray and yellow shaly chalk and is from less than a foot to about 350 feet thick. The Niobrara formation does not yield water in useful quantities and any found is likely to be of poor quality. No wells have been drilled to the Niobrara formation in this area for a water supply.

Pierre shale.—The Pierre shale consists of black, gray, and brownish clay shale with thin layers of bentonite, indurated shaly chalk, well-defined concretionary zones, and, in the upper part, thin sandstones. The shales are of marine origin and are quite finely stratified; their high clay content makes them relatively impervious. The formation ranges in thickness from about 150 to 400 feet, except where it may be thinned as a result of post-Cretaceous erosion. The Pierre shale does not yield water in useful quantities, except in certain localities outside this area, and any water found is likely to be of poor quality. So far as is known, no wells have been drilled to the Pierre shale in this area.

TERTIARY SYSTEM

PLIOCENE SERIES

Ogallala formation.—The Ogallala formation of Pliocene age is the only formation of Tertiary age underlying the area. It is of continental origin, having been laid down by streams, and consists of interbedded hard and soft layers of sandy gravel, sand, silt, and clay. Some layers are cemented by calcium carbonate, but others are relatively unconsolidated. The Ogallala is progressively finer textured in an eastward direction. These finer grained deposits, consisting principally of silt and silty sandstone, have been described as the Seward facies (Condra, Reed, and Gordon, 1950, p. 15) of the Ogallala formation, and they underlie the Pleistocene deposits. The maximum thickness of the Ogallala formation in the Middle Loup River area is about 350 feet. The Ogallala formation exposed near the town of Rockville is a soft, gray, chalky sandstone, believed to be equivalent to the Seward facies.

Fine- to coarse-grained sand constitutes the principal material of the Ogallala formation. Coarser sediments are generally more prevalent in the lower part of the formation. Lenses or beds of sandy silt, some of them cemented with calcium carbonate, occur in all parts of the formation. Gradations from one lithologic type to another may take place both laterally and vertically, in some places within short distances.

The Ogallala is an excellent water-bearing formation where considerable thicknesses of saturated coarse sand are present and some domestic and livestock water supplies in the area are derived from wells that tap the Ogallala. It is possible that a few wells obtain water from a combination source of the Ogallala formation and overlying sands and gravels of Pleistocene age. So far as is known, the yields of wells obtaining water from the Ogallala formation are adequate for domestic and stock supplies.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

Holdrege formation.—The oldest Pleistocene deposits in the area consist of sand and gravel which are found principally in the valleys developed on the pre-Pleistocene surface. The deposits are of widespread occurrence in south-central Nebraska, originally forming a constructional plain interrupted only by the high divides of the ancestral drainage basins. These fluviatile sediments coalesced eastward, where they graded progressively into outwash deposits and till deposited during the Nebraskan stage of glaciation. The fluviatile material consists mostly of erosional products carried in by streams from higher plains and mountains to the west. These basal Pleistocene deposits, referred to as the Holdrege formation, range in thickness from less than a foot to about 15 feet in the area. The lower part of the Holdrege is correlative with sand and gravel which is pre-Nebraskan and the upper part is correlative with the Nebraskan till.

Lugn (1935) described the Holdrege formation as an inwash-outwash fluvioglacial deposit that was built up as an alluvial plain in Nebraskan time. Information on the general lithology of the Holdrege formation in the Middle Loup division is meager because wells are not known definitely to have penetrated this formation. It is believed, however, that large supplies of water could be obtained from its saturated sands and gravels.

Fullerton formation.—After the wasting away of the Nebraskan glacier, the surface of the sand and gravel of the Nebraskan till was exposed to weathering and erosion, with the concurrent development of soil and the local deposition of fine to coarse sediments in eroded areas. These deposits have been named the Fullerton formation. They range in thickness from about 5 to 30 feet. The Fullerton formation is coextensive with the underlying Holdrege formation and is likewise discontinuous, owing to erosion before and after the deposition of the formations that overlie it. The Fullerton formation is equivalent in age to silts of the Aftonian stage of eastern Nebraska. So far as is known, the Fullerton formation is not exposed in the Middle Loup division, but it was described originally from an exposure near Fullerton, Nebr. (Lugn, 1935), and the type locality is southeast of the area described in this report. The formation is not a water-supply source because of the predominance of clay and silt.

Grand Island formation.—The Grand Island formation, like the Holdrege formation, is composed mainly of alluvial sand and gravel and some glacial outwash, its upper part being composed principally of fine sand. Deposited during the advance and subsequent decline of the Kansan glacier, this formation has a thickness ranging from less than a foot to about 60 feet in the Middle Loup River area. The Grand Island formation is coextensive with the underlying Pleistocene deposits but it is less sporadic.

The sands and gravels of the Grand Island formation, like the Holdrege, extend westward as old valley fill, in which direction its materials must have been derived from mountains and tablelands as were the corresponding sands and gravels of the Holdrege formation. The Grand Island formation is exposed in some gravel pits in the Middle Loup River valley. Practically all the irrigation wells in the Middle Loup River valley and bordering areas obtain water supplies from this formation. Many domestic and livestock wells also are supplied from saturated sands and gravels of the Grand Island formation. The reported yields of wells are as high as 1,800 gpm.

Sappa formation.—During the quiescent stage that followed the Kansan glaciation, clay and fine sand were deposited on the Grand Island formation. These deposits, named the Sappa formation (Condra, Reed, and Gordon, 1950), formerly called the Upland formation (Lugn, 1935), range in thickness from about 5 to 50 feet or more. Although probably continuous at the time of deposition, this formation was subsequently subjected to weathering and eroded to the extent that it was reduced to patchy occurrences before the deposition of overlying formations.

The Sappa formation is composed of gray to greenish-gray silty clay and fine greenish-gray sand of aqueous-eolian origin. A volcanic ash, the Pearlette ash member, is present in the lower part of the formation and is perhaps the best horizon marker in the Pleistocene sediments (Condra, Reed, and Gordon, 1950). The Sappa formation is not a water-supply source for wells in this area.

Crete formation.—Post-Kansan erosion reduced the constructional plain formed by the Grand Island and Sappa formations to a deeply and maturely dissected surface. The Crete formation (Condra, Reed, and Gordon, 1950), consisting mostly of sand and gravel modified by materials derived locally from valley slopes, was then deposited in the channels. The thickness of the Crete formation ranges from a feather edge to about 30 feet.

The Crete formation is the unit that Lugn (1935) referred to as the "Valley phase of the Loveland formation." It is a channel-fill deposit which lies unconformably upon the Sappa formation or older Pleistocene sediments, and it is believed to be of Illinoian age (Condra, Reed, and Gordon, 1950). It is possible that some of the sands and gravels found in the upper parts of test holes drilled in the Middle Loup division may belong to the Crete formation, but no attempt has been made to differentiate these deposits from other sands and gravels of late Pleistocene age. Where sands and gravels of the Crete formation are saturated, these deposits may yield water to wells in this area.

Loveland formation.—The early phase of deposition represented by the Crete formation gave way to widespread deposition of the Loveland formation, which consists of stratified silt and clay with some laminae of very fine sand within the valleys and massive reddish-brown loess mantling the upland surfaces. The deposition of sand and gravel of the Crete formation and of loess and silt of the Loveland formation, together with subsequent soil formation, took place during the period of the advance and reduction of the Illinoian glacier. The Loveland formation ranges in thickness from about 20 to 50 feet.

The Loveland formation includes a valley and an upland facies which are often separated by a colluvial, or slope, facies. The Loveland formation was deposited either during the Sangamon interglacial stage or during late Illinoian time (Condra, Reed, and Gordon, 1950). The three facies of the Loveland formation grade into each other. The Loveland is capped by a persistent old soil which has been called the Sangamon soil in Illinois and the Loveland soil in Nebraska and Iowa. The Loveland formation originated, in part, from exposed older Pleistocene deposits through reworking of the materials by wind and water and, in part, from the exposed fine sands and silts of the Ogallala formation and older units.

The Loveland formation is exposed in a number of places along the Middle Loup River valley. It is also known to occur in upland areas immediately adjacent to the valley. In upland areas the Loveland formation is significant only as a transmitting agent for recharge to the ground-water reservoir. Where the formation occurs below the water table, it does not yield water readily to wells.

Todd Valley sand.—The constructional plain on the Loveland formation was subjected to mature dissection, and deposition was again resumed, with aggradation of valleys, by the fine gray sand and gravel of the Todd Valley sand. This formation is a fine grayish sand of alluvial or eolian origin and occurs chiefly as valley fill on the unevenly eroded Loveland formation. It was deposited during the Iowan glaciation in early Wisconsin time (Condra, Reed, and Gordon, 1950). The deposit is reported to be as much as 190 feet thick in places (Lugn, 1935). No deposits that could be positively correlated with the Todd Valley sand have been recognized in the test holes that have been drilled in the Middle Loup River valley. The more permeable parts of this formation are capable of yielding water to wells where they are present below the water table.

Peorian loess.—The Todd Valley phase of sedimentation gave way to widespread deposition of the buff to yellowish Peorian loess, which in some upland areas ranges in thickness from about 30 to 45 feet. The Peorian loess is of Iowan-Mankato age (Condra, Reed, and Gordon, 1950). One fairly thick soil has been recognized on top of the Peorian loess, and traces of other old soils have been recognized in some places. The loess originated from exposed silty alluvium along large rivers (Platte, Loups, and others) and from other sources, but it accumulated to maximum thicknesses in belts bordering the flood plains. A relatively dry cycle followed the wasting away of the Iowan ice sheet during middle Wisconsin time and the Peorian loess was deposited. The Peorian loess is significant only as a transmitting agent in recharge to the ground-water reservoir and it does not yield water to wells.

PLEISTOCENE AND RECENT SERIES

Bignell loess.—Soil formation on the surface of the Peorian loess was followed by deposition of the Bignell loess (Schultz and Stout, 1945), which consists of grayish silt on the terraces and uplands bordering the valleys of the Platte and other rivers. The thickness of this loess ranges from a feather edge to 20 feet and its age is probably Mankato to Recent (Condra, Reed, and Gordon, 1950). The Bignell loess, which consists partly of reworked Peorian loess, was blown from the flood plains and valley sides and deposited on the terraces and uplands. The Bignell loess also is significant only as a transmitting agent in recharge to the ground-water reservoir, and it does not yield water to wells.

Recent deposits.—No sharp line divides Recent deposits from those of Pleistocene age. Recent alluvium is restricted to the bottom lands along the Middle Loup River and its principal tributaries and is limited to a few feet of reworked surface materials. In addition to alluvial deposits, Recent deposits consist of loess, dune sand, and topsoil developed on the valley terraces and upland surfaces. In most locations the Recent deposits are significant only as a transmitting agent in recharge to the ground-water reservoir.

IRRIGATION IN THE MIDDLE LOUP RIVER VALLEY

MIDDLE LOUP PUBLIC POWER AND IRRIGATION DISTRICT

The Middle Loup River valley had been settled only a few years when many of its residents began to recognize the need for supplemental water, in addition to rainfall, to stabilize the farm industry in the area. In 1936 the Federal Emergency Administration of Public Works made the necessary funds available for the construction of a gravity surface-water system for irrigation in the Middle Loup River valley. This was handled through the Middle Loup Public Power and Irrigation District and much of the following information was obtained from their annual reports.

The original plans for the district included 37,687 acres of land of which about 30,000 acres was classified as irrigable. The division of this land, by counties, was about as follows: 29 percent in Custer County, 24 percent in Valley County, and 47 percent in Sherman County.

The project, as proposed, included two diversion dams, four canals, and one hydroelectric plant. The diversion dams were built near the towns of Sargent and Arcadia, Nebr., and canals leading from each of the dams were constructed on each side of the valley to distribute irrigation water downstream. The hydroelectric plant, however, was not constructed because of the difficulties encountered in establishing a market for electrical power.

Construction of the four canals was begun in 1936 and was completed in 1938. The canals, as originally planned, were designated nos. 1, 2, 3, and 4, and were to be the following lengths, respectively: 12.27, 19.75, 24.57, and 31.68 miles.

The Sargent diversion dam was built across the Middle Loup River, 1 mile south of the town of Sargent, Nebr. Water is diverted from the river by this dam into canals 1 and 2. Canal 1 services lands downstream on the north side of the valley to about 3/4 mile south of Comstock where it turns back into the river. Canal 2 receives water from the Sargent diversion dam, serves lands on the south side of the valley, and discharges its surplus water back into the Middle Loup River at a point about 4 miles south of Comstock.

The Arcadia diversion dam is about 6 miles northwest of Arcadia. This structure diverts water from the river into canals 3 and 4. The lands on the east side of the Middle Loup River from the Arcadia diversion dam to Austin, Nebr., are serviced from canal 4. The lands on the west side of the valley, from the diversion dam to a point 5 miles south of Loup City, Nebr., obtain their irrigation water from canal 3.

The construction phase of the project officially closed on December 30, 1938 at which time the following had been completed: 2 diversion dams, 79.3 miles of main canals, 63.5 miles of lateral, 787 main canal structures, and 752 lateral structures.

The irrigation system is now able to service 25,350 irrigable acres and is designed so that more laterals may be constructed to service an additional 5,000 acres. The system has been operated continuously since 1938, the number of acres irrigated during this period being given in table 3.

Table 3.—*Irrigated acreage, Middle Loup Public Power and Irrigation District, 1938–50*

[The figures are billing acreages and are subject to slight reductions for adjustments allowed]

Year	Canal				Totals
	No. 1	No. 2	No. 3	No. 4	
1938	....	....	....	....	750.00
1939	1,219.00	911.00	1,328.00	1,650.00	5,108.00
1940	1,699.00	1,313.00	2,723.00	3,104.00	8,839.00
1941	1,958.00	1,452.00	2,830.00	3,793.00	10,033.00
1942	2,010.00	1,519.00	2,863.00	3,803.00	10,195.00
1943	2,037.00	1,662.00	3,172.76	4,026.68	10,898.44
1944	2,064.00	1,688.00	3,337.12	3,991.88	11,081.00
1945	2,099.90	1,762.60	3,451.72	4,043.10	11,357.32
1946	2,143.10	1,729.70	3,579.32	4,347.00	11,799.12
1947	2,195.60	1,735.15	3,701.52	4,502.09	12,134.36
1948	2,143.35	1,670.90	3,590.92	4,574.64	11,979.81
1949	....	....	....	....	11,961.00
1950	....	....	....	....	11,994.74

IRRIGATION WELLS

The high cash values of cultivated crops during the years following World War II have been an inducement to farmers to bring additional acreage under cultivation. In order to accomplish this, many farmers turned to wells as a source of water supply. Of 57 irrigation wells known to exist in the area in 1950, 6 were installed in 1946, 10 in 1947, 12 in 1948, 7 in 1949, and 2 in 1950; in addition, more wells were scheduled for construction. Only 20 irrigation wells were installed prior to 1946, the oldest having been completed in 1920. Farmers report the yields of the irrigation wells to range from about 300 to 1,800 gpm. The average of the reported yields is about 860 gpm.

The depths of 45 irrigation wells were measured and the average was 114 feet. The number of irrigation wells classified by depth follows:

50 ft or less	2	125-150 ft	2
50-75 ft	2	150-175 ft	5
75-100 ft	13	175-200 ft	2
100-125 ft	17	More than 200 ft	2

Most of the irrigation wells are 18 inches in diameter and all are equipped with deep-well turbine pumps. Tractors and stationary gas engines supply power for most of the irrigation pumps; however, three pumps are run by electric power.

FLUCTUATIONS OF THE WATER TABLE

GENERAL CONSIDERATIONS

The ground-water reservoir in the Middle Loup division is constantly losing water by discharge and receiving water by recharge. Consequently, the water table does not remain stationary but rises and falls with the change in storage. The water table of the ground-water reservoir acts essentially the same as the water surface of a surface-water reservoir; that is, the water table rises when the amount of recharge exceeds the amount of discharge and declines when the discharge is greater than the recharge. Thus, changes in the water levels in wells indicate the state of balance between discharge and recharge to the ground-water reservoir.

Sources of recharge, or factors tending to raise the water table in the area, are: Precipitation within the area that percolates through the soil to the water table, water added by underground movement from the west and northwest, seepage from the Middle Loup River at times when the water surface in the river is higher than the adjoining water table, and seepage of irrigation water.

Methods of discharge, or factors tending to cause decline of the water table, are: Effluent seepage into the Middle Loup River and its tributaries, pumping from wells, evapotranspiration, and underflow from the area.

WATER-LEVEL MEASUREMENTS

Three observation wells in the area have records of water-level measurements dating from 1934. These wells were a part of the statewide water-level observation program begun in 1934 by the U. S. Geological Survey in cooperation with the Conservation and Survey Division of the University of Nebraska. Water-level measurements in the three wells were made periodically from

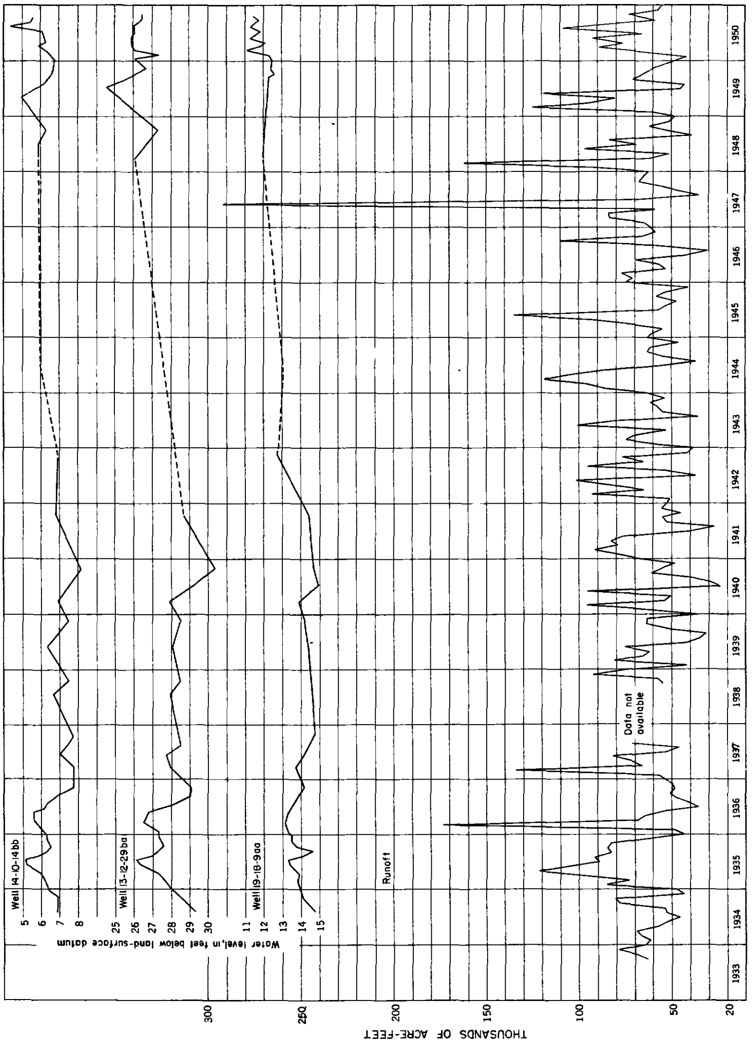

Figure 6. —Hydrographs of the water level in three wells and monthly runoff of the Middle Loup River at St. Paul, Nebr., 1933-50.

1934 to 1936, intermittently from 1936 to 1948, and monthly from 1948 to November 1950. Hydrographs of water levels in the wells and the monthly runoff of the Middle Loup River at St. Paul, Nebr., are shown in figure 6. The water-level measurements that have been made manually in all observation wells in the area are shown in table 8. A recording gage was installed on well 17–16–26dc in Valley County. The lowest daily water levels for this well are given in table 9. The hydrograph of the water-level fluctuation in well 17–16–26dc, the monthly precipitation, and the monthly runoff of the Middle Loup River at Arcadia, Nebr., are shown in figure 7.

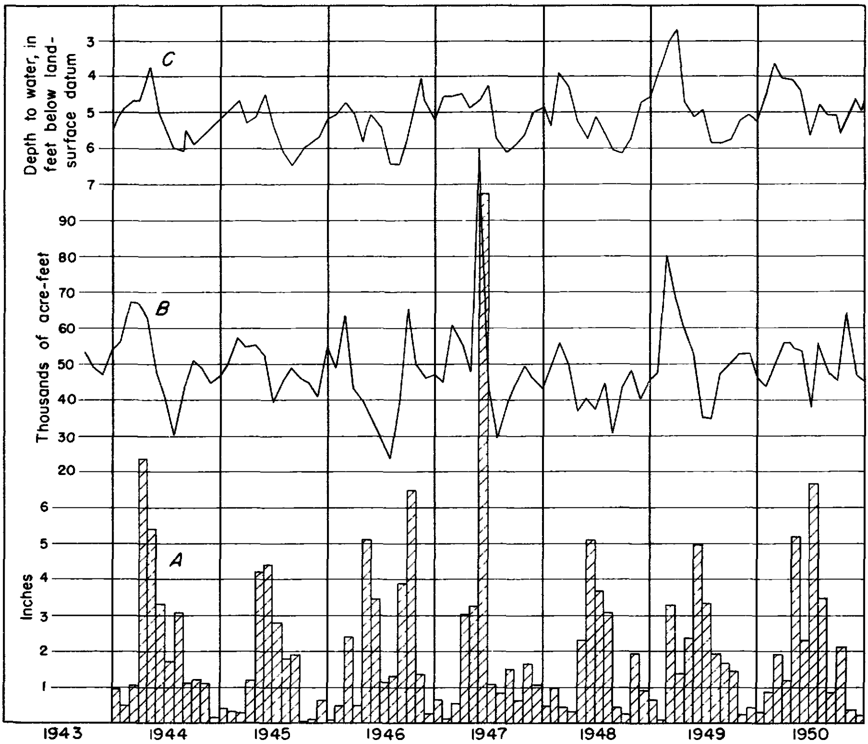

Figure 7.—A, Monthly precipitation at Arcadia, Nebr. B, Monthly runoff of the Middle Loup River at Arcadia, Nebr. C, Hydrograph of the water-level fluctuations in well 17-16-26dc.

One hundred twenty-two small-diameter observation wells were installed in the Middle Loup River valley by the Geological Survey to obtain a more uniform coverage of the area. Descriptions of these wells are included in table 10 and their locations are shown on plates 1 and 2. These wells were installed where existing wells could not be utilized. The number of wells of each type in each county follows:

County	Statewide observation wells used in present study	Observation wells of other government agencies	Privately owned wells used in the observation-well program	Observation wells installed by U. S. Geological Survey in 1949-50	Total number of wells in each county
Howard....	2	....	20	15	37
Sherman...	....	....	35	37	72
Valley......	....	....	2	10	12
Custer......	1	16	36	54	107
Blaine......	....	7	....	6	13
Total....	3	23	93	122	241

CHANGES IN WATER LEVEL

The hydrographs of the three observation wells shown in figure 6 indicate that there has been a net rise in water level since 1934. Because the three wells are widely scattered, it may be assumed that the rise has been of nearly the same magnitude throughout the entire area.

The hydrographs in figure 8 show the water-level fluctuations during the 1950 water year in representative wells dispersed throughout the valley. The hydrographs indicate no net rise or decline of the water table during the periods of record; the only fluctuations were seasonal. Thus, the total amount of ground water in storage did not increase or decrease significantly during the 1950 water year.

Hydrographs are not shown for wells situated near irrigation structures because they do not represent a normal condition of the water table. The water table in many local areas is raised during the irrigation season by the application of surface water for irrigation and by seepage from canals and laterals. Conversely, the water table is lowered temporarily in local areas by pumping of wells for irrigation purposes.

FLUCTUATIONS CAUSED BY PRECIPITATION

Because the silty loam soils of the Farwell unit are relatively impervious, most of the precipitation in this area escapes as surface runoff or returns to the atmosphere by evaporation. Also the water that does infiltrate down to the water table is in transit a long time because of the relatively great depth to water in this area.

By contrast, the soils of the Middle Loup River valley are sandy loams and are much more favorable for infiltration than are the soils of the upland area. These soils are porous and a part of the precipitation quickly penetrates the surface and percolates to the zone of saturation. The shallow depth to ground water in the valley also contributes to the quick response of the water table to precipitation.

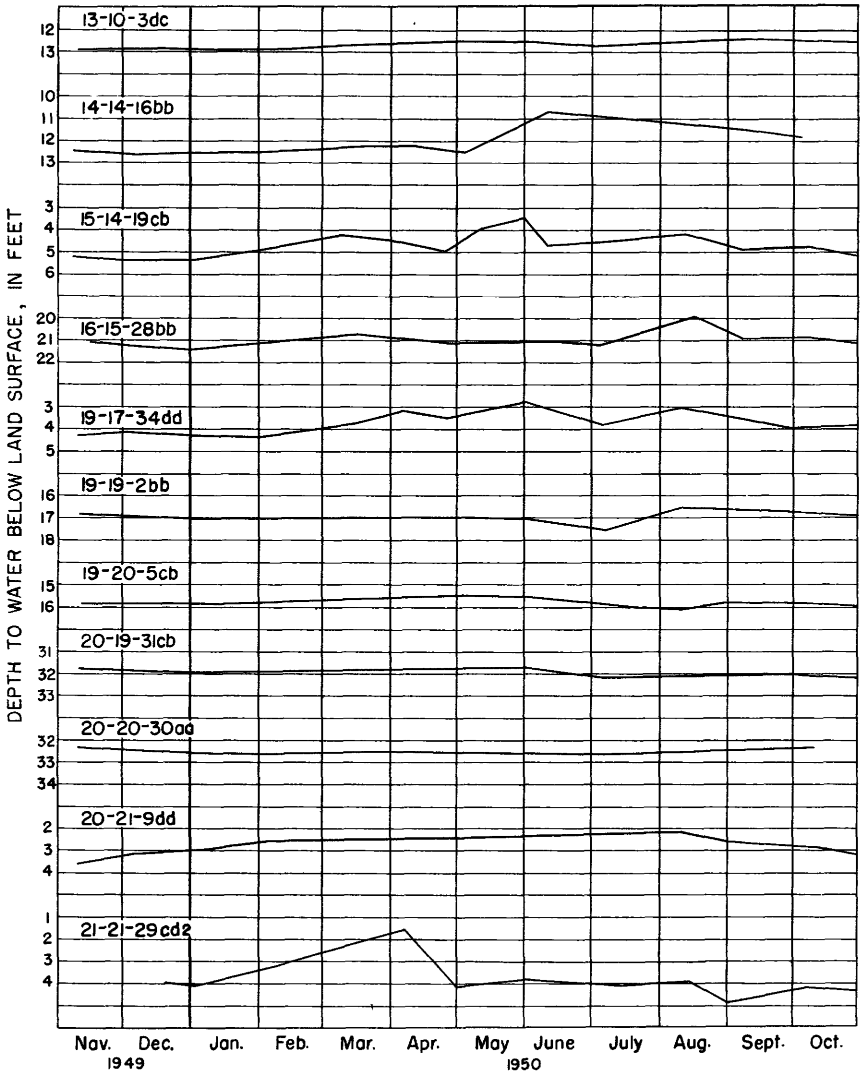

Figure 8. —Fluctuations of the water level in 11 wells in the Middle Loup River valley.

For any locality in the area, following precipitation, the rate of recharge to the zone of saturation is not uniform because of the wide range in soil texture. Because of this, the water table does not rise uniformly after a rain but forms a temporary shape of mounds and hollows which soon level out to a nearly plane surface again after the rain ceases.

FLUCTUATIONS CAUSED BY THE RIVER

The water table under those lands directly adjacent to the Middle Loup River fluctuates with the changes in the stage of the river.

The graph of well 17–16–26dc and the graph of the river discharge at Arcadia, Nebr., (fig. 6) show the close relationship that exists between surface and ground water in areas close to the river. The effect that change of river stage has on the water-table fluctuations diminishes as the distance from the river increases. However, the area from Gates to Sargent on the north side of the river is an exception to this. A change of stage in the river in this area has a pronounced effect on the relative position of the water table for the entire distance from the river to the valley limit.

CONFIGURATION OF THE WATER TABLE

The configuration of the water table in the Middle Loup division is shown on plates 1 and 2 by means of water-table contours. The methods used in preparing these maps are described in following paragraphs. On the maps the altitude is the same for each point on the water table along a given contour line. Ground water moves in the direction of maximum slope; that is, at right angles to the contours. Therefore, the water-table contour lines show the configuration of the water surface in the same manner that topographic contour lines show the configuration of the land surface. The shape of the water table generally conforms to that of the land surface, although it is less accentuated.

Water-level measurements were made in 180 wells during the months of October and November 1950 in order to provide sufficient control for the construction of the water-table contour map. These wells either had been installed by the Geological Survey or were domestic or irrigation wells that has been selected at an earlier date. At the time of the initial visit to each well, all the pertinent information was obtained from the owner or operator. This information is included in the table of well descriptions (table 10).

Altitudes were established by instrumental leveling by the U. S. Bureau of Reclamation for the measuring point of each well. The water-level measurements were then subtracted from the altitudes of the measuring points and the resulting figures were the altitudes of the water table above sea-level datum at the well locations. Contour lines were then drawn on the map representing points of equal altitude on the water table.

The contour lines are all V–shaped upstream, indicating that the Middle Loup River is effluent throughout its entire length. Thus, any rise or fall in the ground-water level will have a direct effect on the discharge of the river. The river recharges the ground-water reservoir only during periods when it is at flood stage.

The greatest deviation in the direction of ground-water movement shown by the water-table contours is on the north side of the river from Milburn to Comstock, Nebr. As usual, the contour lines are V-shaped upstream between the proposed Milburn diversion dam site and the river bridge north of Gates, indicating ground-water movement toward the river; however, the north side of the river in this area also has a gradient of about 10 feet to the mile following the general trend of the valley, and only a slight gradient toward the river. On the south side the gradient is approximately 20 feet to the mile and almost directly toward the river. This suggests that there is, on this latter side, pronounced discharge of ground water relative to surface flow.

North of Gates from the river bridge eastward to Sargent, the contour lines show that on the south side of the valley the direction of ground-water movement is toward the river. On the north side of the valley the movement is away from the river toward the valley limits. This directional difference may be caused by a change in the permeability of the water-bearing materials or effects of irrigation pumping. The concentration of irrigation wells along the northern valley limit indicates a gravel deposit having good water-bearing characteristics. West of Sargent, the situation is different. A low ground-water divide is there, and the movement is both away from and toward the river. The ground water moving away from the river and out of the valley is believed to be following an extension of the gravel deposit that lies beneath, and extends beyond, the northern valley limit.

In the upland part of the Farwell unit between Oak Creek and the Middle Loup River, the direction of ground-water movement is southeasterly and the gradient about 9 feet per mile. To the east, between Oak Creek and Turkey Creek, the direction of movement and the gradient remain about the same. The direction of ground-water movement on the east side of Turkey Creek changes to eastward and continues to change direction until the movement is toward the northeast. The gradient of the water table becomes steeper as the direction of movement changes to the northeast. This gradient reaches a maximum of approximately 20 feet to the mile beneath the upland directly west of the confluence of the Middle Loup with the North Loup River.

DEPTH TO WATER

The depth to the water table in the area investigated is equal to the difference between the altitude of the land surface and that of the water table. The surface topography of the area is more irregular than the water table and the depth to water is governed largely by irregularities in the topography. In general, the depth to water is greater in regions of highest altitude.

In the construction of the depth-to-water maps (pls. 1 and 2), the same wells were utilized that were used in the construction of the water-table contour maps. Two methods were employed to construct the depth-to-water maps. The depth-to-water map for the lands in the Sargent and Farwell units was constructed by superimposing water-table contours upon a map showing surface topography. The difference in altitude between the two sets of contours is the depth to water at any specific point. Isobaths (or lines of equal depth) were drawn, delimiting areas in which the depth-to-water level lies within specific ranges. As of 1950, the area between the Sargent and Farwell units was not mapped topographically, so the above-mentioned method could not be used. The depth to water in each well was used as a control for the map of this part of the area and isobath lines were drawn by interpolation between the wells.

The depth to water in the Middle Loup River valley ranges from less than 10 feet near the river to as much as 60 feet near the valley margins and bordering intermediate slopes. Although water-level information in the Farwell unit is scanty, it is known that the depth to water in much of the upland part of the unit is greater than 100 feet, and in some parts of the unit, greater than 150 feet.

MUNICIPAL WATER SUPPLIES

Water pumped from wells is the source of the water supplies for all towns in the Middle Loup River valley and in the Farwell unit. The communities of Gates, Walworth, and Milburn, however, do not have municipal water-supply systems. Each town was visited during the course of the investigation and inventory was made of the supply wells. Depths of the municipal wells ranged from about 31 to 180 feet, and the diameters, from 5 to 24 inches. At that time a sample of water for chemical analysis was taken directly from the source pump and all available data on consumption were recorded. Examination of the data indicates that a few records were in error; accurate information is not available because most of the towns do not meter their water at the source.

The greatest difficulty encountered by the typical municipality in the region is the finding of a high-yielding aquifer close to the town. Detailed ground-water investigations and test-drilling programs in the vicinities of municipalities would help in the location of future supply wells.

The pertinent data on the municipal wells, arranged in downstream order of the towns, are given in table 4. Table 5 summarizes the data on consumption of water in the towns of the area.

Table 4.—*Municipal well data, Middle Loup division, Nebraska*

[All are drilled wells and, unless otherwise noted, have turbine lifts powered by electric motors. *Chemical analysis made]

City or town and well no.	Date com-pleted	Well			Remarks
		Depth (feet)	Diameter (inches)	Capacity (gpm)	
Arcadia					
17-16-26ba*......	1936	81	12	300	At pumphouse 1 block S. of post office.
Ashton					
15-13-27ab*......	1928	150	12	100	Located ½ block E. of post office.
Boelus					
13-12-29ab*......	1935	31.5	12	80	At pumphouse located on last street in western part of town.
Comstock					
18-17-2db*........	1927	180	8	250	At pumphouse 2 blocks N. and ½ block E. of post office.
Dannebrog					
13-11-11ab.......	1915	60	5	....	Located in Creamland Creamery. Used only in emergency. Plunger type (reciprocating) lift, tractor powered (gasoline).
13-11-11db*......	1934	85	18	....	Located across street from elevator.
Farwell					
14-11-6ba*........	1934	140	8	550	
Loup City					
15-14-18bd1*.....	1922	116	18	375	
15-14-18bd2*.....	1930	123	18	425	At pumphouse by railroad tracks on main street.
Rockville					
13-13-5dd*........	1946	120	2	....	At ball park. Hand operated, cylinder type.
Sargent					
19-18-3dd1.......	1936	90	24	250	Located 2 blocks E. of water tower.
19-18-3dd2.......	1947	90	24	500	Located 4 blocks N. and 1 block E. of water tower.
St. Paul					
14-10-3ac.........	1936	54	18	180	Located ½ block N. of floral shop.
14-10-3cc.........	1948	43	18	180	Located 1 block S. of floral shop.
14-10-3db*........	1926	44	18	180	Located in center of block between Howard, Grand, 4th, and 5th Sts.
14-10-4ad.........	1936	58	18	180	Located at the SE corner of Sheridan and Kendall Sts.

Table 5.—*Municipal water supplies in the Middle Loup division, Nebraska*

City or town	Number of wells	Storage capacity (gallons)	Water main pressure (pounds per square inch)	Daily consumption (thousands of gallons)	
				Maximum	Average
Milburn to Loup City					
Milburn[1]........	....	....	....	....	....
Gates[1]...........	....	....	....	....	....
Walworth[1].......	....	....	....	....	....
Sargent..........	3	50,000	35-45	150	100
Comstock.......	1	50,000	50-85	360	30
Arcadia..........	1	60,000	50-60	432	40
Loup City.......	2	300,000	45-60	1,000	200
Farwell unit					
Ashton...........	1	40,000	60-65	144	6.7
Farwell..........	1	35,000	50-75	93.6	40
Loup City to St. Paul					
Rockville.......	1	0	0	?	?
Boelus...........	1	30,000	40-55	?	10
Dannebrog......	2	50,000	46-54	1,173.6	50
St. Paul.........	4	75,000	50-?	1,008	175

[1]No public water supply.

CHEMICAL QUALITY OF THE GROUND WATER

By Frank H. Rainwater

The extent to which most fresh waters may be effectively utilized is closely associated with the chemical quality of the water. Meteoric water (water from rain and snow) is relatively pure and devoid of contamination except for small quantities of dissolved atmospheric gases. As soon as the water strikes the earth, however, it begins to dissolve the soluble materials in the earth's crust. The water may quickly run off into streams and dissolve little material, or it may slowly percolate to ground-water reservoirs and eventually discharge into a stream. The latter process favors solution of materials, and the resultant water usually is more highly mineralized. The extent of solution is dependent on the nature of the solid material, the solubility of the material in water, and the contact time. In areas where the water table is near the surface and few soluble salts are in the soil, precipitation may actually dilute the ground water. The chemical character of the water is, therefore, the resultant of its geologic and hydrologic environment, and often gives valuable information concerning the nature of the soil and the subsurface geology with which the water has been in contact.

In the period July 1949 to July 1950, 21 samples of water for chemical analysis were collected from wells in the lower Middle Loup River valley. It was not possible to ascertain the specific water-bearing formations from which these samples were obtained, but the known water sources in the area are either unconsolidated sediments of Quaternary age or the Ogallala formation of Tertiary age.

In the following pages the quality of the ground water in terms of its predominant characteristics is described, the suitability of the water for domestic and irrigation uses is discussed, and the possibilities of changes in ground-water quality under an extended irrigation program are considered.

SIGNIFICANCE OF CHEMICAL CONSTITUENTS IN RELATION TO USE

Water for domestic use.—Maximum concentration limits have been established for some of the mineral constituents commonly found in water. These concentration limitations for potable water on interstate carriers are shown in table 6.

Table 6.—*Allowable limits for certain constituents in potable water used on interstate carriers*

[Parts per million. Standards by U. S. Public Health Service, 1946]

Iron and Manganese (Fe + Mn)	0.3	Chloride (Cl)	250
Magnesium (Mg)	125	Fluoride (F)	1.5
Sulfate (SO_4)	250	Nitrate (NO_3)	[1]44
		Dissolved solids	[2]500

[1]Natl. Research Council, Comm. on Sanitary Eng. and Environment, 1950.
[2]1,000 permissible if better water not available.

High fluoride concentration in water may cause the dental defect known as mottled enamel, if the water is used for drinking by young children during calcification of the permanent teeth, but consumption of water containing small quantities of fluoride (as much as 1.0 to 1.5 ppm) has been shown to reduce tooth decay.

Nitrate in water may indicate contamination by sewage or other organic matter, as nitrate represents the final stage of oxidation in the nitrogen cycle. However, the origin of a high nitrate content in some natural water is not completely understood and may in some places be related to sources other than contamination. Medical research indicates that drinking-water with a high nitrate content may cause cyanosis in infants ("blue baby").

Hardness is that property of water usually recognized because of the increased quantity of soap to produce a lather or because of the deposits of insoluble salts (generally of calcium, magnesium, or both) when water is heated or evaporated. Constituents other than calcium and magnesium, such as iron, aluminum, strontium, barium, zinc, or free acid, also cause hardness, but as a rule these constituents are not present in sufficient quantities to have any appreciable effect. Hard water is objectionable in the home because of its soap-consuming properties. Specific concentration limits are not established for hardness, but it is generally agreed that water having a hardness of less than 50 or 60 ppm is soft and water having more than about 200 ppm is very hard.

Water for irrigation.—All waters used for irrigation contain varying quantities of certain chemical constituents. If their concentration is not too great, some of the constituents improve the growth of plants; others are harmful to plant growth and to soils. The more important factors that affect the quality of water for irrigation are total salt concentration, percent sodium, and carbonate, bicarbonate, and boron concentrations.

The total concentration of dissolved salts may be expressed in terms of weight per unit weight (parts per million), total equivalents per million, or specific conductance as micromhos. Equivalents per million show the true chemical relations of the positively charged ions (calcium, magnesium, sodium, and potassium), termed "cations," and the negatively charged ions (carbonate, bicarbonate, sulfate, chloride, nitrate, and fluoride), termed "anions." Equivalents per million for an ion are calculated by dividing parts per million by the combining weight of that ion or by multiplying by the reciprocal of the combining weight. The equivalents per million corresponding to one part per million (reciprocal of combining weight), of the more prevalent ions in water are shown below:

Cations		*Anions*	
Calcium	0.050	Carbonate	0.033
Magnesium	.082	Bicarbonate	.016
Sodium	.043	Sulfate	.021
Potassium	.026	Chloride	.028
		Fluoride	.053
		Nitrate	.016

Percent sodium is calculated by dividing the equivalents per million of sodium by the sum of the equivalents per million of the cations and multiplying by 100.

According to Wilcox (1948):

"The cations—calcium, magnesium and sodium—react with the base exchange material of the soil and determine very largely the physical character of the soil. Calcium and magnesium, in proper proportion, maintain the soil in good condition of tilth and structure* * *. Sodium, like the other cations, when applied to the soil in the irrigation water reacts with certain clay minerals known as the base exchange material of the soil. Unfavorable physical conditions result when sodium is the predominant cation."

The irrigationist should consider not only the chemical quality of the water before application of the water to the soil but also the chemical changes that take place while the water stands on the land or infiltrates the soil. The ratio of carbonate and bicarbonate to the various cations is primarily responsible for changes in water quality brought about by evaporation. Eaton (1949) describes the following changes that may take place during evaporation: (1) If water contains little carbonate, all the ions will tend to increase in concentration in the same general proportion; (2) if the water contains calcium and magnesium in equivalent quantities to that of carbonate, there will be an increase in percent sodium as the less soluble calcium and magnesium carbonates precipitate; and (3) if the water contains carbonate in excess of calcium and magnesium, not only will percent sodium increase but there will be a residue of sodium carbonate. Residual sodium carbonate increases the pH of the water. At higher pH values the organic material of the soil is brought into solution and the soil may become rather impervious to water movement. Magistad and Christiansen (1944) report that waters containing less than 0.5 ppm of boron are classified as excellent to good, with reference to boron, and are suitable for most plants under most conditions.

The generalizations concerning quality-of-water requirements for irrigation have application to normal soils under average conditions. There is general agreement among the investigators that other factors, such as soil composition, permeability, drainage, and irrigation practices, must be considered in rating waters for irrigation.

PHYSICAL AND CHEMICAL RELATIONSHIPS IN THE WATER

Ground water in the lower Middle Loup River valley is of the calcium bicarbonate type and contains appreciable quantities of silica. Chemical analyses of samples collected in this region are shown in table 7. These analyses show that the water is generally of good quality and uniform in content of dissolved constituents. Abnormal concentrations of nitrate occur in water from wells 13-12-29ab, 13-13-13cc, 14-10-30ba, 19-18-3ddl, and 20-21-10bc and suggest pollution of these wells by surface drainage.

Figure 9 shows that an increase in total concentration of dissolved solids is accompanied by a proportional increase in calcium and magnesium but by only a slight increase in sodium and potassium. Relations between predominant cations and anions are also of interest. The principal anions are carbonate and bicarbonate, together termed "alkalinity." Alkalinity plotted against concentrations of alkaline earths as obtained from the analytical data, is shown graphically in figure 10. On cursory inspection the correlation

Table 7.—*Chemical constituents and related physical measurements of ground-water samples, lower Middle Loup River valley, Nebraska*

[Analytical results in parts per million except as indicated]

Well no.	Municipality	Well depth (feet)	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium	Specific conductance (micromhos at 25°C)	pH
13-11-6bd	....	80	10-9-49	54	44	2.7	60	10	16	4.8	6	234	8.0	11	0.2	2.9	0.30	304	191	0	15	416	8.2
13-11-11db	Dannebrog......	85	2-2-50	54	52	.32	124	15	12	9.1	0	396	72	13	.1	2.7	.30	516	371	46	6	722	7.7
13-12-29ab	Boelus...........	31.5	11-10-49	56	45	.05	92	8.5	11	4.7	15	226	32	12	.2	34	.17	388	265	55	8	527	8.5
13-13-5dd	....	120	10-9-49	56	40	5.0	55	9.2	7.9	5.2	0	212	11	10	.1	7.0	.30	270	176	2	9	368	8.0
13-13-13cc	....	78	9-1-49	55	46	.02	114	10	5.0	11	18	341	1.0	16	.2	20	.30	436	326	16	3	621	8.3
14-10-30ba	....	32	10-18-49	55	41	.08	200	47	40	24	18	313	182	49	.3	314	.10	1,070	693	406	11	1,450	8.3
....	Farwell.........	115	8-15-49	54	58	.04	36	9.4	9.4	7.4	0	181	4.0	3.2	.2	.8	.30	228	129	0	13	303	8.0
14-14-3cc	....	38	10-9-49	53	41	.92	81	14	13	17	15	209	74	18	.3	8.9	.23	422	260	64	9	555	8.4
....	Ashton..........	....	7-21-49	.....	58	.05	40	13	12	11	0	174	18	24	.2	3.2	.44	282	154	11	13	378	8.1
15-14-18bd1	Loup City......	116	10-18-49	55	53	2.8	59	15	22	12	0	239	54	17	.2	.6	.30	368	209	13	18	505	7.8
16-16-12bc	....	124	8-29-49	54	44	.32	90	11	12	10	0	348	8.0	7.0	.2	3.3	.20	367	270	0	8	551	8.0
17-16-26b	Arcadia.........	81	10-17-49	55	50	.09	60	7.9	17	12	5	212	27	16	.2	1.1	.30	332	182	0	16	429	8.2
18-17-2db	Comstock......	180	10-17-49	52	52	.01	54	9.1	10	5.6	8	215	4.0	4.0	.3	3.8	.18	276	173	0	11	369	8.3
19-17-9ca	....	170	8-26-49	52	45	.17	39	5.0	6.5	6.5	0	160	.4	1.4	.1	4.6	.20	207	118	0	10	262	8.0
19-18-3dd1	Sargent.........	90	7-7-50	53	35	.08	48	8.6	9.6	9.0	0	165	11	13	.1	34	.19	274	156	21	11	366	7.1
19-20-5cb	....	112	8-25-49	54	48	.44	46	6.0	10	8.6	0	198	1.0	2.2	.5	.8	.30	242	140	0	13	316	8.1
19-20-9aa	....	85	8-25-49	54	49	.25	61	8.8	10	15	14	230	5.6	2.4	.5	2.8	.20	302	188	0	10	400	8.4
20-19-31cb	....	110	8-24-49	54	49	.23	60	8.3	10	9.0	18	214	1.4	2.0	.2	1.1	.20	279	184	0	10	376	8.5
20-19-34ab	....	122	8-25-49	53	54	.67	49	8.1	12	9.5	0	230	3.0	2.4	.2	1.5	.30	254	156	0	13	354	8.0
20-20-30aa	....	77	8-25-49	54	48	.02	32	4.8	4.8	5.6	0	127	4.0	1.5	.4	5.3	.30	186	100	0	9	226	8.1
20-21-10bc	....	30	8-24-49	54	38	.03	97	16	28	16	6	136	63	44	.3	176	.23	672	308	187	16	796	8.3

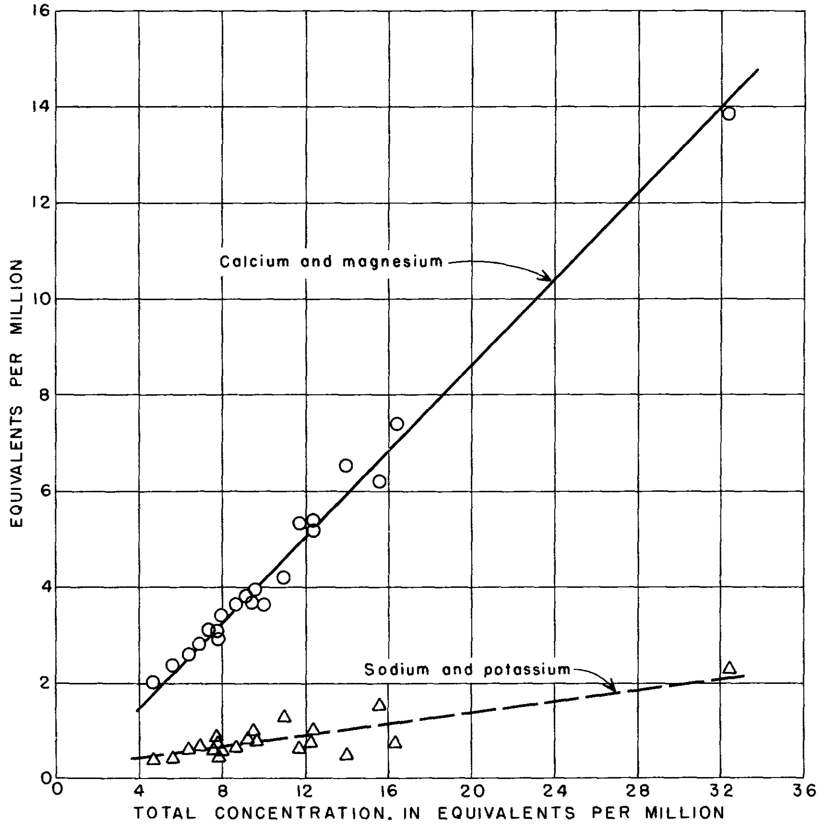

Figure 9. — Relation of alkaline earths and alkalies to total concentration of dissolved solids, lower Middle Loup River valley, Nebraska.

appears poor. However, those samples that are apparently deficient in alkalinity are found to have a high nitrate content. Microbiological metabolism is offered as a plausible explanation for increase in nitrate accompanied by decrease in alkalinity. During periods of precipitation wells are often contaminated by nitrogenous organic matter carried by surface seepage around the casing. Nitrogenous material may also infiltrate to the ground-water reservoir in those areas that have poor surface drainage and loose soil texture. Nitrogenous material is decomposed in the presence of oxygen by nitrobacterial organisms normally present in the soil. One reaction in the decomposition produces nitrous acid, which may be oxidized to nitric acid. The acid reacts instantaneously with the bicarbonate ion to produce carbon dioxide, water, and nitrate ion. The resultant solution contains the nitrate ion in equivalent proportion to the amount of bicarbonate ion decomposed. If the bicarbonate equivalent of the nitrate is added to the normal alkalinity, the relation between corrected alkalinity and total hardness shows closer correlation. The slope of the actual-ratio line in figure 10 is approximately unity. From this it must be deduced that almost stoichiometric relations exist between the alkaline earths and alkalinity.

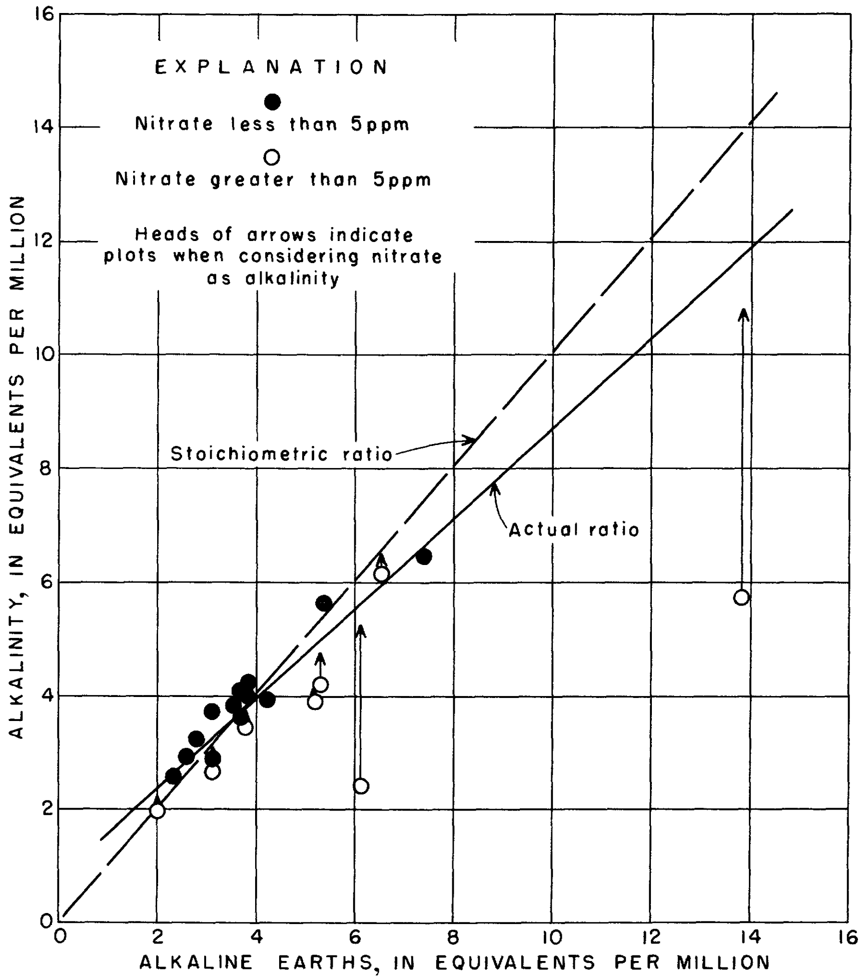

Figure 10.—Relation of alkalinity to alkaline earths, lower Middle Loup River valley, Nebraska.

Silica constitutes 10 to 26 percent by weight of the anhydrous residue of the samples from unpolluted wells. The location of all sampling points and the percentage of silica found at each are shown in figure 11. Although local conditions cause variation in the percentage of silica in the water, there is a general trend toward lower percentages downstream along the Middle Loup River valley. The two samples collected in the Oak Creek valley indicate a similar tendency. Connor (1951) reports a similar downward trend in percentage of silica in the Middle Loup River water between Dunning and St. Paul. This similarity between the valley and the river is to be expected because the Middle Loup River is an effluent stream in most of this section of the valley and receives a major part of its water from ground-water inflow.

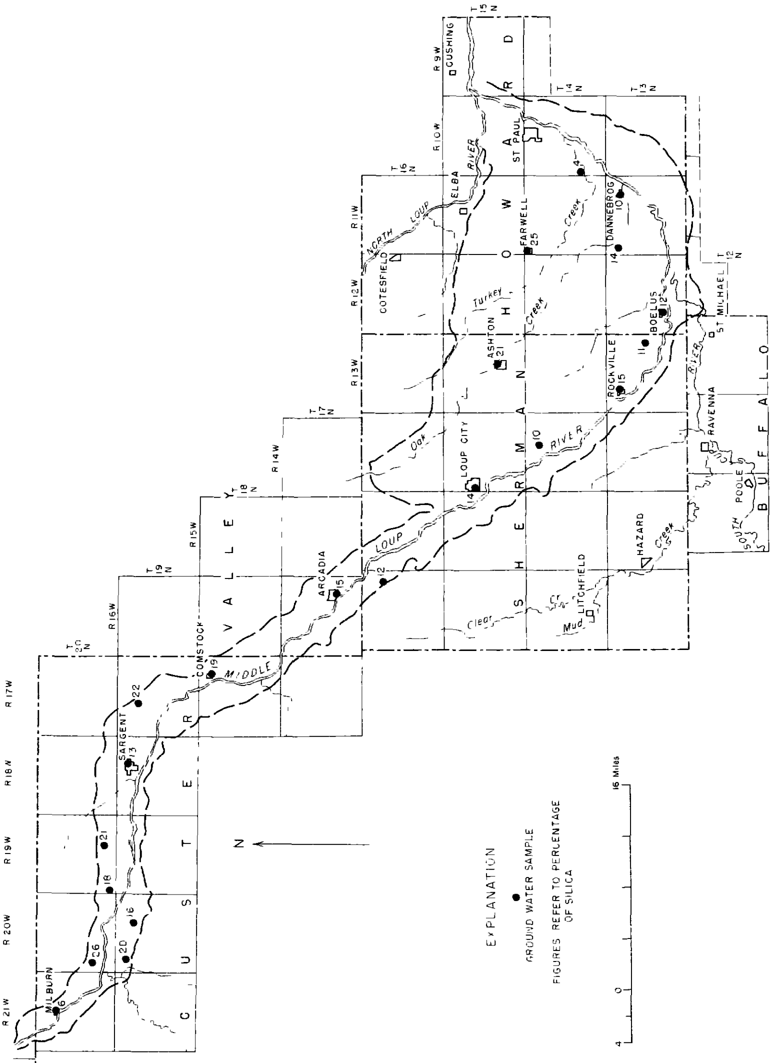

Figure 11. —Sampling points and percentage of silica in ground water of the lower Middle Loup River valley, Nebraska.

Relation of sulfate to depth to water.—The concentration of the sulfate ion is the largest single variable in the analyses of the ground water. The concentration of sulfate bears no relation to geographic location of the well, direction of ground-water movement, or well depth, but it may be closely correlated with the depth to water below the land surface. Concentrations of sulfate greater than 11 ppm were not found in samples where the depth to water exceeded 20 feet. Where the depth to water was less than 20 feet, sulfate concentrations of 1.0 to 182 ppm were found. Although the exact nature of the water-bearing material in the sampled wells is not known, the sulfate content of the water may be an indication of the different types of water-bearing materials in the area, or the shallow wells may be more likely to obtain sulfate from surface sources.

USABILITY OF THE GROUND WATER

Domestic purposes.—All the municipal supplies sampled in the lower Middle Loup River valley are potable if classified by concentration limitations given in table 6. The high iron content in the water from one of the wells of Loup City is not representative of the delivered water. Three analyses of the delivered water of Loup City by the Nebraska State Health Department give a maximum of 0.1 ppm of iron. Although the raw water may be high in iron content, most of the iron is probably precipitated by natural oxidation while the water is standing in the reservoir. The ground water of the entire area is hard, and the public supplies of Dannebrog and Boelus are excessively so. The chemical quality of municipal water supplies of the lower Middle Loup River valley is expressed graphically as equivalents per million in figure 12.

Irrigation purposes.—The ground-water samples collected in the lower Middle Loup River valley are classified graphically in figure 13, after Wilcox (1948), on the basis of percent sodium and specific conductance. All samples are classified as "excellent to good" with the exception of those from the two most highly polluted wells. These samples fall into the "good to permissible" class because their total salt concentration is higher.

Figure 10 shows that carbonate and bicarbonate are present in the water in an approximate stoichiometric ratio with calcium and magnesium. This characteristic places the water in the second category described by Eaton (1949). (See p. 35.) The percent sodium will increase if evaporation causes the precipitation of calcium and magnesium carbonates. However, on the basis of the samples collected, the initial percent sodium is very low and the quality of the water would be impaired for irrigation use only under the most adverse irrigation practices.

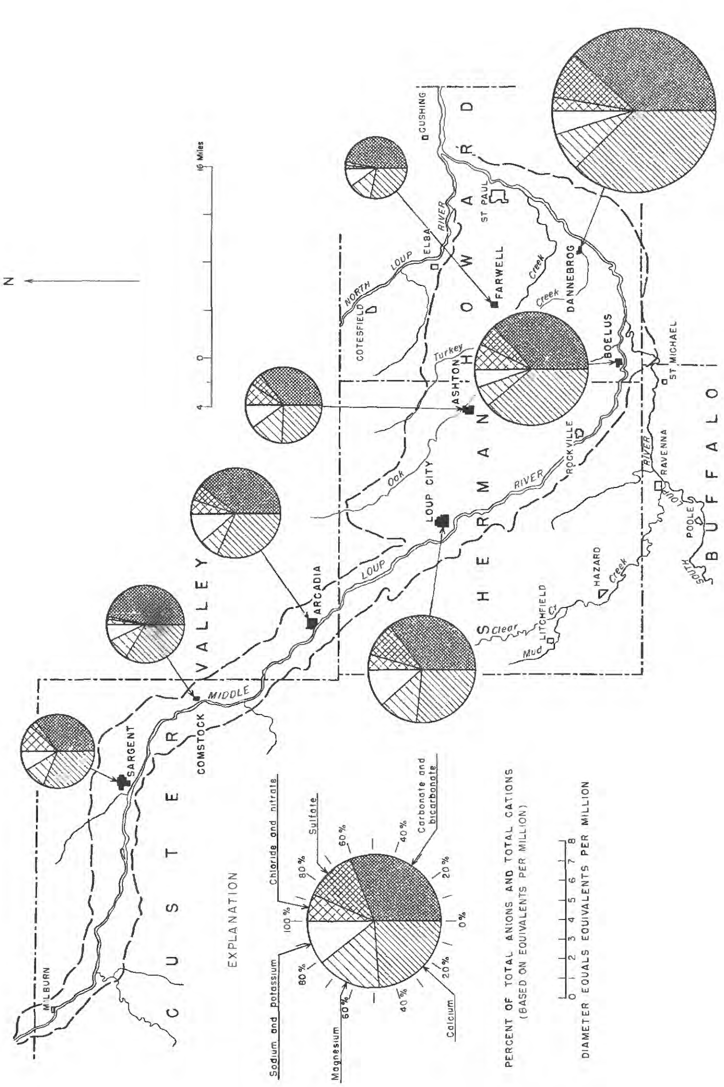

Figure 12. — Principal mineral constituents of municipal water supplies, lower Middle Loup River valley, Nebraska.

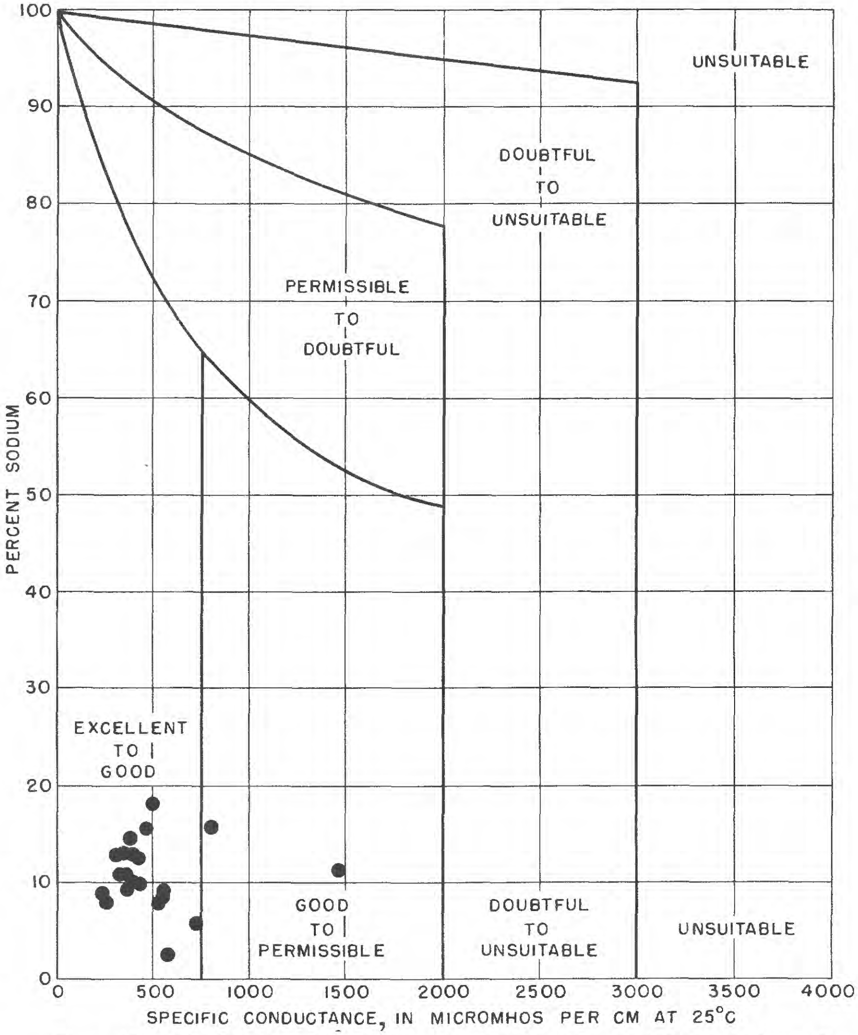

Figure 13.—Classification of ground water for irrigation, lower Middle Loup River valley, Nebraska (after Wilcox).

EFFECT OF IRRIGATION ON FUTURE WATER QUALITY

Land in the lower Middle Loup River valley is now irrigated to some extent with both surface and ground water. The Middle Loup division of the lower Platte River basin project (U. S. Bureau of Reclamation, 1951) includes plans for surface-water irrigation of 103,000 acres, in the Sargent, Lees Park, Middle Loup, and Farwell units. Whenever irrigation water is applied to the land, the question arises as to the probable effect of irrigation on the quality of the ground water. The quality of the ground water may be changed by three principal means: (1) Irrigation water different in chemical character from the ground water may percolate to the ground-water reservoir and change the quality of the latter; (2) the irrigation water as it percolates to the ground-water reservoir dissolves soluble material from the mantle rock, which may result in an increase in mineral salt content of the ground water; (3) salts will be concentrated in the soil solution or precipitated on the surface soil by evapotranspiration in areas where the water table is now, or may be in the future, sufficiently close to the ground surface to bring the capillary zone in contact with the surface or root zone. The result of the last change is an increase in the concentration of salts in the ground water in that vicinity.

Significant changes in the quality of the ground water in the lower Middle Loup River valley are not expected from the first two mechanisms. Connor (1951) states that "Although more mineralized, the ground water is similar in composition to the surface water." Soil surveys in Custer, Valley, Sherman, and Howard Counties by Hayes and others (1926), Gemmell and others (1932), Brown, Gemmell, and Hayes (1931), and Hayes and others (1924) indicate that the principal soils in the proposed irrigation area are of the Valentine, Grundy, Hall, and Cass series. In general, these soils have been leached of much of their soluble salts and are known to contain little calcareous material. The small quantities of sodium in the ground- and surface-water samples indicate the relative absence of soluble sodium in the soil. Irrigation water percolating through such soil would be expected to dissolve a minimum quantity of salts.

Increased concentrations of dissolved salts in the ground water in some areas as a result of raising the water table is a very real possibility. Plate 2 shows that the depth to water in much of the area along the river is less than 10 feet. Meinzer (1923, p. 32–38) cites several investigators who have described the movement of water by capillarity in various types of soils. The consensus is that the effective capillary zone varies in thickness from 3 to 4 feet in coarse sandy or gravelly soils to 8 feet or more in fine soil. Raising of the water table would appreciably increase the probability of concentration of salts in the soil and ground water of these areas. However, because the quality of the ground water is excellent, a change in chemical character of considerable magnitude would be required before the water would be impaired for domestic or irrigation use, except possibly in local areas.

It must be borne in mind that the lower Middle Loup River valley is only a small part of the vast ground-water system underlying this area of Nebraska. Any modification of conditions that affect ground water in the upgradient areas outside of the valley might affect the chemical quality of the water within this area also.

GENERAL SUMMARY

The Middle Loup division includes the valley lands lying along the course of the Middle Loup River from a point about 3 miles north of the town of Milburn to the confluence of the Middle Loup River with the North Loup River about 5 miles downstream from St. Paul. It includes also the interstream divide area between the Middle Loup River and the North Loup River south of a line across the divide between a point about 5 miles upstream from Loup City on the Middle Loup River to a point on the North Loup River near Elba. The area is roughly 112 miles long and encompasses approximately 650 square miles. The area has a semiarid climate, with an average annual precipitation of about 23.25 inches. Although this amount of precipitation is sufficient for crop production if it is received at favorable times during the growing season, the distribution usually is not favorable; hence, farming is dependent upon irrigation for high crop yields. The principal crops are corn, wheat, oats, wild hay, alfalfa, rye, and barley. Irrigation in part of the area was begun in 1938 with the completion of the Middle Loup Public Power and Irrigation District project. About 12,000 acres is irrigated in this project. Additional lands are irrigated each year from ground-water sources. A total of 57 irrigation wells were pumped during the summer of 1950. The Bureau of Reclamation plans to furnish supplementary water supplies to permit putting additional acreage under irrigation.

The major part of the area considered in this report is flat to gently sloping and comprises valley bottom land and stream terraces. In addition to the valley lands, part of the upland area in the lower end of the divide between Middle Loup and North Loup Rivers is also considered. The bedrock underlying the area is of Cretaceous and Tertiary age and consists principally of the Niobrara formation and the Pierre shale. Above these is the Ogallala formation. Of the formations referred to, only the Ogallala can be considered as a source of ground-water supply. It is believed to range in thickness from about 150 to 350 feet in the area.

The principal sources of ground water for irrigation and domestic uses at present are sand and gravel formations of Pleistocene age. Ample water supplies from these for domestic and stock needs can be obtained throughout the area, and adequate supplies for irrigation needs can also be obtained over much of the area. However in parts of the area, particularly in the vicinity of Rockville, the sand and gravel deposits are relatively thin; consequently, water from them is somewhat limited. The Ogallala formation underlying the area is capable of yielding water of good quality, but when wells are developed in it difficulty is experienced in screening out fine sand without materially decreasing the yield of water.

The water table in much of the area is near the land surface and, with the proposed importation of water to the area, waterlogging of the lower lying land is likely to occur. Thus, further detailed investigations of the shallow ground water should be made preliminary to the design and construction of drainage systems, because the present general investigation was not designed to give the detailed data required for drainage developments.

Ground water in the lower Middle Loup River valley is of the calcium bicarbonate type and contains high concentrations of silica. The silica-dissolved solids ratio decreases downstream. The water is hard but otherwise generally satisfies requirements for a potable water. Two of the samples were found to contain nitrate in excess of the maximum concentration thought to be safe for infant feeding. The water is suitable for irrigation use because of its low mineral content, low percent sodium, and low concentration of boron.

Little change in the chemical quality of the ground water is expected in the advent of extended irrigation practices, except in areas where the water table is raised to bring the capillary zone in contact with either the soil surface or the root zone. A more detailed study of the relation of depth to water to chemical quality would be desirable in areas in which the water table may rise as a result of future irrigation.

WATER-LEVEL MEASUREMENTS

As pointed out earlier, the investigation on which this report is based included periodic manual measurements of the depth to water in 241 observation wells. Additional manual water-level measurements were made infrequently in other observation wells. A recording gage was established on observation well 17-16-26dc. Measurements of the depth to water below land surface in all observation wells are given in tables 8 and 9.

DESCRIPTION OF WELLS

Records were obtained for 243 wells in the Middle Loup division. The locations of all wells are shown in plates 1 and 2. The available pertinent data for all wells that are shown on the two maps are given in table 10.

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Table 8. --Water-level measurements in wells
[In feet below land-surface datum]

Blaine County

Date	Water level	Date	Water level	Date	Water level
		21-21-29cc			
Dec. 19, 1949	2.59	Apr. 27, 1950	2.30	Sept. 1, 1950	2.05
Jan. 3, 1950	2.51	June 2	2.17	Oct. 10	2.21
Feb. 6	2.66	July 14	2.73	Oct. 30	2.30
Apr. 7	2.01	Aug. 11	2.15		
		21-21-29cd1			
Jan. 3, 1950	3.54	June 2, 1950	5.68	Oct. 10, 1950	5.72
Feb. 6	2.20	July 14	5.68	Oct. 30	5.82
Apr. 7	3.99	Aug. 11	5.61		
Apr. 27	3.99	Sept. 1	5.70		
		21-21-29cd2			
Dec. 19, 1949	3.97	May 1, 1950	4.07	Sept. 1, 1950	4.82
Jan. 3, 1950	4.07	June 2	3.94	Oct. 10	4.17
Feb. 6	3.29	July 14	4.12	Oct. 30	4.26
Apr. 7	1.56	Aug. 11	3.92		
		21-21-29dc			
Apr. 7, 1950	5.83	July 7, 1950	[a]6.07	Sept. 1, 1950	5.36
May 1	5.99	July 14	[a]6.15	Oct. 10	5.64
June 2	5.56	Aug. 11	5.49	Oct. 30	5.83
		21-21-32aa			
Dec. 19, 1949	11.47	May 1, 1950	11.22	Sept. 1, 1950	9.71
Jan. 3, 1950	11.45	June 2	10.55	Oct. 10	10.20
Feb. 6	11.59	July 14	10.16	Oct. 30	10.32
Apr. 7	11.31	Aug. 11	10.24		
		21-21-32bb			
Apr. 7, 1950	1.68	July 7, 1950	[a]3.66	Sept. 1, 1950	2.92
Apr. 27	2.49	July 14	[a]3.75	Oct. 17	3.24
June 2	[a]2.57	Aug. 11	2.59	Oct. 30	3.20
		21-21-32ca			
Apr. 7, 1950	3.98	July 7, 1950	[a]4.67	Sept. 1, 1950	4.50
Apr. 27	4.28	July 14	[a]4.71	Oct. 17	4.66
June 2	4.48	Aug. 11	[a]4.19	Oct. 30	4.78
		21-21-32dc			
Apr. 6, 1950	8.69	July 7, 1950	[a]8.90	Sept. 1, 1950	8.73
Apr. 27	8.87	July 14	[a]8.98	Oct. 17	8.85
June 2	8.75	Aug. 11	8.74	Oct. 30	8.79
		21-21-33ba			
Apr. 7, 1950	42.87	July 7, 1950	[a]42.30	Sept. 1, 1950	42.24
May 1	42.67	July 14	[a]42.25	Oct. 30	42.17
June 2	42.78	Aug. 11	42.33		
		21-21-33bc			
Apr. 7, 1950	7.77	July 7, 1950	[a]7.69	Sept. 1, 1950	6.95
May 1	7.94	July 14	[a]7.75	Oct. 30	7.37
June 2	7.66	Aug. 11	7.24		

[a] Measured by Bureau of Reclamation.

Table 8. -- Water-level measurements in wells--Continued

Blaine County--Continued

Date	Water level	Date	Water level	Date	Water level
		21-21-33cc			
Dec. 19 1949	4.47	May 1, 1950	3.74	Sept. 1, 1950	3.75
Jan. 3, 1950	4.41	June 2	3.64	Oct. 10	4.50
Feb. 6	4.21	July 14	4.49	Oct. 30	3.87
Apr. 7	3.51	Aug. 11	3.99		
		21-21-33cd			
Dec. 19, 1949	7.61	May 1, 1950	7.38	Sept. 1, 1950	6.86
Jan. 3, 1950	7.69	June 2	7.09	Oct. 10	6.94
Feb. 6	7.65	July 14	7.49	Oct. 30	7.07
Apr. 7	7.39	Aug. 11	7.26		
		21-21-33dc			
Apr. 7, 1950	10.99	July 7, 1950	[a]10.64	Sept. 1, 1950	10.39
May 1	10.89	July 14	[a]10.70	Oct. 10	10.35
June 2	10.44	Aug. 11	10.85	Oct. 30	10.45

Custer County

Date	Water level	Date	Water level	Date	Water level
		15-17-1ad			
June 21, 1950	21.84	Sept. 27, 1950	21.30	Nov. 6, 1950	21.48
		17-17-1aa			
Nov. 9, 1949	5.19	Apr. 5, 1950	4.05	Aug. 8, 1950	1.84
Dec. 5	5.15	May 2	4.48	Aug. 30	4.70
Jan. 5, 1950	4.52	May 31	4.19	Sept. 28	4.37
Feb. 3	4.37	July 5	4.68	Nov. 1	4.80
Mar. 6	4.04				
		18-17-3bb			
Oct. 6, 1949	6.48	Mar. 13, 1950	5.87	Aug. 8, 1950	6.84
Nov. 11	6.49	Apr. 4	5.59	Aug. 30	5.47
Dec. 1	6.47	Apr. 26	5.77	Sept. 28	6.04
Jan. 5, 1950	6.37	May 31	5.35	Nov. 2	6.14
Feb. 3	6.40	July 6	6.19		
		18-17-4ac			
Apr. 13, 1950	12.35	May 31, 1950	12.05	Sept. 28, 1950	12.49
		18-17-9bb			
Nov. 11, 1949	12.51	Apr. 4, 1950	15.26	Aug. 8, 1950	11.21
Dec. 1	13.73	Apr. 26	15.43	Aug. 30	11.87
Jan. 5, 1950	14.55	May 31	15.37	Sept. 28	10.81
Feb. 3	15.12	July 5	10.73	Nov. 2	12.46
Mar. 13	15.35				
		18-17-11cb			
Aug. 8, 1950	3.19	Sept. 27, 1950	4.08	Nov. 1, 1950	4.06
Aug. 30	3.63				

Table 8. --Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		18-17-11db1			
Nov. 18, 1949	4.82	Apr. 4, 1950	4.66	Aug. 8, 1950	3.09
Dec. 2	5.02	Apr. 26	5.03	Aug. 30	3.84
Jan. 5, 1950	5.31	May 31	4.28	Sept. 28	3.67
Feb. 3	5.47	July 5	3.99	Nov. 2	3.99
Mar. 13	5.31				
		18-17-11db2			
Nov. 18, 1949	5.79	Apr. 4, 1950	5.39	Aug. 8, 1950	3.92
Dec. 2	5.90	Apr. 26	5.85	Aug. 30	4.73
Jan. 5, 1950	6.22	May 31	4.97	Sept. 28	4.03
Feb. 3	6.32	July 5	4.14	Nov. 2	4.85
Mar. 13	5.86				
		18-17-14aa			
Dec. 1, 1949	3.36	Apr. 4, 1950	2.13	Aug. 8, 1950	2.03
Jan. 5, 1950	3.79	Apr. 26	3.32	Aug. 30	2.72
Feb. 3	3.82	May 31	2.47	Sept. 28	2.70
Mar. 13	3.09	July 5	3.31	Nov. 1	2.83
		18-17-14bb			
Nov. 18, 1949	5.03	Feb. 3, 1950	4.18	July 5, 1950	5.20
Dec. 1	5.46	Apr. 26	5.24	Sept. 27	5.46
Jan. 5, 1950	5.03	May 31	4.89	Nov. 1	5.27
		18-17-15db			
Nov. 18, 1949	1.08	May 31, 1950	1.21	Aug. 30, 1950	1.09
Dec. 1	1.30	July 5	1.37	Sept. 27	1.08
Jan. 5, 1950	1.38	Aug. 8	1.17	Nov. 1	.98
Apr. 26	1.03				
		18-17-16da			
Dec. 1, 1949	13.55	Apr. 4, 1950	14.85	Aug. 8, 1950	14.55
Jan. 5, 1950	14.08	Apr. 26	15.16	Aug. 30	14.41
Feb. 3	14.55	May 31	15.32	Sept. 27	14.48
Mar. 13	14.76	July 5	15.56	Nov. 1	14.88
		18-17-23ba			
Aug. 8, 1950	1.69	Sept. 28, 1950	2.43	Nov. 2, 1950	2.24
Aug. 30	2.00				
		18-17-23dd			
Aug. 8, 1950	1.50	Sept. 28, 1950	1.77	Nov. 2, 1950	1.80
Aug. 30	1.58				
		18-17-26cc			
Sept. 27 1950	8.62				
		18-17-26dd			
Sept. 27, 1950	14.99				

[a] Measured by Bureau of Reclamation.

Table 8. --Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		18-17-36dd			
Nov. 9, 1949	2.87	May 31, 1950	1.29	Aug. 30, 1950	1.94
Dec. 5,	2.83	July 5	1.76	Sept. 28	1.94
Feb. 3, 1950	1.38	Aug. 8	4.55	Nov. 1	2.26
Apr. 26	1.39				
		19-17-6dd			
Jan. 5, 1950	20.72	Aug. 8, 1950	19.36	Sept. 28, 1950	19.28
June 1	20.95	Aug. 30	19.74	Nov. 1	19.16
July 6	20.51				
		19-17-8ad			
Apr. 13, 1950	52.82	July 6, 1950	52.77	Sept. 28, 1950	52.38
		19-17-9ca			
Sept. 26, 1949	69.38	Mar. 13, 1950	69.10	Aug. 8, 1950	68.74
Nov. 10	69.04	Apr. 26	69.02	Aug. 30	68.66
Dec. 5	69.14	June 1	68.85	Sept. 28	68.73
Jan. 5, 1950	69.12	July 6	68.99	Nov. 1	68.69
Feb. 3	69.22				
		19-17-17bb			
Nov. 9, 1949	8.53	Apr. 4, 1950	8.88	Aug. 8, 1950	5.86
Dec. 5	9.14	Apr. 26	8.70	Aug. 30	6.63
Jan. 5, 1950	9.29	June 1	6.12	Sept. 28	7.37
Feb. 3	9.44	July 6	7.06	Nov. 1	7.53
		19-17-19ad			
Nov. 11, 1949	4.69	Apr. 26, 1950	4.26	Aug. 30, 1950	4.06
Dec. 1	4.78	May 31	3.56	Sept. 28	4.23
Feb. 3, 1950	4.74	July 6	3.28	Nov. 1	4.48
Apr. 4	3.37	Aug. 8	3.44		
		19-17-20cd			
Aug. 8, 1950	2.63	Sept. 28, 1950	3.39		
		19-17-21bb			
May 31, 1950	5.74	Sept. 28, 1950	6.46	Nov. 1, 1950	6.56
Aug. 8	5.59				
		19-17-24bc			
Apr. 26, 1950	59.59	July 6, 1950	60.91	Sept. 28, 1950	60.84
May 2	60.91	Aug. 8	60.77	Nov. 1	60.80
May 31	60.80	Aug. 30	60.79		
		19-17-27bb			
July 6, 1950	5.98	Aug. 30, 1950	6.02	Nov. 1, 1950	6.67
Aug. 8	5.43	Sept. 28	6.56		
		19-17-27dd			
July 6, 1950	3.86	Aug. 30, 1950	3.36	Nov. 1, 1950	2.84
Aug. 8	2.66	Sept. 28	3.63		

Table 8. --Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		19-17-29cd			
Nov. 11, 1949	10.40	Apr. 26, 1950	11.87	Aug. 30, 1950	10.52
Dec. 1	11.06	May 31	11.66	Sept. 28	10.98
Jan. 5, 1950	11.52	July 6	10.92	Nov. 1	11.25
Apr. 4	11.88	Aug. 8	10.06		
		19-17-33ad			
Dec. 1, 1949	8.40	Apr. 26, 1950	8.56	Aug. 30, 1950	8.19
Jan. 5, 1950	8.13	May 31	8.09	Sept. 28	8.71
Feb. 3	7.07	July 6	8.37	Nov. 2	8.43
Apr. 4	8.32	Aug. 8	8.15		
		19-17-34dd			
Nov. 9, 1949	4.34	Apr. 4, 1950	3.19	Aug. 8, 1950	3.04
Dec. 5	4.21	Apr. 26	3.50	Aug. 30	3.47
Jan. 5, 1950	4.33	May 31	2.73	Sept. 28	4.00
Feb. 3	4.37	July 6	3.83	Nov. 1	3.92
Mar. 13	3.72				
		19-18-2ad			
Nov. 22, 1949	28.96	Feb. 3, 1950	29.56	Sept. 29, 1950	27.66
		19-18-3ad			
Sept. 28, 1950	26.87				
		19-18-5cb			
June 1, 1950	6.82	Aug. 29, 1950	7.00	Nov. 2, 1950	7.35
Aug. 9	6.82	Sept. 29	7.18		
		19-18-8da			
June 1, 1950	3.28	Aug. 10, 1950	3.54	Oct. 9, 1950	3.70
July 7	3.82	Sept. 1	3.84	Nov. 2	3.76
		19-18-9aa			
Aug. 9, 1934	14.78	Nov. 5, 1936	14.18	Sept. 10, 1949	12.28
Nov. 5	14.19	Mar. 28, 1937	13.72	Oct. 6	12.58
Dec. 28	14.00	June 12	14.15	Nov. 10	12.38
Feb. 20, 1935	13.83	Oct. 11	14.79	Dec. 2	12.42
Apr. 15	13.90	Oct. 20, 1938	14.58	Jan. 5, 1950	12.42
June 10	13.41	June 2, 1939	14.40	Feb. 3	12.33
July 10	13.32	Nov. 25	14.20	Mar. 13	11.16
Aug. 8	14.05	Mar. 26 1940	13.85	Apr. 5	11.96
Sept. 11	14.66	July 16	14.98	Apr. 26	12.04
Oct. 15	13.79	Oct. 28	14.69	June 1	11.30
Nov. 20	13.52	Oct. 16, 1941	14.41	July 6	11.94
Dec. 22	13.51	Nov. 11, 1942	12.73	Aug. 9	11.37
Jan. 11, 1936	13.39	May 16, 1945	13.09	Aug. 29	11.48
Mar. 23	13.19	Mar. 27, 1948	11.98	Sept. 27	11.76
May 29	13.48			Oct. 30	11.58
		19-18-9bb			
Aug. 9. 1950	11.20	Sept. 29, 1950	11.53	Nov. 2, 1950	11.61
Aug. 29	11.28				

Table 8. --Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		19-18-10db			
Nov. 10, 1949	8.09	Mar. 13, 1950	7.52	Aug. 8, 1950	5.68
Dec. 1	8.26	Apr. 4	7.42	Aug. 30	6.33
Jan. 5, 1950	8.25	Apr. 26	7.69	Sept. 28	6.75
Feb. 3	8.24	July 6	6.84	Nov. 1	7.03
		19-18-11ab			
Apr. 13, 1950	9.51	Sept. 28, 1950	8.79		
		19-18-14ad			
Aug. 8, 1950	7.58	Sept. 27, 1950	7.69	Nov. 1, 1950	8.34
Aug. 30	8.03				
		19-18-14da			
May 31, 1950	2.91	Sept. 28, 1950	3.67		
		19-18-15ab			
Nov. 10, 1949	3.54	Apr. 4, 1950	2.35	Aug. 8, 1950	2.85
Dec. 1	3.48	Apr. 26	3.20	Aug. 30	3.22
Jan. 5, 1950	2.65	June 1	2.79	Sept. 28	3.21
Feb. 3	2.28	July 6	3.50	Nov. 1	3.34
Mar. 13	2.13				
		19-18-24bd			
July 6, 1950	21.81	Aug. 30, 1950	21.71	Oct. 9, 1950	21.92
Aug. 8	21.62	Sept. 28	21.88		
		19-19-1ad			
Nov. 10, 1949	7.55	Apr. 5, 1950	8.67	Aug. 9, 1950	8.22
Dec. 2	8.19	May 2	8.67	Aug. 31	8.39
Jan. 5, 1950	8.89	June 1	8.17	Sept. 29	8.60
Feb. 3	9.08	July 6	8.45	Nov. 2	8.68
		19-19-2bb			
Aug. 23, 1949	17.51	Feb. 3, 1950	17.07	Aug. 9, 1950	16.55
Sept. 26	16.90	Apr. 5	17.05	Aug. 31	16.62
Nov. 10	16.80	May 2	16.94	Sept. 29	16.71
Dec. 2	16.89	June 1	17.00	Nov. 2	16.87
Jan. 5, 1950	17.00	July 6	17.56		
		19-19-4cc			
Nov. 10, 1949	8.95	May 2, 1950	9.48	Aug. 31, 1950	9.57
Dec. 2	9.76	June 1	9.51	Sept. 29	9.72
Feb. 3, 1950	8.21	July 6	9.62	Nov. 2	9.89
Apr. 5	9.07	Aug. 9	9.53		
		19-19-4da			
Aug. 9, 1950	4.62	Aug. 31, 1950	4.91	Sept. 29, 1950	5.13
		19-19-5cc			
Aug. 10, 1950	12.39	Aug. 31, 1950	12.43	Oct. 9, 1950	12.44

Table 8.--Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		19-19-9bc			
Nov. 10, 1949	8.57	Apr. 5, 1950	7.38	Sept. 1, 1950	8.22
Dec. 2	8.17	May 2	7.59	Oct. 9	8.06
Jan. 5, 1950	8.12	June 1	7.77	Nov. 2	8.20
Feb. 3	7.95	July 6	8.37		
		19-19-10ad			
Oct. 9, 1950	11.89	Nov. 2, 1950	11.97		
		19-19-12ac			
June 1, 1950	3.80	Aug. 10, 1950	4.00	Oct. 9, 1950	3.96
July 7	4.06	Sept. 1	4.08		
		19-20-1cc			
Aug. 9, 1950	15.96	Oct. 9, 1950	15.80	Nov. 2, 1950	15.83
Aug. 31	15.79				
		19-20-1cd			
Sept. 7, 1949	12.88	Feb. 6, 1950	12.11	July 6, 1950	12.07
Nov. 11	12.15	Apr. 5	11.79	Aug. 10	11.79
Dec. 2	12.09	May 2	11.85	Aug. 31	11.81
Jan. 5, 1950	12.12	June 1	11.74	Oct. 9	11.94
		19-20-1dd			
Aug. 9, 1950	18.38	Oct. 9, 1950	18.40	Nov. 2, 1950	18.51
Aug. 31	18.32				
		19-20-2aa			
Aug. 9, 1950	4.14	Oct. 9, 1950	4.09	Nov. 2, 1950	4.23
Aug. 31	4.06				
		19-20-3bc			
Apr. 14, 1950	10.57	May 2, 1950	10.62	Oct. 9, 1950	10.23
		19-20-3dd			
Aug. 9, 1950	9.98	Oct. 9, 1950	9.68	Nov. 2, 1950	9.68
Aug. 31	9.55				
		19-20-5aa			
Aug. 10, 1950	14.32	Oct. 9, 1950	14.41	Nov. 2, 1950	14.50
Aug. 31	14.52				
		19-20-5bb			
Oct. 6, 1949	19.29	Apr. 5, 1950	19.33	Aug. 10, 1950	19.72
Nov. 11	19.33	May 2	19.43	Aug. 31	19.41
Dec. 2	19.58	June 1	19.49	Oct. 9	19.45
Jan. 3, 1950	19.46	July 7	19.67	Nov. 2	19.52
Feb. 6	18.80				

Table 8.--Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		19-20-5cb			
Aug. 25, 1949	15.44	Feb. 6, 1950	15.79	Aug. 10, 1950	16.11
Sept. 26	15.81	Apr. 5	15.59	Aug. 31	15.81
Nov. 11	15.82	May 2	15.48	Oct. 9	15.80
Dec. 2	15.80	June 1	15.52	Nov. 2	15.96
Jan. 3, 1950	15.82	July 6	15.90		
		19-20-9aa			
Aug. 23, 1949	17.04	Feb. 6, 1950	16.78	Aug. 10, 1950	17.07
Sept. 26	16.89	Apr. 5	16.63	Aug. 31	16.50
Nov. 11	16.83	May 2	16.52	Oct. 9	16.42
Dec. 2	16.77	June 1	16.50	Nov. 2	16.52
Jan. 5, 1950	16.78	July 7	16.91		
		19-20-12db			
Sept. 7, 1949	22.11	Dec. 2, 1949	21.96	May 2, 1950	21.63
Nov. 11	21.98	Jan. 5, 1950	21.96		
		19-20-13bb			
Sept. 11, 1950	[a]16.79	Nov. 16, 1950	17.82		
		20-17-31ac			
July 6, 1950	77.95	Sept. 28, 1950	77.69		
		20-17-31ca			
Apr. 14, 1950	81.11	Sept. 28, 1950	80.89		
		20-18-27db			
Apr. 12, 1950	79.12	Sept. 29, 1950	78.82		
		20-18-28da			
Sept. 29, 1950	77.14				
		20-18-29cb			
Sept. 29, 1950	76.67				
		20-18-34cb			
Apr. 12, 1950	39.14	Aug. 9, 1950	39.10	Sept. 29, 1950	38.89
July 6	40.41	Aug. 30	38.98	Nov. 2	38.87
		20-18-35ba			
Apr. 12, 1950	74.83	Aug. 8, 1950	74.74	Sept. 28, 1950	74.70
June 1	74.80	Aug. 30	74.91	Nov. 2	74.68
		20-18-35db			
Apr. 12, 1950	53.74	Sept. 28, 1950	52.04		
		20-18-36db			
Sept. 28, 1950	63.22				

Table 8. --Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		20-19-25da			
Sept. 29, 1950	54.58				
		20-19-25dd			
Nov. 10, 1949	32.99	Apr. 5, 1950	34.75	Aug. 9, 1950	35.38
Dec. 2	33.22	May 2	34.88	Aug. 31	35.28
Jan. 5, 1950	33.98	June 1	35.09	Sept. 29	35.19
Feb. 3	34.29	July 6	35.43	Nov. 2	35.17
		20-19-26cd			
Apr. 13, 1950	64.45	Sept. 29, 1950	65.15		
		20-19-31cb			
Aug. 26, 1949	32.02	Feb. 6, 1950	31.90	Aug. 9, 1950	32.05
Sept. 26	31.84	Apr. 5	31.84	Aug. 31	32.03
Nov. 10	31.79	May 2	31.86	Sept. 29	31.99
Dec. 2	31.88	June 1	31.89	Nov. 2	32.08
Jan. 5, 1950	30.38	July 6	32.13		
		20-19-33cc			
Nov. 10, 1949	22.84	Apr. 5, 1950	23.02	Aug. 9, 1950	23.36
Dec. 2	22.87	May 2	23.01	Aug. 31	23.35
Jan. 5, 1950	22.91	June 1	23.12	Sept. 29	23.33
Feb. 3	23.07	July 6	23.30	Nov. 2	23.47
		20-19-34ab			
Sept. 26, 1949	54.34	Feb. 3, 1950	52.80	July 6, 1950	52.85
Nov. 10	52.66	Apr. 5	52.88	Aug. 9	52.74
Dec. 2	52.72	May 2	52.61	Aug. 31	52.69
Jan. 5, 1950	52.79	June 1	52.70	Sept. 29	52.62
				Nov. 2	52.68
		20-19-34cb			
Sept. 29, 1950	25.39				
		20-20-28dd			
June 1, 1950	14.26	Aug. 10, 1950	12.96	Oct. 9, 1950	13.00
		20-20-29bb			
Apr. 14, 1950	34.10	July 7, 1950	34.18	Oct. 10, 1950	33.82
May 2	34.11	Aug. 10	34.22	Nov. 3	33.92
June 1	34.13	Aug. 31	33.89		
		20-20-30aa			
Aug. 24, 1949	33.09	Jan. 3, 1950	32.57	June 1, 1950	32.62
Sept. 26	32.54	Feb. 6	32.67	July 7	32.69
Nov. 10	32.38	Apr. 5	32.58	Oct. 10	32.27
Dec. 2	32.47	May 2	32.60		
		20-20-30da			
Apr. 14, 1950	19.37	Oct. 9, 1950	18.98		

[a] Measured by Bureau of Reclamation.

Table 8. --Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		20-20-32bb			
June 1, 1950	3.89	Oct. 9, 1950	3.72		
		20-20-33bb			
Aug. 10, 1950	7.70	Oct. 9, 1950	7.65	Nov. 2, 1950	7.77
		20-20-33da			
Aug. 31, 1950	11.17	Oct. 9, 1950	10.75	Nov. 2, 1950	11.41
		20-20-35aa			
Aug. 9, 1950	38.94	Sept. 29, 1950	38.90	Nov. 2, 1950	38.92
Aug. 31	38.88				
		20-20-36cc			
Oct. 6, 1949	4.21	Apr. 5, 1950	1.83	Aug. 9, 1950	3.39
Nov. 10	3.90	May 2	2.32	Aug. 31	3.13
Dec. 2	3.26	June 1	2.76	Sept. 29	3.09
Jan. 5, 1950	3.11	July 6	3.51	Nov. 2	3.24
Feb. 6	2.19				
		20-21-4bd			
Apr. 7, 1950	16.01	July 7, 1950	[a]15.82	Aug. 11, 1950	15.77
May 1	15.96	July 14	[a]15.85	Sept. 1	[b]15.04
June 2	15.75				
		20-21-4dd			
Apr. 7, 1950	17.76	July 7, 1950	17.71	Sept. 1, 1950	16.97
May 1	18.24	July 14	17.76	Oct. 17	17.04
June 2	17.58	Aug. 11	17.63	Oct. 30	17.04
		20-21-5ca			
Apr. 7, 1950	[c]+0.15	July 7, 1950	[a]0.35	Aug. 11, 1950	[c]+0.06
Apr. 27	[c]+.02	July 14	[a].49	Oct. 17	[c]+.14
June 2	[c]+.05				
		20-21-5dc			
Apr. 7, 1950	4.84	July 7, 1950	[a]5.71	Sept. 1, 1950	4.73
Apr. 27	5.18	July 14	[a]5.81	Oct. 17	5.26
June 2	4.85	Aug. 11	4.86	Oct. 30	5.38
		20-21-6aa			
Jan. 3, 1950	5.27	June 2, 1950	5.24	Sept. 1, 1950	5.26
Feb. 6	5.09	July 14	5.70	Oct. 17	5.35
Apr. 6	5.10	Aug. 11	5.16	Oct. 30	5.42
Apr. 27	5.36				
		20-21-6ab			
Jan. 3, 1950	13.97	June 2, 1950	14.29	Oct. 11, 1950	13.61
Feb. 6	14.06	July 14	14.23	Oct. 17	13.51
Apr. 7	14.16	Aug. 11	14.19	Oct. 30	13.48
Apr. 27	14.25	Sept. 1	13.83		

Table 8.--Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		20-21-8ad			
Apr. 6, 1950	6.59	July 7, 1950	[a]7.27	Sept. 1, 1950	6.81
Apr. 27	6.86	July 14	[a]7.40	Oct. 17	6.97
June 2	6.79	Aug. 11	6.89		
		20-21-9cc			
Apr. 6, 1950	4.78	July 7, 1950	[a]6.12	Sept. 1, 1950	5.26
Apr. 27	5.43	July 14	[a]4.34	Oct. 17	5.58
June 2	5.35	Aug. 11	5.02	Oct. 30	5.66
		20-21-9dd			
Nov. 10, 1949	3.59	Apr. 27, 1950	2.45	Sept. 1, 1950	2.52
Dec. 2	3.22	June 2	2.28	Oct. 11	2.86
Jan. 3, 1950	2.99	July 14	4.04	Oct. 30	3.12
Feb. 6	2.53	Aug. 10	2.19		
		20-21-10bc			
Sept. 26, 1949	21.15	Jan. 3, 1950	20.52	Aug. 10, 1950	21.94
Nov. 10	21.18	Apr. 27	20.66	Oct. 9	20.89
Dec. 2	21.09	June 2	20.93	Oct. 30	21.09
		20-21-16bd			
Apr. 6, 1950	7.04	July 7, 1950	[a]6.94	Sept. 1, 1950	6.66
Apr. 27	6.74	July 14	7.10	Oct. 17	6.95
June 2	6.34	Aug. 11	6.94	Oct. 30	7.05
		20-21-17ad			
Apr. 6, 1950	6.00	July 7, 1950	7.27	Sept. 1, 1950	6.42
Apr. 27	6.40	July 14	7.37	Oct. 17	6.74
June 2	6.32	Aug. 11	4.68	Oct. 30	6.79
		20-21-21ab			
Apr. 6, 1950	1.54	July 7, 1950	[a]3.73	Oct. 11, 1950	2.18
Apr. 27	2.74	July 14	[a]4.03	Nov. 2	2.58
June 2	2.42	Sept. 1	.83		
		20-21-21ad			
Apr. 6, 1950	7.19	July 7, 1950	7.56	Sept. 1, 1950	6.91
Apr. 27	7.07	July 14	7.66	Oct. 11	6.82
June 1	6.84	Aug. 11	7.74	Nov. 2	6.90
		20-21-22bc			
Oct. 6, 1949	3.45	Apr. 6, 1950	1.59	Sept. 1, 1950	2.13
Nov. 10	2.49	June 2	2.42	Oct. 9	2.28
Dec. 2	2.36	July 14	3.99	Nov. 1	2.38
Jan. 3, 1950	2.56	Aug. 10	1.67		

[a] Measured by Bureau of Reclamation.
[b] Well destroyed after this date.
[c] In feet above land-surface datum.

Table 8.--Water-level measurements in wells--Continued

Custer County--Continued

Date	Water level	Date	Water level	Date	Water level
		20-21-22cc			
Apr. 27, 1950	6.33	July 14, 1950	6.80	Oct. 17, 1950	5.70
June 2	5.67	Sept. 1	5.87	Nov. 2	5.87
July 7	[a]6.67				
		20-21-23da			
June 1, 1950	11.54	Aug. 10, 1950	11.46	Oct. 10, 1950	10.73
July 7	11.51	Aug. 31	10.76	Nov. 2	10.86
		20-21-26cb			
Sept. 11, 1950	[a]27.26	Nov. 16, 1950	28.69		
		20-21-26cd			
Sept. 11, 1950	[a]43.33	Nov. 16, 1950	44.73		
		20-21-27ab			
Sept. 11, 1950	[a]18.26	Nov. 16, 1950	23.00		
		20-21-35ab			
Sept. 11, 1950	[a]35.37	Nov. 16, 1950	37.84		
		20-21-36ad			
Oct. 9, 1950	16.91				

Howard County

13-10-3dc

Date	Water level	Date	Water level	Date	Water level
May 22, 1949	12.68	Jan. 9, 1950	12.87	May 31, 1950	12.57
July 8	12.57	Feb. 7	12.89	July 7	12.75
Aug. 5	12.98	Mar. 6	12.70	Sept. 8	12.44
Sept. 28	13.07	Apr. 10	12.61	Oct. 4	12.45
Nov. 9	12.94	May 3	12.66	Oct. 31	12.48
Dec. 6	12.87				

13-10-4ad

Date	Water level	Date	Water level	Date	Water level
May 22, 1949	6.13	Dec. 6, 1949	9.79	May 3, 1950	8.36
July 8	9.14	Jan. 9, 1950	9.47	May 31	6.86
Aug. 5	11.63	Feb. 7	9.92	Sept. 8	9.87
Sept. 29	11.81	Mar. 6	9.06	Oct. 4	9.36
Nov. 9	10.59	Apr. 10	8.26	Oct. 31	9.34

Table 8.--Water-level measurements in wells--Continued

Howard County--Continued

Date	Water level	Date	Water level	Date	Water level
13-10-7cd					
July 8, 1949	1.90	Feb. 7, 1950	3.16	July 7, 1950	2.58
Aug. 5	3.00	Mar. 6	2.48	Aug. 17	2.17
Sept. 28	3.22	Apr. 10	1.93	Sept. 8	2.84
Nov. 8	3.22	May 3	2.40	Sept. 29	2.94
Dec. 6	3.17	May 31	1.31	Oct. 31	2.93
Jan. 9, 1950	3.31				
13-11-6aa					
Jan. 11, 1950	12.00	May 3, 1950	11.59	Sept. 6, 1950	11.72
Feb. 21	11.39	June 1	11.18	Oct. 13	11.74
Mar. 6	11.19	July 6	12.11	Nov. 6	11.52
Apr. 11	12.67				
13-11-6bd					
July 20, 1949	49.81	Nov. 9, 1949	50.84	Oct. 13, 1950	48.61
Sept. 28	49.12	May 3, 1950	48.95		
13-11-8dd					
Jan. 11, 1950	16.68	Apr. 11, 1950	16.26	July 6, 1950	16.71
Feb. 21	15.72	May 3	15.98	Sept. 6	16.39
Mar. 6	15.52	June 1	15.49	Oct. 13	16.46
13-11-9bb					
Oct. 13, 1950	42.93				
13-11-9db					
July 25, 1949	55.02	Jan. 11, 1950	54.02	June 1, 1950	52.89
Sept. 28	55.92	Mar. 6	52.49	Aug. 17	53.59
Nov. 9	54.54	Apr. 11	53.33	Sept. 6	54.23
Dec. 6	54.36	May 3	53.22	Oct. 13	53.99
13-11-14da					
Oct. 31, 1950	3.87				
13-11-17aa					
July 27, 1949	58.56	Nov. 9, 1949	60.56	Jan. 11, 1950	58.22
Sept. 28	60.15	Dec. 6	58.26	Apr. 11	59.77
13-11-20dd					
May 27, 1949	41.41	Nov. 9, 1949	42.45	Oct. 4, 1950	43.12
July 8	41.29	Dec. 6	42.48		
Sept. 28	42.60	Jan. 9, 1950	42.33		

[a] Measured by Bureau of Reclamation.

Table 8.--Water-level measurements in wells--Continued

Howard County--Continued

13-11-22dd

Date	Water level	Date	Water level	Date	Water level
Oct. 31, 1950	11.91				

13-11-28da

Date	Water level	Date	Water level	Date	Water level
May 26, 1949	7.88	Jan. 9, 1950	9.54	May 31, 1950	9.19
July 8	7.67	Feb. 10	9.19	July 7	9.00
Aug. 5	9.70	Mar. 6	8.78	Sept. 7	9.67
Sept. 28	9.38	Apr. 10	9.13	Sept. 29	9.44
Nov. 8	9.51	May 3	9.34	Oct. 31	9.52
Dec. 6	9.66				

13-11-29cb

Date	Water level	Date	Water level	Date	Water level
June 16, 1949	3.58	Jan. 9, 1950	4.99	July 7, 1950	5.44
July 7	4.14	Feb. 10	4.53	Aug. 16	5.17
Aug. 5	5.14	Mar. 6	4.19	Sept. 7	5.22
Sept. 23	5.29	Apr. 10	2.79	Oct. 4	5.29
Nov. 8	5.17	May 3	4.95	Oct. 31	5.46
Dec. 6	5.18	May 31	4.66		

13-11-30aa

Date	Water level	Date	Water level	Date	Water level
Oct. 27, 1950	9.25	Oct. 31, 1950	9.32		

13-11-36aa

Date	Water level	Date	Water level	Date	Water level
May 27, 1949	6.63	Dec. 6, 1949	8.36	July 7, 1950	7.08
July 8	6.15	Jan. 9, 1950	8.33	Sept. 29	8.01
Sept. 28	8.28	Feb. 10	8.42	Oct. 31	7.87
Nov. 8	8.32	May 31	7.54		

13-12-27aa

Date	Water level	Date	Water level	Date	Water level
June 16, 1949	3.85	Jan. 9, 1950	5.42	July 7, 1950	5.49
July 8	3.76	Feb. 10	6.53	Aug. 16	5.21
Aug. 5	4.11	Mar. 3	5.48	Sept. 7	4.69
Sept. 23	4.65	Apr. 10	5.56	Oct. 4	5.03
Nov. 8	5.12	May 3	5.59	Oct. 31	5.02
Dec. 6	5.27	May 31	5.58		

13-12-29ba

Date	Water level	Date	Water level	Date	Water level
Aug. 7, 1934	29.38	Nov. 4, 1936	29.04	May 2, 1949	24.95
Nov. 5	28.66	Mar. 28, 1937	27.75	July 8	24.36
Dec. 28	28.13	June 12	27.54	Aug. 5	25.08
Feb. 20, 1935	27.71	Aug. 8	28.34	Sept. 23	25.77
Apr. 15	27.29	July 11, 1938	27.70	Nov. 8	26.42
June 10	26.38	Oct. 19	28.27	Jan. 9, 1950	25.94
July 9	26.07	June 1, 1939	27.87	Feb. 10	27.22
Aug. 8	26.92	Nov. 25	28.32	Mar. 3	25.90
Sept. 10	27.26	Mar. 26, 1940	27.62	Apr. 10	24.72
Oct. 15	27.62	July 16	29.09	May 3	25.76
Nov. 19	27.52	Oct. 28	30.19	May 31	25.71
Dec. 22	27.39	Oct. 16, 1941	28.47	July 7	25.90
Jan. 11, 1936	27.35	Nov. 26, 1942	26.95	Aug. 16	25.80
Mar. 23	26.58	Mar. 29, 1948	25.84	Sept. 7	26.13
May 28	26.76	July 2	26.60	Oct. 4	26.27
July 14	28.04	Oct. 1	27.10	Oct. 31	26.27
Sept. 15	29.09				

Table 8. --Water-level measurements in wells--Continued

Howard County--Continued

Date	Water level	Date	Water level	Date	Water level
		13-12-31ba			
June 28, 1950	3.04	Sept. 7, 1950	3.17	Oct. 31, 1950	2.16
Aug. 16	1.68	Oct. 4	1.36		
		13-12-32cb			
June 16, 1949	2.85	Jan. 9, 1950	6.86	July 6, 1950	5.41
July 8	3.88	Feb. 10	6.71	Aug. 16	5.01
Aug. 5	5.99	Mar. 6	6.26	Sept. 7	5.68
Sept. 23	6.77	Apr. 10	6.06	Oct. 4	5.89
Nov. 8	6.72	May 3	6.08	Oct. 31	6.22
Dec. 6	6.72	May 31	5.06		
		13-12-35aa			
Oct. 27, 1950	9.39	Oct. 31, 1950	9.44		
		13-12-36cc			
Oct. 27, 1950	1.32	Oct. 31, 1950	0.94		
		14-10-4ca			
May 21, 1948	29.27	Nov. 9, 1949	27.21	June 1, 1950	27.17
Oct. 1	28.29	Dec. 6	27.71	Aug. 16	27.89
May 2, 1949	27.79	Jan. 9, 1950	27.65	Sept. 6	26.36
June 1	27.58	Mar. 6	27.36	Oct. 13	26.34
Aug. 10	27.33	Apr. 11	27.39	Nov. 3	26.37
Sept. 29	28.00	May 3	27.24		
		14-10-8dd			
June 17, 1949	3.45	Feb. 10, 1950	7.48	July 6, 1950	6.73
Aug. 10	5.24	Mar. 6	7.17	Aug. 16	3.49
Sept. 29	5.44	Apr. 11	7.58	Sept. 6	4.36
Nov. 9	5.97	May 3	7.68	Oct. 13	4.83
Dec. 6	6.45	June 1	7.36	Nov. 3	5.30
Jan. 9, 1950	6.81				
		14-10-14bb			
Aug. 7, 1934	7.79	Nov. 6, 1936	7.89	June 28, 1948	5.85
Nov. 6	7.87	Mar. 29, 1937	7.07	Oct. 1	6.27
Dec. 29	7.51	June 13	6.94	May 2, 1949	4.92
Feb. 21, 1935	7.23	Aug. 8	7.36	May 31	5.21
Apr. 16	6.99	Oct. 12	7.70	Aug. 5	6.23
June 3	6.21	July 12, 1938	6.60	Sept. 29	6.58
July 10	6.06	Oct. 20	7.67	Nov. 9	6.68
Aug. 9	6.87	June 2, 1939	6.28	Dec. 6	6.70
Sept. 11	7.29	Nov. 27	7.43	Jan. 9, 1950	6.75
Oct. 16	7.51	Mar. 27, 1940	6.91	Mar. 6	6.33
Nov. 20	7.39	July 17	7.55	Apr. 10	5.99
Dec. 23	7.25	Oct. 29	8.09	May 3	6.28
Jan. 12, 1936	7.16	Oct. 17, 1941	6.77	July 7	6.11
Mar. 24	6.62	Oct. 31, 1942	6.95	Aug. 17	4.21
May 29	6.60	July 18, 1944	5.97	Sept. 8	5.46
July 16	7.29	Mar. 29, 1948	5.89	Oct. 4	5.58
Sept. 15	7.85				

Table 8.--Water-level measurements in wells--Continued

Howard County--Continued

Date	Water level	Date	Water level	Date	Water level
14-10-28dd					
May 22, 1949	4.06	Feb. 7, 1950	5.19	July 7, 1950	5.22
Aug. 5	5.40	Mar. 6	5.25	Aug. 17	4.91
Sept. 29	5.42	Apr. 10	5.35	Sept. 8	5.17
Nov. 9	5.44	May 3	5.06	Oct. 4	5.04
Dec. 6	5.47	May 31	5.22	Oct. 31	4.81
Jan. 9, 1950	5.37				
14-10-30ba					
May 24, 1949	13.80	Jan. 9, 1950	14.58	July 6, 1950	14.72
Aug. 10	13.40	Feb. 10	14.89	Aug. 16	12.57
Sept. 29	16.66	Apr. 11	14.66	Oct. 13	13.27
Nov. 9	13.81	May 3	14.81	Nov. 3	14.38
14-11-30cb					
July 27, 1949	30.33	Dec. 6, 1949	32.27	Apr. 11, 1950	29.26
Nov. 9	31.56	Jan. 11, 1950	31.73		
14-11-36dc					
May 24, 1949	36.02	Apr. 11, 1950	35.63	Sept. 6, 1950	36.81
Aug. 9	36.56	May 3	35.91	Oct. 13	35.15
Dec. 6	34.59	Aug. 16	35.52	Nov. 3	35.29
Jan. 9, 1950	34.50				
14-12-5cc					
Jan. 11, 1950	4.78	Apr. 11, 1950	4.64	Sept. 6, 1950	4.51
Feb. 21	4.69	May 3	4.68	Oct. 13	4.35
Mar. 6	4.57	June 1	3.64	Nov. 6	4.39
14-12-15bb					
Jan. 11, 1950	9.24	May 3, 1950	9.04	Sept. 6, 1950	8.13
Feb. 21	9.24	June 1	8.68	Oct. 13	8.44
Mar. 6	9.09	Aug. 17	7.54	Nov. 6	8.40
Apr. 11	9.11				
14-12-24dc					
Jan. 11, 1950	7.33	May 3, 1950	7.00	Sept. 6, 1950	7.18
Feb. 21	7.00	June 1	6.86	Oct. 13	7.22
Mar. 6	6.81	Aug. 17	6.36	Nov. 6	7.05
Apr. 11	7.04				
15-10-34cb					
June 29, 1948	19.60	Nov. 9, 1949	17.31	June 6, 1950	17.94
Oct. 1	19.50	Dec. 6	17.45	Aug. 17	14.72
Apr. 26, 1949	17.97	Jan. 4, 1950	17.61	Sept. 11	15.46
May 31	17.74	Feb. 9	17.74	Oct. 4	15.28
June 30	16.86	Mar. 29	17.87	Oct. 31	15.43
Sept. 27	17.35	May 2	17.87		
Sherman County					
13-13-2cd					
May 4, 1950	156.75	Oct. 20, 1950	156.70		

Table 8.--Water-level measurements in wells--Continued

Sherman County--Continued

Date	Water level	Date	Water level	Date	Water level
		13-13-4dc			
June 22, 1949	119.10	Dec. 6, 1949	118.64	Apr. 10, 1950	118.82
Sept. 22	118.92	Jan. 9, 1950	118.84	May 3	119.46
Nov. 7	119.70	Feb. 7	120.11	Oct. 3	118.76
		13-13-5dd			
Oct. 9, 1949	23.61	Mar. 14, 1950	23.45	May 3, 1950	23.40
Nov. 8	23.27	Apr. 10	23.45	June 2	23.46
Feb. 7, 1950	23.40				
		13-13-7ba			
July 7, 1950	3.04	Sept. 8, 1950	3.46	Nov. 7, 1950	2.79
Aug. 16	2.92	Oct. 4	1.97		
		13-13-7da			
July 7, 1950	3.50	Aug. 16, 1950	3.24	Oct. 4, 1950	2.55
July 9	3.50	Sept. 7	3.84	Nov. 7	3.13
		13-13-13cc			
Sept. 1, 1949	58.84	Feb. 7, 1950	53.60	Aug. 16, 1950	53.69
Sept. 23	54.93	Apr. 10	53.63	Sept. 7	54.86
Nov. 8	53.55	May 3	53.61	Oct. 3	53.66
Dec. 6	57.07	July 7	58.62	Nov. 7	53.59
		13-13-15cb			
July 7, 1950	15.29	Sept. 7, 1950	15.69	Nov. 7, 1950	15.75
Aug. 16	15.00	Oct. 3	15.83		
		13-13-21aa			
June 27, 1950	4.69	Sept. 7, 1950	4.69	Nov. 7, 1950	4.08
July 6	4.65	Oct. 4	2.49		
		13-13-21bb			
June 27, 1950	11.58	Aug. 16, 1950	11.29	Oct. 4, 1950	11.59
July 6	11.67	Sept. 7	11.50	Nov. 7	11.48
		13-13-23da			
June 23, 1949	37.95	Feb. 7, 1950	38.51	Sept. 7, 1950	37.64
Sept. 23	37.93	Apr. 10	38.22	Oct. 3	37.75
Dec. 6	38.37	June 2	37.78	Nov. 7	37.81
Jan. 9, 1950	38.45	July 7	37.95		
		13-13-26da			
July 6, 1950	10.66	Oct. 4, 1950	10.79	Nov. 7, 1950	10.65
Sept. 7	10.95				
		13-13-27ba			
Oct. 4, 1950	2.10	Nov. 7, 1950	2.51		

Table 8.--Water-level measurements in wells--Continued

Sherman County--Continued

Date	Water level	Date	Water level	Date	Water level
		13-13-35aa			
July 6, 1950	20.73	Sept. 7, 1950	20.66	Nov. 7, 1950	20.67
Aug. 16	20.64	Oct. 4	20.67		
		13-14-1ab			
Aug. 7, 1950	4.25	Sept. 7, 1950	4.69	Nov. 7, 1950	4.32
Aug. 16	4.42	Oct. 4	4.20		
		13-14-12ab			
June 23, 1949	93.05	Nov. 7, 1949	93.08	May 3, 1950	93.13
Sept. 22	93.41	Apr. 10, 1950	93.12	Oct. 4	93.49
		13-15-29ad			
Aug. 18, 1950	4.35	Sept. 27, 1950	5.36	Nov. 6, 1950	6.17
Sept. 8	4.64				
		13-16-13aa			
June 28, 1950	7.00	Sept. 27, 1950	7.69	Nov. 6, 1950	7.59
Sept. 8	7.38				
		14-13-26ab			
Jan. 18, 1949	52.82	May 3, 1950	52.83	Oct. 20, 1950	52.13
Apr. 10, 1950	52.88				
		14-14-3cc			
June 26, 1949	6.37	Apr. 10, 1950	9.20	Sept. 7, 1950	6.84
Sept. 22	6.63	June 2	7.37	Oct. 3	6.42
Nov. 7	8.03	July 6	7.71	Nov. 7	7.43
Jan. 9, 1950	9.09	Aug. 16	6.44		
		14-14-5bc			
Mar. 29, 1948	11.42	Dec. 5, 1949	11.33	June 2, 1950	12.26
Oct. 1	9.71	Jan. 9, 1950	12.00	July 6	11.46
Apr. 29, 1949	10.95	Feb. 7	11.98	Aug. 16	10.04
June 3	11.15	Mar. 14	12.19	Sept. 7	10.75
Aug. 5	8.87	Apr. 10	12.34	Oct. 4	9.82
Sept. 22	9.89	May 3	12.51	Nov. 7	10.56
Nov. 7	10.89				
		14-14-8ac			
Mar. 29, 1948	6.51	Nov. 7, 1949	7.95	June 2, 1950	6.64
Oct. 1	8.76	Dec. 6	8.02	July 6	6.99
Apr. 29, 1949	6.46	Jan. 9, 1950	8.03	Aug. 16	5.79
June 3	6.43	Feb. 7	8.08	Sept. 7	6.28
July 7	6.01	Apr. 10	7.56	Oct. 4	6.63
Sept. 22	7.95	May 3	7.78		
		14-14-15ba			
Aug. 7, 1950	7.55	Oct. 3, 1950	8.45	Nov. 7, 1950	9.72
Sept. 7	8.31				

Table 8.--Water-level measurements in wells--Continued

Sherman County--Continued

Date	Water level	Date	Water level	Date	Water level
		14-14-16bb			
June 24, 1949	10.16	Jan. 9, 1950	12.55	May 3, 1950	12.54
Sept. 22	12.33	Feb. 7	12.50	June 2	10.70
Nov. 7	12.43	Mar. 14	12.27	Sept. 7	11.53
Dec. 5	12.58	Apr. 10	12.29	Oct. 4	11.80
		14-14-21da			
Aug. 7, 1950	4.52	Sept. 7, 1950	4.99	Nov. 7, 1950	4.87
Aug. 16	4.79	Oct. 4	4.59		
		14-14-23cb			
June 26, 1949	10.88	Nov. 7, 1949	12.65	July 6, 1950	11.92
Sept. 22	12.46	Jan. 9, 1950	12.65	Oct. 3	12.04
		14-14-25dd			
Aug. 7, 1950	6.94	Sept. 7, 1950	7.72	Nov. 7, 1950	8.51
Aug. 16	7.12	Oct. 3	8.18		
		14-14-35cb			
June 24, 1949	30.14	Jan. 9, 1950	30.50	June 2, 1950	30.72
Dec. 6	30.35	Feb. 7	30.59	Oct. 4	30.51
		14-16-4ab1			
June 22, 1950	19.42	Sept. 8, 1950	19.12	Nov. 6, 1950	19.41
Aug. 18	18.79	Sept. 27	19.20		
		14-16-4ab2			
June 22, 1950	18.00	Sept. 27, 1950	17.77		
		14-16-9dc			
June 22, 1950	32.79				
		14-16-10cd			
June 21, 1950	40.28	Sept. 27, 1950	39.96	Nov. 6, 1950	39.91
Sept. 8	39.92				
		14-16-23bb			
June 22, 1950	39.79	Sept. 8, 1950	39.47	Nov. 6, 1950	39.56
Aug. 18	39.35	Sept. 27	39.48		
		15-13-9cd			
July 21, 1949	28.63	Feb. 7, 1950	29.25	Aug. 17, 1950	27.01
Sept. 28	29.90	Apr. 11	29.16	Sept. 6	27.22
Nov. 9	29.53	May 3	29.19	Oct. 6	27.50
Dec. 6	29.57	June 1	29.24	Nov. 6	27.67
Jan. 11, 1950	29.62				

Table 8. --Water-level measurements in wells--Continued

Sherman County--Continued

Date	Water level	Date	Water level	Date	Water level
		15-13-9dc			
July 22, 1949	31.73	Feb. 7, 1950	32.48	Aug. 17, 1950	31.75
Sept. 28	32.68	Apr. 11	32.04	Sept. 6	30.74
Nov. 9	32.44	May 3	32.12	Oct. 6	30.98
Dec. 6	32.43	June 1	31.98	Nov. 6	31.06
Jan. 11, 1950	32.44				
		15-13-29ca			
Apr. 17, 1950	107.01	Oct. 20, 1950	107.14		
		15-13-30dd			
Apr. 17, 1950	101.22	May 3, 1950	101.29	Oct. 20, 1950	101.23
		15-14-17cb			
Jan. 4, 1950	16.77	May 3, 1950	18.56	May 31, 1950	17.84
Feb. 1	17.48	May 4	18.58	June 2	17.72
Mar. 27	18.27	May 8	18.62	June 16	17.36
Apr. 24	18.48	May 10	18.62	Oct. 3	13.06
May 1	18.54	May 29	17.46	Nov. 7	13.22
May 2	18.57				
		15-14-19ab			
Nov. 7, 1949	10.52	May 2, 1950	11.87	June 16, 1950	11.55
Nov. 8	10.55	May 3	11.81	July 3	11.38
Nov. 30	11.70	May 4	11.81	Aug. 16	10.30
Jan. 4, 1950	11.66	May 8	11.84	Sept. 7	10.79
Feb. 1	11.39	May 10	11.80	Sept. 29	11.08
Mar. 6	11.21	May 29	11.40	Oct. 3	11.16
Mar. 27	11.56	May 31	11.44	Nov. 7	11.39
Apr. 24	11.89	June 2	11.50	Nov. 27	11.48
May 1	11.83	June 9	11.56	Dec. 29	11.37
		15-14-19cb			
July 1, 1948	5.48	Mar. 6, 1950	4.24	May 31, 1950	3.88
Oct. 1	6.52	Mar. 27	4.42	June 2	4.10
Apr. 29, 1949	5.01	Apr. 24	5.03	June 9	4.72
June 3	5.24	May 1	4.80	June 16	4.63
July 7	5.65	May 2	4.82	July 3	4.60
Sept. 22	4.88	May 3	4.90	July 6	4.60
Nov. 7	5.28	May 4	4.89	Aug. 16	4.19
Nov. 8	5.29	May 8	4.49	Sept. 7	4.97
Nov. 30	5.37	May 10	4.09	Oct. 4	4.70
Jan. 4, 1950	5.32	May 29	3.52	Nov. 7	5.24
Feb. 1	4.93				
		15-14-32aa			
Aug. 7, 1950	5.24	Sept. 8, 1950	5.94	Nov. 7, 1950	6.98
Aug. 16	5.39	Oct. 3	6.62		
		15-15-2ab			
Oct. 3, 1950	1.34	Nov. 7, 1950	2.10		

Table 8.--Water-level measurements in wells--Continued

Sherman County--Continued

15-15-2cd

Date	Water level	Date	Water level	Date	Water level
Nov. 16, 1949	4.55	Mar. 31, 1950	4.05	Aug. 14, 1950	4.37
Nov. 30	4.42	Apr. 24	4.54	Sept. 12	4.72
Jan. 4, 1950	4.18	June 9	4.69	Oct. 2	4.29
Feb. 3	3.69	July 3	4.62	Nov. 7	4.29
Mar. 6	3.37				

15-15-3dc

Date	Water level	Date	Water level	Date	Water level
June 26, 1949	14.19	Mar. 31, 1950	14.86	Aug. 14, 1950	13.98
Sept. 23	14.11	Apr. 24	15.17	Sept. 12	14.16
Nov. 30	14.82	June 9	14.82	Oct. 3	14.16
Feb. 3, 1950	15.29	July 3	14.60	Nov. 7	14.58
Mar. 6	15.06				

15-15-4aa

Date	Water level	Date	Water level	Date	Water level
June 9, 1950	4.02	Aug. 14, 1950	2.98	Oct. 3, 1950	3.17
July 3	4.41	Sept. 12	4.49	Nov. 7	4.21

15-15-11cb

Date	Water level	Date	Water level	Date	Water level
Nov. 30, 1949	6.89	Mar. 31, 1950	7.00	Sept. 12, 1950	6.34
Jan. 4, 1950	7.15	Apr. 24	7.38	Oct. 2	6.02
Feb. 3	7.27	June 9	6.92	Nov. 7	6.61
Mar. 6	7.10	July 3	6.46		

15-15-13bb

Date	Water level	Date	Water level	Date	Water level
Aug. 16, 1950	2.05	Oct. 2, 1950	1.54	Nov. 7, 1950	2.74
Sept. 7	3.07				

15-15-14bd

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	16.49	Mar. 6, 1950	17.75	July 3, 1950	17.51
Sept. 23	16.75	Mar. 28	18.10	Aug. 14	17.40
Nov. 30	17.73	Apr. 24	18.30	Oct. 3	16.89
Jan. 4, 1950	17.92	June 9	17.85	Nov. 7	17.43
Feb. 1	17.79				

15-15-24cc

Date	Water level	Date	Water level	Date	Water level
Sept. 23, 1949	12.56	Apr. 24, 1950	16.03	June 16, 1950	7.79
Nov. 7	13.22	May 1	16.09	July 3	10.02
Nov. 8	13.25	May 2	16.08	July 6	10.35
Nov. 30	13.55	May 3	16.01	Aug. 16	11.97
Jan. 4, 1950	14.17	May 4	16.14	Sept. 7	12.33
Feb. 1	14.88	May 8	16.16	Oct. 4	12.44
Mar. 6	15.36	May 10	16.20	Nov. 7	12.29
Mar. 28	15.67	June 9	7.19		

15-16-7aa

Date	Water level	Date	Water level	Date	Water level
June 27, 1950	26.87	Sept. 27, 1950	26.64	Nov. 6, 1950	26.55
Sept. 8	26.63				

15-16-7da

Date	Water level	Date	Water level	Date	Water level
June 21, 1950	23.77	Sept. 27, 1950	24.12	Nov. 6, 1950	23.78

Table 8.--Water-level measurements in wells--Continued

Sherman County--Continued

Date	Water level	Date	Water level	Date	Water level
		15-16-17ac			
June 22, 1950	28.42	Sept. 8, 1950	27.35	Sept. 27, 1950	27.43
		15-16-33ad			
June 22, 1950	19.66	Sept. 27, 1950	19.38		
		16-14-8bd			
July 21, 1949	110.26	May 3, 1950	109.97	Oct. 6, 1950	109.74
		16-14-20aa			
July 21, 1949	77.87	Feb. 7, 1950	76.68	Aug. 17, 1950	76.97
Sept. 28	76.89	Apr. 11	77.10	Sept. 6	76.71
Nov. 9	76.53	May 3	76.66	Oct. 6	76.45
Dec. 5	76.63	June 1	76.70	Nov. 6	76.77
Jan. 11, 1950	76.59				
		16-15-5dd			
Oct. 11, 1949	42.94	Mar. 6, 1950	44.80	July 5, 1950	41.23
Nov. 30	42.76	Apr. 3	42.59	Sept. 12	41.94
Jan. 4, 1950	43.03	Apr. 24	43.14	Oct. 3	40.69
Feb. 2	45.30	June 9	42.45		
		16-15-6da			
Oct. 3, 1950	5.00	Nov. 7, 1950	5.24		
		16-15-8dd			
Sept. 27, 1949	4.30	Mar. 6, 1950	3.28	Aug. 14, 1950	3.02
Nov. 7	4.08	Apr. 3	2.60	Sept. 12	3.88
Nov. 30	3.88	Apr. 24	3.14	Oct. 3	3.33
Jan. 4, 1950	3.87	June 9	3.13	Nov. 7	3.82
Feb. 2	3.98	July 5	3.55		
		16-15-9dc			
Sept. 27, 1949	12.59	Mar. 6, 1950	14.19	Aug. 14, 1950	14.38
Nov. 7	13.35	Apr. 3	14.44	Sept. 12	14.31
Nov. 30	13.50	Apr. 24	14.66	Oct. 6	14.64
Jan. 4, 1950	13.79	June 9	14.93	Nov. 7	14.99
Feb. 2	13.99	July 5	14.41		
		16-15-16cd			
Nov. 16, 1949	6.25	Mar. 6, 1950	5.65	July 5, 1950	5.75
Nov. 30	6.24	Apr. 3	5.50	Sept. 12	5.43
Jan. 4, 1950	6.21	Apr. 24	5.64	Oct. 3	5.37
Feb. 2	6.09	June 9	5.36	Nov. 7	5.56
		16-15-19ab			
Nov. 20, 1949	22.21	Apr. 24, 1950	24.11	Oct. 19, 1950	20.73
Jan. 4, 1950	22.99	July 3	18.49	Nov. 7	21.47
Feb. 3	23.38	Sept. 12	18.89		

Table 8.--Water-level measurements in wells--Continued

Sherman County--Continued

Date	Water level	Date	Water level	Date	Water level
16-15-20cc					
Nov. 15, 1949	9.21	Mar. 31, 1950	10.76	Aug. 14, 1950	8.26
Dec. 1	9.52	Apr. 24	10.98	Sept. 12	7.91
Jan. 4, 1950	10.01	June 9	11.06	Oct. 3	7.47
Feb. 3	10.37	July 3	8.31	Nov. 7	8.62
Mar. 13	10.72				
16-15-21aa					
Nov. 16, 1949	5.05	Apr. 3, 1950	4.67	Aug. 14, 1950	4.63
Nov. 30	5.09	Apr. 24	4.99	Sept. 12	5.02
Jan. 4, 1950	5.16	June 9	4.88	Oct. 3	4.95
Feb. 2	5.17	July 5	5.14	Nov. 7	4.98
Mar. 6	4.74				
16-15-26ca					
Oct. 11, 1949	48.93	Mar. 6, 1950	50.69	June 9, 1950	51.28
Nov. 30	49.82	Apr. 3	51.19	Sept. 12	49.61
Jan. 4, 1950	50.40	Apr. 24	51.35	Oct. 3	48.49
Feb. 2	50.73				
16-15-27ab					
Nov. 16, 1949	4.40	Apr. 24, 1950	4.10	Sept. 12, 1950	4.59
Jan. 4, 1950	4.64	June 9	4.07	Oct. 19	4.22
Feb. 2	4.51	July 5	3.99	Nov. 7	4.32
16-15-28bb					
Nov. 15, 1949	21.05	Mar. 31, 1950	20.89	Aug. 14, 1950	19.99
Dec. 1	21.20	Apr. 24	21.27	Sept. 12	20.96
Jan. 4, 1950	21.41	June 9	21.03	Oct. 3	20.92
Feb. 3	21.04	July 3	21.12	Nov. 7	21.15
Mar. 13	20.79				
16-15-33aa					
June 9, 1950	3.90	Sept. 11, 1950	5.01	Nov. 7, 1950	5.04
July 3	4.42	Oct. 3	4.30		
16-15-34dd					
Sept. 12, 1950	5.27	Oct. 19, 1950	4.77	Nov. 7, 1950	4.78
16-15-36cc					
Sept. 23, 1949	12.21	Feb. 2, 1950	13.84	June 9, 1950	20.39
Nov. 7	20.29	Mar. 6	15.91	July 5	21.22
Nov. 30	8.38	Apr. 3	17.43	Oct. 3	23.02
Jan. 4, 1950	11.59	Apr. 24	18.22	Nov. 7	23.78
16-16-1da					
Aug. 14, 1950	4.35	Oct. 3, 1950	3.76	Nov. 7, 1950	4.42
Sept. 12	5.25				
16-16-2ad					
Aug. 16, 1950	8.46	Oct. 3, 1950	8.84	Nov. 7, 1950	8.92
Sept. 12	8.80				

Table 8.--Water-level measurements in wells--Continued

Sherman County--Continued

Date	Water level	Date	Water level	Date	Water level
		16-16-12bc			
Aug. 29, 1949	32.37	Jan. 4, 1950	35.62	Aug. 14, 1950	34.12
Sept. 27	33.68	Feb. 3	35.92	Sept. 12	34.03
Nov. 7	34.78	June 9	36.41	Oct. 3	34.60
Dec. 1	35.22	July 3	33.22	Nov. 7	35.35
		16-16-12dc			
Aug. 22, 1949	26.08	Feb. 3, 1950	29.99	July 3, 1950	26.85
Sept. 27	26.29	Mar. 13	30.33	Aug. 14	28.32
Nov. 7	28.35	Apr. 3	30.53	Sept. 12	27.78
Dec. 1	28.91	Apr. 24	30.65	Oct. 3	27.95
Jan. 4, 1950	29.49	June 9	30.69	Nov. 7	29.76
		16-16-13aa			
Aug. 23, 1949	6.83	Feb. 3, 1950	14.29	Aug. 14, 1950	14.32
Sept. 27	13.18	Mar. 13	14.47	Sept. 12	14.14
Nov. 7	13.56	Apr. 24	14.74	Oct. 3	14.13
Dec. 1	13.69	June 9	14.95	Nov. 7	14.19
Jan. 4, 1950	13.99	July 3	12.92		
		Valley County			
		17-16-3cc			
July 5, 1950	24.97	Aug. 30, 1950	25.58	Sept. 27, 1950	25.67
Aug. 8	25.31				
		17-16-6bc			
Apr. 17, 1950	21.94	July 5, 1950	22.56	Aug. 30, 1950	22.28
May 31	21.81	Aug. 8	22.22	Sept. 27	22.42
		17-16-7ab			
Apr. 17, 1950	29.92	Aug. 8, 1950	29.79	Sept. 27, 1950	29.98
May 31	29.94	Aug. 30	29.86	Nov. 1	29.97
July 5	29.82				
		17-16-9bd			
Sept. 26, 1949	7.73	Feb. 3, 1950	10.77	Aug. 8, 1950	8.36
Nov. 8	9.45	Mar. 3	11.66	Aug. 30	8.28
Dec. 1	10.15	Apr. 3	11.89	Sept. 27	8.07
Jan. 5, 1950	10.73	July 5	7.85	Nov. 2	9.27
		17-16-10dd			
Aug. 8, 1950	11.69	Sept. 27, 1950	11.33		
Aug. 30	11.87				
		17-16-17ac			
Sept. 26, 1949	3.48	Mar. 13, 1950	3.63	Aug. 8, 1950	3.29
Dec. 5	4.46	Apr. 5	3.10	Aug. 30	3.78
Jan. 5, 1950	4.09	May 2	3.26	Sept. 27	4.16
Feb. 3	4.26	May 31	3.36	Nov. 1	3.98
Mar. 3	3.57	July 5	2.75		

Table 8.--Water-level measurements in wells--Continued

Valley County--Continued

Date	Water level	Date	Water level	Date	Water level
		17-16-21da			
Nov. 28, 1949	0.70	Apr. 24, 1950	0.41	Sept. 27, 1950	0.70
Dec. 6	.68	May 31	.06	Nov. 1	.42
Apr. 5, 1950	.08	July 5	.58		
		17-16-25aa			
Aug. 24, 1949	9.06	Apr. 3, 1950	9.47	Aug. 14, 1950	8.28
Sept. 27	9.58	Apr. 24	9.34	Aug. 30	8.34
Nov. 7	9.44	May 31	9.19	Sept. 27	8.92
Nov. 30	9.34	July 5	9.16	Oct. 30	9.04
Jan. 4, 1950	9.42	July 5	9.35	Nov. 27	9.25
Feb. 3	9.61	Aug. 8	8.37	Dec. 29	9.24
Mar. 3	9.55				
		17-16-25cb			
Sept. 27, 1949	3.19	Apr. 3, 1950	1.11	Aug. 8, 1950	2.18
Nov. 7	2.80	Apr. 24	2.15	Aug. 14	2.25
Nov. 30	2.67	May 31	1.43	Aug. 30	2.23
Jan. 4, 1950	2.54	July 5	2.34	Sept. 27	2.80
Feb. 3	1.72	July 5	2.36	Nov. 1	2.62
Mar. 3	1.04				
		[d] 17-16-26dc			
		17-16-34aa			
Sept. 27, 1949	9.71	Mar. 13, 1950	10.87	Aug. 8, 1950	9.36
Nov. 7	10.94	Apr. 3	11.28	Aug. 14	9.17
Nov. 30	11.18	Apr. 24	11.59	Aug. 29	9.81
Jan. 4, 1950	11.65	May 31	11.15	Sept. 27	9.65
Feb. 3	11.93	July 5	7.96	Nov. 1	10.70
		18-16-30cc			
Nov. 8, 1949	4.69	Apr. 4, 1950	4.75	Aug. 8, 1950	4.02
Dec. 1	4.79	Apr. 26	4.86	Aug. 30	4.03
Jan. 5, 1950	4.06	May 31	4.08	Sept. 27	4.37
Feb. 3	5.27	July 5	4.47	Nov. 1	4.24
Mar. 3	5.27				

[d] Record given in table 9.

Table 9.--Water-level record, well 17-16-26dc, Valley County
[Lowest daily stage taken from recorder charts, in feet below land-surface datum]

1944

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.52	4.88	4.66	4.66	3.75	5.02	....	....	5.49	5.89	5.70	5.44
2	5.51	4.87	4.66	4.32	3.81	5.11	....	....	5.54	5.89	5.71	5.47
3	5.49	4.88	4.67	4.37	3.01	5.11	....	....	5.61	5.84	5.71	5.47
4	5.48	4.87	4.70	4.82	3.45	5.18	....	....	5.66	5.79	5.71	5.39
5	5.46	4.85	4.63	4.88	3.85	5.25	....	....	5.67	5.71	5.69	5.25
6	5.44	4.86	4.73	4.92	4.02	5.33	....	....	5.45	5.44	5.66	5.19
7	5.42	4.84	4.86	4.92	4.07	....	....	....	5.39	5.41	5.62	5.14
8	5.40	4.83	4.97	4.87	4.00	....	....	....	5.44	5.44	5.57	5.10
9	5.38	4.86	4.99	4.78	4.18	....	....	....	5.50	5.46	5.57	5.15
10	[a]5.37	[a]4.88	4.99	4.88	4.27	....	....	....	5.54	5.48	5.57	5.21
11	[a]5.37	[a]4.89	4.98	4.39	4.24	....	....	....	5.57	5.51	5.57	5.27
12	[a]5.35	[a]4.91	4.91	3.59	3.33	....	....	....	5.55	5.54	5.56	5.32
13	[a]5.34	[a]4.92	4.90	3.24	3.60	....	....	....	5.58	5.57	5.55	5.33
14	[a]5.32	4.93	4.93	....	3.60	....	....	....	5.61	5.60	5.53	5.32
15	[a]5.30	4.82	5.90	....	3.81	....	....	....	5.65	5.62	5.54	5.28
16	[a]5.28	4.89	5.02	....	4.01	....	....	....	5.69	5.63	5.55	5.24
17	[a]5.26	4.85	4.99	....	4.27	....	....	....	5.72	5.65	5.55	5.21
18	[a]5.24	4.88	4.89	....	4.52	....	5.99	....	[a]5.74	5.67	5.54	5.28
19	[a]5.22	4.91	4.91	....	4.66	....	6.03	....	[a]5.72	5.67	5.54	5.31
20	5.19	4.90	4.94	....	4.72	....	6.06	....	[a]5.73	5.64	5.50	5.32
21	5.17	4.79	4.97	....	4.45	....	6.09	....	[a]5.75	5.64	5.48	5.33
22	5.15	4.70	4.98	....	4.29	....	6.13	....	[a]5.77	5.64	5.47	5.36
23	5.11	4.65	4.92	....	4.38	....	6.16	....	[a]5.78	5.66	5.47	5.38
24	5.08	4.60	4.71	....	4.57	....	6.18	....	[a]5.81	5.67	5.47	5.39
25	[a]5.05	4.56	4.73	3.35	4.58	....	6.21	6.07	[a]5.82	5.69	5.45	5.41
26	[a]5.04	4.58	4.78	3.44	4.56	....	....	6.00	5.83	5.70	5.31	5.41
27	5.02	4.64	4.79	3.63	4.66	....	....	5.93	5.84	5.71	5.24	5.41
28	4.97	4.63	4.76	3.83	3.20	....	....	5.89	5.85	5.71	5.22	5.40
29	4.93	4.64	4.65	3.87	4.84	....	....	5.88	5.85	5.71	5.27	5.35
30	4.91		4.77	3.47	4.92	....	....	5.83	5.87	5.71	5.36	5.27
31	4.88		4.76		4.96		....	5.60		....		5.21

1945

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a]5.17	4.90	4.66	5.37	[a]5.14	4.53	5.43	6.14	6.45	6.18	5.95	5.71
2	[a]5.21	4.91	4.60	5.41	5.21	4.73	5.49	6.17	6.47	6.15	5.94	5.71
3	[a]5.25	4.91	4.62	5.42	5.27	4.87	5.56	6.18	6.48	6.14	5.94	5.70
4	[a]5.26	4.85	4.62	5.42	5.32	4.92	[a]5.64	6.19	6.49	6.12	5.94	5.69
5	5.25	4.81	[a]4.63	[a]5.38	5.37	4.88	[a]5.73	6.21	6.49	6.11	5.92	5.69
6	5.19	4.74	4.73	[a]5.39	5.42	4.16	5.76	6.24	6.53	6.10	5.91	[a]5.67
7	5.14	4.69	[a]4.74	[a]5.40	5.47	[a]4.01	5.80	6.27	6.54	6.08	5.91	[a]5.65
8	5.08	[a]4.66	[a]4.75	[a]5.41	5.53	[a]4.08	5.85	[a]6.28	6.54	6.08	5.90	5.63
9	5.06	[a]4.63	[a]4.76	[a]5.42	5.54	[a]4.15	5.88	6.27	6.55	[a]6.08	5.89	5.62
10	5.07	[a]4.59	[a]4.77	5.43	5.44	[a]4.22	5.90	6.25	6.56	[a]6.06	5.89	5.62
11	5.04	[a]4.55	[a]4.78	5.46	[a]5.37	[a]4.29	5.90	6.21	6.56	[a]6.05	5.88	5.63
12	5.00	[a]4.52	[a]4.79	5.49	[a]5.34	[a]4.36	[a]5.95	6.23	6.56	[a]6.04	5.87	5.63
13	4.96	[a]4.48	[a]4.80	5.51	[a]5.32	[a]4.42	[a]5.98	6.14	6.55	[a]6.04	5.86	5.62
14	4.92	[a]4.44	[a]4.81	5.42	[a]5.29	[a]4.50	[a]5.98	6.26	6.53	[a]6.03	5.85	5.60
15	4.87	4.41	[a]4.82	5.29	[a]5.26	[a]4.57	[a]5.95	6.28	6.53	[a]6.03	5.84	5.58
16	4.84	4.50	[a]4.83	5.20	5.26	[a]4.64	[a]5.96	6.30	6.55	[a]6.03	5.83	5.57
17	4.79	4.58	[a]4.84	4.79	5.34	[a]4.71	[a]5.84	6.32	6.56	[a]6.02	5.83	5.58
18	4.76	4.63	[a]4.85	4.35	5.45	[a]4.78	5.73	6.34	6.56	[a]6.02	5.82	5.58
19	4.73	4.66	[a]4.86	[a]4.22	5.52	[a]4.85	5.76	6.35	6.51	[a]6.02	5.82	5.57
20	4.71	4.67	4.88	[a]4.30	5.56	4.94	5.83	6.38	6.47	[a]6.02	5.81	5.54
21	4.68	4.67	4.91	[a]4.37	5.56	5.03	5.91	6.39	6.44	[a]6.01	5.80	5.50
22	4.65	4.67	4.94	[a]4.45	5.30	5.12	5.95	6.30	6.45	[a]6.01	5.80	5.47
23	4.63	4.68	4.98	[a]4.53	5.22	5.22	5.99	6.20	6.47	[a]6.01	5.80	5.44
24	4.61	4.66	5.06	[a]4.60	5.32	5.23	6.03	6.17	6.48	[a]6.00	5.80	5.42
25	4.56	4.61	5.09	[a]4.68	5.41	5.28	[a]6.05	6.19	6.48	[a]6.00	5.79	5.38
26	4.54	4.51	5.13	[a]4.76	5.48	5.34	[a]5.86	6.23	6.48	[a]5.98	5.77	5.36
27	4.52	4.65	5.16	[a]4.83	5.50	5.40	5.79	6.30	6.43	[a]5.98	5.76	5.33
28	4.51	4.67	5.24	[a]4.91	5.08	5.30	5.82	6.35	6.33	[a]5.98	5.74	5.31
29	4.58		5.28	[a]4.99	4.96	5.38	5.89	6.38	6.27	[a]5.97	5.73	5.27
30	4.70		5.31	[a]5.06	5.03	5.42	5.98	6.40	6.23	[a]5.96	5.72	5.24
31	4.73		5.33		5.04		6.07	6.43		[a]5.96		5.21

[a] Interpolated.

Table 9.--Water-level record, well 17-16-26dc, Valley County--Continued

1946

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.17	5.09	4.76	....	5.88	5.03	5.39	6.41	6.41	5.75	....	4.69
2	5.13	5.12	4.77	5.01	5.79	5.11	5.46	6.43	6.42	5.77	....	4.72
3	5.10	5.13	4.77	5.07	5.52	5.17	5.53	6.44	6.42	5.79	....	4.76
4	5.08	5.13	4.81	5.13	5.46	5.24	5.60	6.46	6.37	5.80	....	4.69
5	5.05	5.10	4.84	5.17	5.50	5.32	5.66	6.47	6.34	5.71	....	4.65
6	5.03	5.06	4.81	5.21	5.54	5.39	5.72	6.47	6.34	4.30	....	4.66
7	5.02	5.03	4.73	5.25	5.58	5.48	5.77	6.45	6.34	3.82	....	4.67
8	5.02	5.01	4.69	5.29	5.62	5.56	5.82	6.46	6.30	3.35	....	4.70
9	5.03	5.01	4.64	5.30	5.65	5.63	5.86	6.47	6.23	3.53	....	4.76
10	5.03	4.99	4.66	5.29	5.62	5.70	5.92	6.49	6.16	3.46	....	4.78
11	5.05	4.99	4.66	5.19	5.26	5.78	5.98	6.51	6.13	3.81	....	4.77
12	5.09	....	4.71	5.08	5.14	5.85	6.03	6.52	6.11	3.88	....	4.80
13	5.12	4.99	4.77	5.14	5.19	5.99	6.08	6.52	6.11	4.14	....	4.84
14	5.14	....	4.80	5.22	5.29	5.95	6.13	6.47	6.09	4.30	....	4.85
15	5.14	....	4.82	5.26	5.37	6.00	6.15	6.44	6.05	4.37	....	4.82
16	5.14	....	4.73	5.31	5.43	6.05	6.15	6.42	6.02	4.40	....	4.84
17	5.18	....	4.10	5.35	5.48	6.08	6.05	6.46	6.01	4.39	....	4.93
18	5.17	4.92	4.22	5.39	5.54	5.43	6.03	6.50	6.01	3.90	4.07	4.99
19	5.11	4.92	4.34	5.44	5.60	4.58	6.08	6.53	6.00	3.95	4.11	5.00
20	5.06	4.90	....	5.48	5.66	4.02	6.13	6.57	5.85	4.16	4.17	5.00
21	5.09	4.87	....	5.53	5.72	5.04	6.16	6.58	5.74	4.30	4.34	4.98
22	5.10	4.85	....	5.58	5.76	4.24	6.19	6.59	5.70	4.42	4.45	4.92
23	5.14	4.82	....	5.64	5.78	4.53	6.24	6.59	5.70	4.42	4.42	4.91
24	5.13	4.80	....	5.67	5.68	4.72	6.26	6.59	5.71	4.50	4.49	4.87
25	5.07	4.78	....	5.71	5.09	4.87	6.29	6.57	5.74	4.56	4.59	4.84
26	5.05	4.75	....	5.74	4.91	4.97	6.31	6.54	5.77	4.62	4.50	6.83
27	5.08	4.78	4.64	5.78	4.98	5.06	6.33	6.49	5.80	4.64	4.60	6.82
28	5.11	4.76	4.71	5.81	5.09	5.15	6.35	6.46	5.83	4.66	4.60	4.92
29	5.11		4.92	5.85	5.17	5.22	6.37	6.43	5.82	....	4.60	5.04
30	5.06		....	5.86	5.17	5.31	6.39	6.42	5.78	....	4.65	5.13
31	5.06		....		4.99		6.40	6.40		....		....

1947

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	....	4.55	4.49	4.89	4.71	4.29	5.81	6.28	5.92	5.64	4.99
2	....	....	4.56	4.52	4.95	4.68	4.46	5.86	6.32	5.90	5.63	4.97
3	5.29	....	4.56	4.52	5.00	4.77	4.59	5.91	6.35	5.89	5.61	5.01
4	5.33	4.55	4.54	4.27	5.07	4.77	4.71	5.96	6.37	5.88	5.60	5.03
5	5.33	4.55	4.52	4.28	5.14	3.79	4.81	6.00	6.40	5.87	5.57	5.04
6	5 31	4.52	4.50	4.08	5.08	3.88	4.91	6.06	6.43	5.87	5.54	5.04
7	5.22	4.52	4.48	4.19	5.21	4.14	4.98	6.09	6.44	5.86	5.60	5.00
8	5.12	4.62	4.43	4.10	5.25	4.44	5.07	6.12	6.46	5.86	5.48	4.97
9	5.02	4.68	4.40	3.84	5.28	4.60	5.15	6.15	6.47	5.86	5.46	4.98
10	4.92	4.69	4.39	4.35	5.31	4.60	5.20	6.19	6.47	5.85	5.43	4.99
11	....	4.69	4.30	....	5.35	....	5.18	6.22	6.44	5.85	5.41	5.02
12	....	4.68	4.31	....	5.37	[b]2.91	5.21	6.24	6.32	5.86	5.37	5.05
13	....	4.45	4.30	....	5.39	3.26	5.28	6.26	6.10	5.87	5.35	5.05
14	4.63	4.35	4.26	4.08	5.42	3.56	5.32	6.28	5.98	5.87	5.32	5.05
15	4.67	3.91	4.29	4.20	5.43	3.77	5.37	6.29	5.94	5.86	5.30	5.01
16	4.73	3.63	4.29	4.28	5.35	3.87	5.42	6.30	5.93	5.86	5.28	4.96
17	4.74	3.77	4.32	4.36	5.34	4.05	5.42	6.32	5.93	5.84	5.25	5.00
18	4.74	3.99	4.33	4.45	5.38	4.09	5.28	6.34	5.94	5.82	5.22	5.00
19	5.71	4.12	4.34	4.52	5.37	3.24	5.36	6.36	5.96	5.82	5.19	4.96
20	4.63	4.20	4.33	4.60	4.85	3.44	5.37	6.37	5.97	5.81	5.14	4.91
21	4.65	4.25	4.30	....	4.89	3.61	5.36	6.38	5.97	5.80	5.07	4.87
22	4.65	4.28	4.25	....	5.00	3.61	5.39	6.40	5.97	5.79	5.01	4.83
23	4.64	4.33	4.22	....	5.10	....	5.42	6.42	5.97	5.79	5.03	4.81
24	4.59	4.41	4.31	....	5.18	....	5.46	6.43	5.97	5.78	5.07	4.79
25	4.55	4.48	4.38	....	5.25	....	5.48	6.43	5.97	5.77	5.08	4.78
26	4.51	4.55	4.43	....	5.35	....	5.50	6.33	5.95	5.75	5.06	4.74
27	4.48	4.56	4.44	....	5.37	....	5.54	6.27	5.94	5.74	4.99	4.70
28	4.47	4.55	4.24	....	5.32	....	5.58	6.25	5.93	5.72	4.97	4.65
29	4.45		4.36	....	4.89	....	5.66	6.24	5.94	5.68	4.98	4.62
30	....		4.40	4.83	4.51	....	5.72	6.24	5.94	5.68	4.99	4.70
31	....		4.40		4.63		5.77	6.25		5.66		4.82

[b] Highest observed stage in period of record.

Table 9.--Water-level record, well 17-16-26dc, Valley County--Continued

1948

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.87	5.41	3.92	4.29	5.36	5.75	5.13	5.60	6.05	6.14	5.70	4.75
2	....	5.35	3.90	4.33	5.38	5.79	5.25	5.61	6.08	6.13	5.68	4.74
3	....	5.27	3.92	4.37	5.41	5.88	5.36	5.48	6.11	6.12	5.67	4.72
4	....	5.23	3.94	4.43	5.44	5.97	5.44	5.32	6.13	6.10	5.65	4.64
5	4.80	5.21	3.91	4.48	5.47	6.01	5.52	5.25	6.16	6.10	5.63	4.56
6	4.71	5.20	3.85	4.49	5.30	6.04	[a]5.59	5.27	6.17	6.10	5.58	4.58
7	4.67	5.17	3.91	4.54	5.03	6.07	5.65	5.28	6.15	6.09	5.55	4.61
8	4.55	5.15	3.93	4.62	5.09	6.09	5.71	5.31	6.12	6.07	5.52	4.63
9	4.48	5.19	3.97	4.65	5.18	6.12	5.77	5.36	6.07	6.05	5.50	4.64
10	4.47	5.20	3.98	4.65	5.22	6.15	5.81	5.45	6.05	6.04	5.48	4.64
11	4.47	5.17	....	4.70	5.25	6.17	5.85	5.53	6.05	6.02	5.47	4.64
12	4.54	....	....	4.74	5.30	6.17	5.84	5.54	6.08	6.00	5.46	4.62
13	4.68	5.05	....	4.75	5.36	6.01	5.84	5.33	6.10	5.99	5.45	4.56
14	4.82	4.98	....	4.78	5.42	5.94	5.82	5.10	6.14	5.98	5.43	4.49
15	4.89	4.94	....	4.82	5.49	5.92	5.82	5.06	6.16	5.97	5.42	4.55
16	4.97	4.86	....	4.88	5.55	5.93	5.85	5.11	6.18	5.95	5.40	4.67
17	5.09	4.78	3.06	4.91	5.61	5.94	5.87	5.21	6.20	5.95	5.39	4.75
18	5.15	4.68	2.97	4.94	5.66	5.80	5.87	5.32	6.22	5.94	5.38	4.77
19	5.20	4.55	3.10	4.99	5.72	5.65	5.72	5.41	6.23	5.92	5.36	4.79
20	5.23	4.49	3.17	5.05	5.78	5.61	5.75	5.50	6.24	5.90	5.34	4.79
21	5.23	4.44	3.26	5.08	5.83	5.46	5.78	....	6.24	5.89	5.33	4.74
22	5.19	4.37	3.31	5.10	5.88	[a]5.28	5.83	....	6.24	5.88	5.30	4.64
23	5.20	4.31	3.42	5.13	5.89	[a]5.12	5.89	....	6.23	5.86	5.26	4.57
24	5.29	4.34	3.60	5.15	5.82	5.02	5.96	5.74	6.22	5.85	....	4.48
25	5.32	4.28	3.72	5.13	5.79	5.11	6.00	5.80	6.19	5.83	....	4.47
26	5.33	4.26	3.94	5.14	5.84	5.18	6.04	5.85	6.17	5.81	5.04	4.46
27	5.35	4.19	4.05	5.19	5.90	5.08	6.06	....	6.16	5.80	4.96	4.44
28	....	4.07	4.02	5.24	5.95	4.76	6.09	....	6.15	5.78	4.88	4.48
29	5.43	4.00	4.07	5.28	5.98	4.88	6.09	....	6.15	5.77	4.83	4.50
30	5.43		4.12	5.32	5.98	5.00	5.71	....	6.14	5.75	4.80	4.54
31	5.43		4.22		5.82		5.62	6.02		5.72		4.57

1949

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.57	....	3.04	2.70	4.76	5.17	4.93	....	5.85	5.80	5.25	5.11
2	4.57	....	3.03	2.86	4.82	5.14	5.00	5.84	5.88	5.81	5.26	5.12
3	4.57	....	2.99	2.95	4.86	5.11	5.18	5.87	5.89	5.83	5.27	5.11
4	4.57	....	3.02	2.95	4.91	5.16	5.28	5.90	5.83	5.84	5.27	5.12
5	....	....	3.32	3.03	4.95	5.18	5.36	5.93	5.76	5.82	5.27	[a]5.13
6	....	....	3.41	3.22	4.75	5.19	5.42	5.97	....	5.80	5.27	5.13
7	....	....	3.41	3.43	4.37	5.15	5.48	6.00	5.41	5.78	5.26	5.13
8	4.42	....	3.48	3.65	4.38	4.06	5.48	6.03	5.36	5.70	5.24	5.14
9	4.50	....	3.62	3.65	3.93	3.78	4.88	6.06	5.34	5.67	5.23	5.17
10	4.58	....	3.69	3.18	4.19	3.58	4.85	6.08	5.29	5.42	5.21	5.13
11	4.59	....	3.72	3.50	4.37	3.88	4.91	6.10	5.24	5.31	5.20	5.13
12	4.56	....	3.77	3.73	4.51	4.04	5.13	6.12	5.22	5.16	5.29	[a]5.01
13	4.48	....	3.80	3.91	4.63	4.20	5.22	6.14	5.16	5.13	5.28	[a]5.05
14	4.43	....	3.71	3.91	4.72	4.36	5.30	6.15	5.19	5.13	5.24	5.08
15	4.38	....	3.76	3.11	4.78	4.51	5.38	6.16	5.23	5.13	5.24	5.09
16	4.36	....	....	3.37	4.80	4.66	5.45	5.94	5.28	5.12	5.24	5.14
17	4.38	....	....	3.73	4.78	4.80	5.53	5.93	5.35	5.14	5.24	5.11
18	4.40	....	....	3.97	4.85	4.89	5.56	5.91	5.43	5.17	5.25	5.08
19	4.43	4.76	....	4.10	4.93	4.97	5.60	5.86	5.50	5.17	5.26	5.06
20	4.43	4.78	....	4.14	4.97	5.03	5.54	5.69	5.54	5.18	5.25	5.03
21	4.41	4.77	....	4.19	4.87	5.10	5.48	5.64	5.60	5.19	5.27	5.10
22	4.38	....	3.57	4.27	4.26	5.19	5.56	5.64	5.63	5.19	5.18	5.17
23	4.36	....	3.60	4.35	4.34	5.26	5.66	5.67	5.66	5.21	5.17	5.23
24	....	....	3.70	4.48	4.47	5.32	5.69	5.75	5.67	5.21	5.14	5.28
25	....	....	3.85	4.50	4.60	5.37	5.73	5.82	5.69	5.22	5.12	5.32
26	....	....	3.87	4.57	4.74	5.43	....	5.86	5.72	5.23	5.11	5.36
27	....	....	2.97	4.63	4.85	5.44	....	5.81	6.70	5.23	5.10	5.39
28	....	3.04	3.14	4.68	4.95	4.82	....	5.81	5.72	5.24	5.10	5.40
29	....		3.20	4.73	5.02	4.78	....	5.80	5.73	5.24	5.10	5.36
30	....		3.12	4.75	5.09	4.82	....	5.82	5.75	5.26	5.11	5.32
31	....		....		5.15		....	5.83		5.26		5.27

[a] Interpolated.

Table 9. --Water-level record, well 17-16-26dc, Valley County--Continued

1950

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.22	....	3.63	4.07	4.21	4.40	5.65	4.75	5.12	5.13	5.15	4.64
2	5.17	4.47	3.63	4.11	4.32	4.52	5.62	4.85	5.17	4.73	5.16	4.61
3	5.10	4.45	3.65	4.11	4.41	4.65	5.43	4.92	5.23	4.15	5.16	4.64
4	5.17	4.43	3.65	3.88	4.45	4.75	5.43	4.83	5.28	4.02	5.14	4.65
5	....	4.37	3.63	4.03	4.45	4.83	5.19	4.62	5.33	4.19	5.11	4.67
6	....	4.31	3.52	4.11	3.90	4.93	5.18	4.64	5.36	4.30	5.14	4.85
7	....	4.24	3.55	4.18	4.13	5.00	5.26	4.71	5.39	4.45	5.14	4.92
8	....	....	3.67	4.23	4.16	5.09	5.27	4.81	5.43	4.55	5.15	4.97
9	....	....	4.70	4.23	3.47	5.17	4.73	4.83	5.46	4.61	5.18	4.97
10	....	....	4.76	4.21	3.75	5.24	4.33	4.58	5.49	4.68	5.20	4.93
11	5.07	....	4.86	4.17	3.97	5.31	4.22	4.62	5.50	4.73	5.20	4.85
12	....	....	4.86	4.25	3.93	[a]5.39	4.37	4.62	5.50	4.78	5.20	4.76
13	....	4.01	4.85	4.32	3.82	5.47	4.54	4.46	5.47	4.82	5.15	4.64
14	....	4.02	4.77	4.34	4.11	5.47	4.70	4.57	5.41	4.85	5.10	4.55
15	....	4.02	3.69	4.38	4.29	5.22	4.79	4.74	5.40	4.87	5.06	4.54
16	....	4.00	3.42	4.39	4.36	5.23	4.84	4.87	5.36	4.91	5.04	4.53
17	....	3.98	3.13	4.38	4.51	5.17	4.85	4.93	4.99	4.93	5.04	4.54
18	4.98	3.97	3.10	4.46	4.53	4.93	....	4.98	4.95	4.95	5.02	4.55
19	....	3.89	3.14	4.57	3.30	4.77	....	4.77	4.95	4.98	5.00	4.55
20	....	3.81	3.17	4.60	3.31	4.84	3.69	4.33	4.92	5.01	5.01	4.50
21	....	3.80	3.23	4.62	3.38	4.91	3.69	4.46	4.96	5.03	4.99	4.51
22	....	3.77	3.15	4.65	3.69	5.04	3.72	4.60	....	5.03	4.82	4.50
23	....	3.80	3.05	4.69	3.98	5.14	3.32	4.75	....	5.03	4.72	4.46
24	....	3.80	3.19	4.73	4.14	5.24	3.48	4.87	....	5.05	4.82	4.43
25	....	3.81	3.31	4.77	4.28	5.33	3.45	4.97	....	5.05	4.86	4.38
26	4.58	3.81	3.38	4.78	4.31	5.41	3.77	4.98	....	5.06	4.86	4.33
27	....	3.71	3.65	4.81	3.90	5.55	4.02	4.84	5.16	5.06	4.82	4.46
28	....	3.61	3.87	4.81	3.66	5.55	4.23	4.86	5.20	5.08	4.74	4.56
29	....		3.96	4.42	[a]3.62	5.58	4.37	4.93	5.26	5.10	4.70	4.57
30	....		3.97	4.09	[a]3.91	5.62	4.50	5.00	5.24	5.11	4.66	4.54
31	....		4.01		[a]4.20		4.62	5.07		5.12		4.39

[a] Interpolated.

Table 10.--Description of wells and test holes in the Middle Loup division, Nebraska

Well no.--See text and figure 2.
Owner.--U. N., Conservation and Survey Division, University of Nebraska; U. S. B. R., United States Bureau of Reclamation; U. S. G. S., United States Geological Survey.
Type of well.--Dn, driven; Dr, drilled; Du, dug; J, jetted.
Type of casing.--B, brick; C, concrete; GI, galvanized iron; I, iron pipe; S, steel; T, tile.
Type of pump.--C, centrifugal; Cy, cylinder; N, none; P, pitcher pump; T, tractor.
Type of power.--E, electricity; G, gas; H, hand; N, none; T, tractor; W, wind.
Use of water.--D, domestic; I, irrigation; O, observation; S, stock.

Well no.	Owner	Date completed	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth to which well is cased (feet)	Type of casing	Type of pump	Capacity of pump (gpm)	Type of power	Use of water	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Description	Measuring point: Altitude above sea level (feet)	Measuring point: Depth to water (feet)	Date of measurement (1950)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
								Blaine County								
21-21-29cd1	U. S. G. S.	Dec. 12, 1949	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	3.3	Top of pipe.......	2,485.82	7.27	Oct. 10, 1950
29cd2	....do..........	Dec. 13, 1949	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.9	....do..........	2,485.00	6.17	Do.
29dc	U. S. B. R.	Mar. 1950	Dn	14	$1\frac{1}{4}$	14	GI	N	.....	N	O	2.0	....do..........	2,487.85	7.64	Do.
29cc	U. S. G. S.	Dec. 12, 1949	J	21	$\frac{3}{4}$	21	GI	N	.....	N	O	2.0	....do..........	2,492.78	4.21	Do.
32aa	....do..........	Dec. 15, 1949	J	25	$\frac{3}{4}$	25	GI	N	.....	N	O	.6	....do..........	2,490.10	10.85	Do.
32bb	U. S. B. R.	Mar. 1950	Dn	6.6	$1\frac{1}{4}$	6.6	GI	N	.....	N	O	1.2	....do..........	2,484.26	4.44	Oct. 17, 1950
32ca	....do..........	....do.......	Dn	9	$1\frac{1}{4}$	9	GI	N	.....	N	O	1.6	....do..........	2,482.39	6.26	Do.
32dc	....do..........	....do.......	Dn	16	$1\frac{1}{4}$	16	GI	N	.....	N	O	2.8	....do..........	2,487.05	11.65	Do.
33ba	....do..........	....do.......	Dn	47	$1\frac{1}{4}$	47	GI	N	.....	N	O	2.0	....do..........	2,520.28	44.24	Sept. 1, 1950
33bc	....do..........	....do.......	Dn	15	$1\frac{1}{4}$	15	GI	N	.....	N	O	2.0	....do..........	....	8.95	Do.
33cd	U. S. G. S.	Dec. 15, 1949	J	28	$\frac{3}{4}$	28	GI	N	.....	N	O	2.5	....do..........	2,482.97	9.44	Oct. 10, 1950
33cc	....do..........	Dec. 14, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.5	....do..........	2,478.33	5.55	Do.
33dc	U. S. B. R.	Mar. 1950	Dn	16	$1\frac{1}{4}$	16	GI	N	.....	N	O	2.0	....do..........	2,484.32	12.35	Do.

Custer County

15-17- 1ad	Glen Smith	1940	Dr	122	24-18	122	GI	T	.....	T	I	0.0	Hole in tin cover	2,222.06	21.30	Sept. 27, 1950
17-17- 1aa	U.S.G.S.	Aug. 25, 1949	Dn	12	$\frac{3}{4}$	12	GI	N	.....	N	O	2.0	Top of pipe	2,200.79	6.37	Sept. 28, 1950
18-17- 3bb	....do	Aug. 31, 1949	J	14	$\frac{3}{4}$	14	GI	N	.....	N	O	2.0	....do	2,261.35	8.04	Do.
4ac	Ben Turdik	1938	Dr	108	32	108	C	T	800	T	I	1.0	Hole in base	2,275.18	13.49	Do.
9bb	U.S.G.S.	Sept. 1, 1949	J	28	$\frac{3}{4}$	28	GI	N	.....	N	O	1.0	Top of pipe	2,284.68	11.81	Do.
9ca	Walter Nelson	1948	Dr	100	18	100	GI	T	650	G	I	...	Hole in base	2,283.99	.....	
11cb	U.S.G.S.	Aug. 1, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.0	Top of pipe	2,237.27	5.08	Sept. 27, 1950
18-17-11db1	.....	.....	Dr	30	$2\frac{1}{2}$	30	I	N	.....	N	O	1.5	Top of pipe	2,239.56	5.17	Sept. 28, 1950
11db2	.....	.....	Dr	16	$2\frac{1}{2}$	16	I	N	.....	N	O	2.3	....do	2,241.03	6.33	Do.
14aa	U.S.G.S.	Nov. 28, 1949	J	14	$\frac{3}{4}$	14	GI	N	.....	N	O	1.9	....do	2,235.83	4.60	Do.
14bb	....do	Nov. 18, 1949	J	14	$\frac{3}{4}$	14	GI	N	.....	N	O	1.7	....do	2,234.81	7.16	Do.
15db	....do	Nov. 18, 1950	J	7	$\frac{3}{4}$	7	GI	N	.....	N	O	2.0	....do	2,235.59	3.08	Sept. 27, 1950
16da	....do	Nov. 18, 1949	J	28	$\frac{3}{4}$	28	GI	N	.....	N	O	1.0	....do	2,266.46	15.48	Do.
23ba	....do	Aug. 1, 1950	J	15	$\frac{3}{4}$	15	GI	N	.....	N	O	1.6	....do	2,227.06	4.03	Sept. 28, 1950
23dd	....do	Sept. 1, 1950	J	15	$\frac{3}{4}$	15	GI	N	.....	N	O	1.3	....do	2,221.17	3.07	Do.
26cc	....do	Sept. 19, 1950	J	21	$\frac{3}{4}$	21	GI	N	.....	N	O	2.0	....do	2,219.43	10.62	Sept. 27, 1950
26dd	....do	Nov. 28, 1949	J	25	$\frac{3}{4}$	25	GI	N	.....	N	O	3.0	....do	2,227.98	17.99	Sept. 28, 1950
36dd	....do	Aug. 25, 1949	Dn	10	$\frac{3}{4}$	10	GI	N	.....	N	O	2.0	....do	2,198.01	3.94	Do.
19-17- 6dd	....do	Sept. 9, 1949	J	28	$\frac{3}{4}$	28	GI	N	.....	N	O	1.0	....do	2,308.88	20.28	Do.
8ad	Ernest Grant	1946	Dr	76	18	76	GI	N	300	N	I	1.0	Hole in base	2,325.52	53.38	Do.
9ca	R. E. Probent	1948	Dr	170	18	170	GI	T	400	G	I	1.0	Hole in casing	2,336.40	69.73	Do.
17bb	U.S.G.S.	Sept. 2, 1949	Dn	17	$\frac{3}{4}$	17	GI	N	.....	N	O	2.0	Top of pipe	2,292.63	9.37	Do.
19ad	....do	....do	Dn	11	$\frac{3}{4}$	11	GI	N	.....	N	O	2.0	....do	2,285.16	6.23	Do.
20cd	....do	Aug. 1, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.3	....do	2,279.35	4.69	Do.
21bb	U.S.G.S.	May 16, 1950	J	15	$\frac{3}{4}$	15	GI	N	.....	N	O	2.4	....do	2,280.28	8.86	Do.
24bc	U.S.B.R.	Apr. 1950	Dr	135	$1\frac{1}{4}$	135	GI	N	.....	N	O	2.0	....do	2,308.04	62.84	Do.
27bb	U.S.G.S.	May 16, 1950	J	14	$\frac{3}{4}$	14	GI	N	.....	N	O	3.4	....do	2,270.12	9.96	Do.
27dd	....do	....do	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	2.0	....do	2,258.67	5.63	Do.
29cd	....do	Sept. 1, 1949	Dn, J	35	$\frac{3}{4}$	35	GI	N	.....	N	O	2.0	....do	2,296.07	12.98	Do.
33ad	....do	Nov. 28, 1950	J	17	$\frac{3}{4}$	17	GI	N	.....	N	O	1.9	....do	2,263.35	10.61	Do.
34dd	....do	Aug. 31, 1949	Dn	13	$\frac{3}{4}$	13	GI	N	.....	N	O	2.0	....do	2,250.73	6.00	Do.
18- 2ad	.....	.....	Dr	55	6	55	GI	Cy	.....	W	S	2.0	Top of casing	2,327.06	29.66	Sept. 29, 1950
3ad	George Semeler	.....	Dr	.....	.....	.....	..	T	300	E	I	.0	Hole in base	2,330.21	26.87	Sept. 28, 1950
5cb	U.S.G.S.	May 16, 1950	J	15	$\frac{3}{4}$	15	GI	N	.....	N	O	.4	Top of pipe	2,332.32	7.58	Sept. 29, 1950
8da	....do	....do	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.8	....do	2,321.67	5.50	Oct. 9, 1950
9aa	Leonard Owen	1914	Dn	28	$1\frac{1}{4}$	28	GI	N	.....	N	O	1.0	....do	2,326.16	12.76	Sept. 27, 1950
9bb	U.S.G.S.	Aug. 1, 1950	J	20	$\frac{3}{4}$	20	GI	N	.....	N	O	2.0	....do	2,330.04	13.53	Sept. 29, 1950

Table 10.--Description of wells and test holes in the Middle Loup division, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Custer County--Continued																
19-18-10db	U. S. G. S.	Sept. 2, 1949	Dn	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.0	Top of pipe.......	2,312.52	7.75	Sept. 28, 1950
11ab	Roy Chaffin	....1947.....	Dr	97	18	97	GI	T	600	T	I	1.0	Hole in base......	2,311.17	9.79	Do.
14ad	U. S. G. S.	Aug. 2, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.7	Top of pipe.......	2,302.76	9.39	Sept. 27, 1950
14da	....do..........	May 15, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	3.2	....do..........	2,297.81	6.97	Sept. 28, 1950
15ab	....do..........	Sept. 2, 1949	Dn	7.0	$\frac{3}{4}$	7.0	GI	N	.....	N	O	1.0	....do..........	2,306.84	4.21	Do.
24bd	....	....1950.....	Dr	.....	18	.....	GI	T	.....	G	I	1.2	....do..........	2,317.59	23.08	Do.
19- 1ad	U. S. G. S.	Sept. 7, 1949	Dn	20	$\frac{3}{4}$	20	GI	N	.....	N	O	1.0	....do..........	2,342.63	9.60	Do.
2bb	Ralph Slagel......	....	.....	.....	.....	.....	..	T	.....	G	I	.0	Hole in base......	2,361.95	16.71	Sept. 29, 1950
4cc	U. S. G. S.	Sept. 5, 1949	Dn	14	$\frac{3}{4}$	14	GI	N	.....	N	O	1.0	Top of pipe.......	2,369.71	10.72	Do.
4da	....do..........	Aug. 2, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	2.5	....do..........	2,361.18	7.63	Do.
5cc	....do..........	Aug. 9, 1950	J	15	$\frac{3}{4}$	15	GI	N	.....	N	O	2.0	....do..........	2,385.79	14.44	Oct. 9, 1950
9bc	....do..........	Sept. 5, 1949	J	14	$\frac{3}{4}$	14	GI	N	.....	N	O	2.0	....do..........	2,374.94	10.22	Do.
10ad	....do..........	May 15, 1950	J	20	$\frac{3}{4}$	20	GI	N	.....	N	O	3.0	....do..........	2,362.91	14.89	Do.
12ac	....do..........	May 16, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	2.2	....do..........	2,345.47	6.16	Do.
20- 1cc	U. S. B. R.	Aug. 1950	Dr	23	$1\frac{1}{4}$	23	GI	N	.....	N	O	2.9	....do..........	2,410.00	18.70	Do.
1cd	....	....	Dr	.....	18	.....	GI	T	.....	T	I	1.0	Hole in base......	2,399.03	12.94	Do.
1dd	U. S. B. R.	July 1950	Dr	24	$1\frac{1}{4}$	24	GI	N	.....	N	O	1.0	Top of pipe.......	2,401.30	19.40	Do.
2aa	U. S. G. S.	Aug. 2, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.3	....do..........	2,389.50	5.39	Do.
3bc	....	....	Dr	51	18	51	GI	T	.....	G	I	.8	Top of casing.....	2,414.08	11.03	Do.
3dd	U. S. B. R.	Aug. 1950	Dr	24	$1\frac{1}{4}$	24	GI	N	.....	N	O	2.9	....	2,414.96	12.58	Do.
5aa	U. S. G. S.	Aug. 4, 1950	J	18	$\frac{3}{4}$	18	GI	N	.....	N	O	1.9	Top of casing.....	2,425.54	16.31	Do.
5bb	....do..........	Sept. 10, 1949	Dn	21	$\frac{3}{4}$	21	GI	N	.....	N	O	1.0	....do..........	2,437.38	20.45	Do.
5cb	John Jacobson....	....1942.....	Dr	112	18	122	GI	T	1,890	G	I	1.0	Hole in base......	2,447.85	16.80	Do.
9aa	Oscar Swick......	....1948.....	Dr	80	18	80	GI	T	1,800	G	I	.0	....do..........	2,427.76	16.42	Do.
12db	....	....	Dr	.....	18	.....	GI	T	.....	T	I	1.0	....do..........	....	......	
13bb	U. S. B. R.	....1950.....	Dn	31	$1\frac{1}{4}$	31	GI	N	.....	N	O	1.0	Top of pipe.......	2,424.55	18.82	Oct. 16, 1950
20-17-31ac	John Greene......	....1949.....	Dr	110	18	110	GI	T	.....	G	I	.4	Hole in base......	2,347.14	78.09	Sept. 28, 1950
31ca	William Weverka .	....1949.....	Dr	107	18	107	GI	T	850	G	I	1.0	....do..........	2,354.30	81.89	Do.
18-27db	John Cosner......	....1946.....	Dr	140	18	140	GI	T	1,000	G	I	1.0	....do..........	2,374.47	79.82	Do.
28da	Mable Rusho	....1946.....	Dr	136	16	136	GI	T	1,500	G	I	.0	....do..........	2,378.03	77.14	Sept. 29, 1950
29cb	Frank Slangle	....1947.....	Dr	155	18	155	GI	T	1,500	T	I	.0	....do..........	2,391.82	76.67	Do.
34cb	Howard Liebart...	....1946.....	Dr	73	18	73	GI	T	800	E	I	.0	....do..........	2,340.64	38.89	Do.
35ba	Ed Ruzicka.......	....	.....	.....	.....	.....	..	T	.....	G	I	1.0	....do..........	2,363.51	75.70	Sept. 28, 1950
35db	Lee Penny	....1947.....	Dr	186	18	186	GI	T	900	G	I	3.0	....do..........	2,341.20	55.04	Do.
36db	Martin Weverka ..	....1947.....	Dr	105	18	105	GI	T	1,000	G	I	1.0	....do..........	2,342.61	64.22	Do.
20-19-25da	George Clayton...	....1947.....	Dr	107	18	107	GI	T	1,000	G	I	.2	....do..........	2,381.78	54.78	Sept. 29, 1950
25dd	U. S. G. S.	Sept. 7, 1949	Dn	41	$\frac{3}{4}$	41	GI	N	.....	N	O	1.0	Top of pipe.......	2,366.59	36.19	Do.

Custer County--Continued

20-19-26cd	Dale Price	....1949....	Dr	100	18	100	GI	T	800	T	I	0.6	Hole in base	2,404.89	65.80	Sept. 29, 1950
31cb	Evert E. Stone	....1949....	Dr	110	18	110	GI	T	900	T	I	1.0	....do....	2,408.71	32.99	Do.
33cc	U.S.G.S.	Sept. 5, 1949	Dn	28	$\frac{3}{4}$	28	GI	N	.....	N	O	1.0	Top of pipe	2,384.73	24.33	Do.
34ab	Ray Johnson	....1948....	Dr	122	18	122	GI	T	950	T	I	.0	Hole in base	2,398.87	52.62	Do.
34cb	Earl Coslor	....1949....	Dr	160	18	160	GI	T	600	G	I	.2	....do....	2,377.19	25.59	Do.
20-20-28dd	U.S.G.S.	May 17, 1950	J	21	$\frac{3}{4}$	21	GI	N	.....	N	O	1.3	Top of pipe	2,410.77	14.30	Oct. 9, 1950
29bb	Marvin Price	....1943....	Dr	96	18	96	GI	T	1,600	T	I	.0	Hole in base	2,444.96	33.82	Oct. 10, 1950
30aa	Ted Holmes	....1948....	Dr	77	18	77	GI	T	1,000	G	I	.0	....do....	2,445.90	32.27	Do.
30da	A. M. Russell	....1946....	Dr	85	18	85	GI	T	1,000	T	I	.0	....do....	2,430.32	18.98	Oct. 9, 1950
32bb	U.S.G.S.	May 17, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.6	Top of pipe	2,415.59	5.32	Do.
33bb	....do....	Aug. 4, 1950	J	15	$\frac{3}{4}$	15	GI	N	.....	N	O	2.0	....do....	2,413.89	9.65	Do.
33da	....do....	May 17, 1950	J	15	$\frac{3}{4}$	15	GI	N	.....	N	O	3.0	....do....	2,414.83	13.75	Do.
35aa	U.S.B.R.	July 1950	Dr	51	$1\frac{1}{4}$	51	I	N	.....	N	O	2.8	....do....	2,425.36	41.70	Sept. 29, 1950
36cc	U.S.G.S.	Sept. 7, 1950	Dn	17	$\frac{3}{4}$	17	GI	N	.....	N	O	1.0	....do....	2,385.79	4.09	Do.
21- 4bd	U.S.B.R.	Mar. 1950	Dr	20	$1\frac{1}{4}$	20	GI	N	.....	N	O	1.8	....do....	2,484.40	16.84	Sept. 1, 1950
4dd	....do....	....do....	Dr	23	$1\frac{1}{4}$	23	GI	N	.....	N	O	3.5	....do....	2,485.03	20.54	Oct. 17, 1950
5ca	....do....	....do....	Dr	9.6	$1\frac{1}{4}$	9.6	GI	N	.....	N	O	2.9	....do....	2,421.16	2.77	Do.
5dc	....do....	....do....	Dr	9.8	$1\frac{1}{4}$	9.8	GI	N	.....	N	O	1.5	....do....	2,484.12	6.76	Do.
6aa	U.S.G.S.	Dec. 12, 1949	J	14	$\frac{3}{4}$	14	GI	N	.....	N	O	2.0	....do....	2,487.57	7.35	Do.
6ab	....do....	....do....	J	21	$\frac{3}{4}$	21	GI	N	.....	N	O	1.5	....do....	2,506.27	15.01	Do.
8ad	....do....	Mar. 1950	Dr	12	$1\frac{1}{4}$	12	GI	N	.....	N	O	1.9	....do....	2,481.19	8.87	Do.
9cc	U.S.B.R.	....do....	Dn	12	$1\frac{1}{4}$	12	GI	N	.....	N	O	1.6	....do....	2,481.16	7.18	Do.
9dd	U.S.G.S.	Sept. 8, 1949	Dn	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.0	....do....	2,458.46	3.86	Oct. 11, 1950
10bc	A. C. Turner	....1937....	Dr	30	6	30	GI	Cy	.....	W	D	1.0	Top of casing	2,477.68	21.89	Oct. 9, 1950
16bd	U.S.B.R.	Mar. 1950	Dr	14	$1\frac{1}{4}$	14	GI	N	.....	N	O	2.0	Top of pipe	2,481.95	8.95	Oct. 17, 1950
17ad	....do....	....do....	Dn	16	$1\frac{1}{4}$	16	GI	N	.....	N	O	1.7	....do....	2,494.80	8.44	Do.
21ab	....do....	....do....	Dn	7.5	$1\frac{1}{4}$	7.5	GI	N	.....	N	O	.7	....do....	2,479.85	2.88	Oct. 11, 1950
21ad	....do....	....do....	Dn	13	$1\frac{1}{4}$	13	GI	N	.....	N	O	1.3	....do....	2,484.70	8.12	Do.
22bc	U.S.G.S.	Sept. 8, 1949	Dn	17	$\frac{3}{4}$	17	GI	N	.....	N	O	2.0	....do....	2,466.62	4.28	Oct. 9, 1950
22cc	U.S.B.R.	Mar. 1950	Dn	20	$1\frac{1}{4}$	20	GI	N	.....	N	O	4.0	....do....	2,418.18	9.70	Oct. 17, 1950
23da	U.S.G.S.	May 17, 1950	J	25	$\frac{3}{4}$	25	GI	N	.....	N	O	3.3	....do....	2,451.16	14.03	Oct. 9, 1950
24ab	....do....	May 16, 1950	J	25	$\frac{3}{4}$	25	GI	N	.....	N	O	3.1	....do....	2,469.69	14.64	Do.
26cb	U.S.B.R.	....1950....	Dr	33	$1\frac{1}{4}$	33	GI	N	.....	N	O	.5	....do....	2,474.40	29.19	Oct. 16, 1950
26cd	....do....	....1950....	Dr	55	$1\frac{1}{4}$	55	GI	N	.....	N	O	3.0	....do....	2,486.20	47.73	Do.
27ab	....do....	....1950....	Dr	33	$1\frac{1}{4}$	33	GI	N	.....	N	O	3.7	....do....	2,480.67	26.70	Do.
35ab	....do....	....1950....	Dr	42	$1\frac{1}{4}$	42	GI	N	.....	N	O	1.8	....do....	2,477.10	39.64	Do.
36ad	U.S.G.S.	Aug. 4, 1950	J	21	$\frac{3}{4}$	21	GI	N	.....	N	O	2.0	....do....	2,441.80	18.91	Oct. 9, 1950

Table 10.--Description of wells and test holes in the Middle Loup division, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Howard County																
13-10- 3dc	....	....	Du, Dn	61	$1\frac{1}{4}$	61	GI	N	.....	N	O	4.0	Top of pipe.......	1,877.87	16.45	Oct. 4, 1950
4ad	....	....	Dn	61	$1\frac{1}{4}$	.....	GI	P	.....	N	O	2.5	....do..........	1,837.38	11.86	Do.
7cd	Emil Schear......	....	.....	15	$1\frac{1}{4}$	15	GI	N	.....	N	O	.5	....do..........	1,839.36	3.44	Sept. 29, 1950
11- 6aa	U.S.G.S.	Dec. 27, 1949	J	31.5	$\frac{3}{4}$	31.5	GI	N	.....	N	O	5.5	....do..........	1,907.68	17.24	Oct. 13, 1950
6bd	J. C. Peterson...	....1900.....	Dr	80	6	80	GI	Cy	.....	W	D, S	1.0	Top of concrete platform........	1,955.43	49.61	Do.
8dd	U.S.G.S.	Dec. 28, 1949	J	30	$\frac{3}{4}$	30	GI	N	.....	N	O	3.0	Top of pipe.......	1,889.22	19.46	Oct. 13, 1950
9bb	....	....1950.....	Dr	160	18	160	GI	T	.....	T	I	1.0	Hole in base......	1,922.67	43.93	Do.
9db	John Jacobson....	....1939.....	Dr	80	4	80	GI	Cy	.....	W	D, S	1.0	Top of casing.....	1,916.27	54.99	Do.
11ba	City of Dannebrog.	....	Dr	32	8	32	I	N	.....	N	O	1.0	Concrete platform	1,870.84	27.99	Sept. 29, 1950
14da	U.S.G.S.	Oct. 19, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	...	Top of pipe.......	1,847.67	......	
17aa	McDonald Estate..	....	Dr	84	4	84	GI	Cy	.....	W	D, S	.0	Top of concrete platform........	1,928.07	59.77	May 3, 1950
20dd	August Granlund..	....1934.....	Dr	92	6	92	GI	Cy	.....	W	S	1.0	Top of casing.....	1,906.68	44.12	Oct. 4, 1950
22dd	U.S.G.S.	Oct. 19, 1950	J	21	$\frac{3}{4}$	21	GI	N	.....	N	O	2.0	Top of pipe.......	1,866.11	......	
28da	Bob Hadenfeldt ...	....1947.....	Dr	50	18	50	GI	T	350	T	I	.0	Hole in base......	1,870.38	9.44	Sept. 29, 1950
29cb	U.S.G.S.	June 16, 1949	Dr, Dn	11	$1\frac{1}{4}$	11	GI	N	.....	N	O	1.0	Top of pipe.......	1,876.92	6.29	Oct. 4, 1950
30aa	....	....	Dr	20	3	20	I	N	.....	N	O	1.0	....do..........	1,879.58	5.53	July 7, 1950
36aa	Carl Rief	....1948.....	Dr	80	18	80	GI	T	1,100	T	I	0	Hole in base......	1,897.18	8.01	Sept. 29, 1950
12-27aa	U.S.G.S.	June 16, 1949	Dr, Dn	10.7	$1\frac{1}{4}$	10.7	GI	N	.....	N	O	1.3	Top of pipe.......	1,895.71	6.33	Oct. 4, 1950
29ba	Mrs. Olga Young .	....1910.....	.....	31	36	31	B	N	.....	N	O	.2	Top of iron pipe ..	1,938.28	26.47	Do.
31ba	U.S.G.S.	June 28, 1950	J	10	$\frac{3}{4}$	10	GI	N	.....	N	O	1.2	Top of pipe.......	1,923.23	2.56	Do.
32cb	....do..........	July 16, 1950	Dr, Dn	20.9	$1\frac{1}{4}$	20.9	GI	N	.....	N	O	3.0	....do..........	1,926.38	......	
35aa	....do..........	Oct. 19, 1950	J	16	$\frac{3}{4}$	16	GI	N	.....	N	O	3.0	....do..........	1,894.63	12.39	Oct. 27, 1950
36cc	....do..........	....do.......	J	11	$\frac{3}{4}$	11	GI	N	.....	N	O	2.0	....do..........	1,905.60	3.32	Do.
14-10- 4ca	O. V. Svoboda....	....1924.....	Dr	48	96-48	48	GI B	C	.....	N	O	.0	Edge of brick.....	1,825.19	26.34	Oct. 13, 1950
8dd	U.S.G.S.	June 1949	Dr, Dn	18.8	$1\frac{1}{4}$	18.8	GI	N	.....	N	O	1.0	Top of pipe.......	1,829.17	5.83	Oct. 13, 1950
14bb	U.N.	....1936.....	Dn	12	1	12	I	N	.....	N	O	1.0	....do..........	1,796.83	6.58	Oct. 4, 1950
28dd	School district ...	....	.....	.....	$1\frac{1}{4}$	.....	I	N	.....	N	O	3.0	....do..........	1,816.22	......	
30ba	Ivan McCackin....	....	Dr	32	4	32	GI	Cy	.....	W	D	.5	Top of casing.....	1,853.44	13.77	Oct. 13, 1950
11-30cb	Arnold Krogh.....	....1939.....	Du, Dr	72	24	72	GI	N	.....	N	O	1.0	Top of plank over well	1,941.61	......	
36dc	....	....	.....	.....	4	.....	GI	Cy	.....	W	S	2.0	Top of casing.....	1,875.90	37.15	Oct. 13, 1950
12- 5cc	U.S.G.S.	Dec. 29, 1949	J	17	$\frac{3}{4}$	17	GI	N	.....	N	O	3.0	Top of pipe.......	1,974.40	7.35	Do.
15bb	....do..........	....do.......	J	21	$\frac{3}{4}$	21	GI	N	.....	N	O	6.0	....do..........	1,961.91	14.44	Do.
24dc	....do..........	Dec. 28, 1949	J	27	$\frac{3}{4}$	27	GI	N	.....	N	O	2.6	....do..........	1,927.41	9.82	Do.

Howard County--Continued

15- 9- 9aa	Wilbur Edwards ..	....1946.....	Dr	90	18	90	GI	N	.....	N	O	0.4	Top of casing.....	1,780.03	31.39	Sept. 29, 1950
10-34cb	Mrs. Auterburn ..	....1948.....	Dr	.....	18	.....	GI	T	600	.	I	.5	Hole in base......	1,804.83	15.78	Oct. 4, 1950

Sherman County

13-13- 2cd	....	....	Dr	170	4	170	GI	Cy	.....	N	O	0.6	Top of casing.....	2,120.57	......	
4dc	Thomas..........	....1935.....	Dr	190	4	190	GI	Cy	.....	W	S	.0	....do..........	2,085.92	120.76	Oct. 3, 1950
7ba	U. S. G. S.	July 7, 1950	J	10.5	3/4	10.5	GI	N	.....	N	O	1.8	....do..........	1,970.99	3.77	Oct. 4, 1950
7da	....do..........	July 9, 1950	J	11	3/4	11	GI	N	.....	N	O	3.0	....do..........	1,968.84	5.55	Do.
13cc	John Siefert......	....1935.....	Du	78	4	78	B	Cy	.....	W	S	.0	Hole in platform ..	1,995.32	53.66	Oct. 3, 1950
15cb	U. S. G. S.	July 7, 1950	J	20.9	3/4	20.9	GI	N	.....	N	O	2.5	Top of pipe.......	1,967.59	18.33	Do.
21aa	....do..........	June 27, 1950	J	10.5	3/4	10.5	GI	N	.....	N	O	2.0	....do..........	1,952.60	4.49	Oct. 4, 1950
21bb	....do..........	....do......	J	15.7	3/4	15.7	GI	N	.....	N	O	1.4	....do..........	1,966.77	12.99	Do.
23da	Bill McDonald....	....	Du, Dr	44	4	44	GI	Cy	.....	N	O	.0	Hole in platform ..	1,976.53	37.75	Oct. 3, 1950
26da	U. S. G. S.	July 6, 1950	J	16	3/4	16	GI	N	.....	N	O	2.4	Top of pipe.......	1,942.47	13.19	Oct. 4, 1950
27ba	....do..........	Aug. 17, 1950	J	10	3/4	10	GI	N	.....	N	O	1.0	....do..........	1,944.30	3.10	Do.
35aa	....do..........	July 6, 1950	J	31	3/4	31	GI	N	.....	N	O	3.7	....do..........	1,956.96	24.37	Do.
14- 1ab	....do..........	Aug. 3, 1950	J	10	3/4	10	GI	N	.....	N	O	.8	....do..........	1,981.14	5.00	Do.
12ab	....	....	.....	.....	4	.....	GI	Cy	.....	H	O	1.0	Top of casing.....	2,073.26	94.49	Oct. 3, 1950
15-29ad	U. S. G. S.	July 7, 1950	J	29	3/4	29	GI	N	.....	N	O	1.0	Top of pipe.......	2,064.42	6.36	Sept. 27, 1950
16-13aa	....do..........	June 28, 1950	J	15	3/4	15	GI	N	.....	N	O	3.0	....do..........	2,087.20	10.69	Do.
14-13-26ab	....	....	Dr	64	5	64	GI	Cy	.....	H	O	.5	Top of casing.....	2,038.85	......	
14- 3cc	Bill Couton.......	....	Du	17	.....	17	B	C	.....	T	S, I	.5	....do..........	2,033.81	6.92	Oct. 3, 1950
5bc	Walter Macejeski .	....1947.....	Dr	108	18	108	GI	T	.....	G	I	.8	Hole in base......	2,048.99	10.62	Do.
8ac	Claude Zimmermann	....1947.....	Dr	155	18	155	S	T	.....	T	I	2.0	....do..........	2,034.77	8.63	Do.
15ba	U. S. G. S.	Aug. 4, 1950	J	15	3/4	15	GI	N	.....	N	O	.5	Top of pipe.......	2,020.75	8.95	Do.
16bb	Ignas Snedre	....1948.....	Dr	90	18	90	GI	T	525	T	I	3.0	Hole in base......	2,030.03	14.80	Do.
21da	U. S. G. S.	Aug. 3, 1950	J	10	3/4	10	GI	N	.....	N	O	1.4	Top of pipe.......	2,006.38	5.99	Do.
23cb	Lee Heil.........	....1948.....	Dr	85	18	85	GI	T	800	T	I	1.0	Hole in base......	2,010.41	13.04	Do.
25dd	U. S. G. S.	Aug. 3, 1950	J	15	3/4	15	GI	N	.....	N	O	2.4	Top of pipe.......	1,994.26	10.58	Do.
35cb	School district....	....	.....	.....	.....	.....	GI	Cy	.....	H	D	1.0	Top of casing.....	2,024.56	31.51	Oct. 4, 1950
16- 4ab1	Louis Kohl.......	....1947.....	Dr	105	18	105	GI	T	.....	G	I	.6	Edge of pump frame	2,171.11	19.80	Sept. 27, 1950
4ab2	....do..........	....1945.....	Dr	97	18	97	GI	T	.....	G	I	1.2	....do..........	2,169.39	18.97	Do.
9dc	A. R. Outhouse...	....1940.....	Dr	90	18	90	GI	T	.....	G	I	.0	Hole in base......	2,171.42	......	
10cd	Albert Heapy & Son	....1948.....	Dr	208	18	208	GI	T	.....	G	I	.7	Edge of pump frame	2,172.73	40.66	Sept. 27, 1950
23bb	Henry Franssen ..	....1942.....	Dr	123	18	123	GI	T	.....	T	I	.0	Hole in base......	2,159.36	39.48	Do.
15-13- 9cd	Adolph Moeller...	....1896.....	Du	37	4	37	T	Cy	.....	H	O	1.0	Top of concrete platform........	2,061.83	28.50	Oct. 6, 1950

Table 10.--Description of wells and test holes in the Middle Loup division, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Sherman County--Continued																
15-13- 9dc	....	....	Du	37	.....	37	..	Cy	.....	W	S	0.0	Top of wooden platform	2,061.02	30.98	Oct. 6, 1950
29ca	....	....	Dr	129	5	129	GI	Cy	.....	N	O	...	Inspection hole ...	2,133.08	......	
30dd	....	....	Dr	145	5	145	I	Cy	.....	N	O	-2.3	....do..........	2,165.85	......	
14-17cb	U.S.G.S.	Nov. 15, 1949	J	28	3/4	28	GI	N	.....	N	O	.0	Top of pipe.......	2,074.84	13.06	Oct. 3, 1950
19ab	....do..........	....do.......	J	21	3/4	21	GI	N	.....	N	O	2.2	....do..........	2,062.78	13.36	Do.
19cb	George Heil......	....1948.....	Dr	105	18	105	GI	T	1,000	T	I	2.0	Hole in base......	2,057.01	6.70	Oct. 4, 1950
32aa	U.S.G.S.	Aug. 3, 1950	J	20	3/4	20	GI	N	.....	N	O	3.0	Top of pipe.......	2,044.54	9.62	Oct. 3, 1950
15- 2ab	....do..........	July 31, 1950	J	10	3/4	10	GI	N	.....	N	O	2.0	....do..........	2,080.51	5.34	Do.
2cd	....do..........	Nov. 16, 1949	J	14	3/4	14	GI	N	.....	N	O	2.0	....do..........	2,076.23	6.26	Oct. 2, 1950
3dc	Fred Larson	....1949.....	Dr	205	18	205	GI	T	950	G	I	1.0	Hole in base......	2,105.75	15.16	Do.
4aa	U.S.G.S.	June 9, 1950	J	10	3/4	10	GI	N	.....	N	O	2.0	Top of pipe.......	2,107.4[illegible]	5.17	Oct. 3, 1950
11cb	....	....	Dr	.....	5	.....	GI	P	.....	W	O	2.0	Top of casing.....	2,091.83	8.02	Oct. 2, 1950
13bb	U.S.G.S.	July 27, 1950	J	10	3/4	10	GI	N	.....	N	O	2.0	Top of pipe.......	2,065.88	3.54	Do.
14bd	Edwin Chelewski..	....1948.....	Dr	183	18	183	GI	T	1,260	G	I	1.0	Top of casing.....	2,092.22	17.89	Oct. 3, 1950
24cc	U.S.G.S.	Aug. 18, 1949	J	32	3/4	32	GI	N	.....	N	O	3.8	Top of pipe.......	2,089.33	16.24	Oct. 4, 1950
16- 7aa	M. Reiter	....	Dr	.....	.....	.....	GI	T	.....	T	I	.5	Edge of pump frame	2,217.89	27.14	Sept. 27, 1950
7da	....	....	Dr	.....	.....	.....	GI	T	.....	T	I	.7	....do..........	2,212.72	24.82	Do.
17ac	Vincent Kusek....	....1947.....	Dr	92	18	92	GI	T	300	G	I	1.6	Hole in base......	2,234.57	29.03	Do.
33ad	John Cherry......	....1948.....	Dr	106	18	106	GI	T	500	T	I	1.0	Edge of pump frame	2,132.53	20.38	Do.
16-14- 8bd	School district ...	....	Dr	163	6	163	GI	Cy	.....	W	D	1.0	Top of casing.....	2,204.94	110.74	Oct. 4, 1950
20aa	....	....	Dr	.....	4	.....	GI	N	.....	N	O	2.0	....do..........	2,164.10	78.45	Oct. 6, 1950
15- 5dd	....	....	Dr	86	5	86	GI	Cy	.....	W	S	1.0	....do..........	2,165.67	41.69	Oct. 3, 1950
6da	U.S.G.S.	Aug. 4, 1950	J	21	3/4	21	GI	N	.....	N	O	2.0	Top of pipe.......	2,129.62	7.00	Do.
8dd	....do..........	Aug. 22, 1949	J	21	3/4	21	GI	N	.....	N	O	2.0	....do..........	2,116.81	5.33	Do.
9dc	....do..........	....do.......	J	17	3/4	17	GI	N	.....	N	O	1.0	....do..........	2,133.20	15.64	Do.
16cd	....do..........	Nov. 16, 1949	J	14	3/4	14	GI	N	.....	N	O	2.3	....do..........	2,110.78	7.67	Do.
19ab	Ervan Fowler	....1948.....	Dr	124	18	124	I	T	500	T	I	.0	Hole in base......	2,154.45	20.73	Oct. 19, 1950
20cc	U.S.G.S.	Nov. 15, 1949	J	37.9	3/4	37.9	GI	N	.....	N	O	2.5	Top of pipe.......	2,137.00	9.97	Oct. 3, 1950
21aa	....do..........	Nov. 16, 1949	J	17.5	3/4	17.5	GI	N	.....	N	O	2.2	....do..........	2,108.80	7.15	Do.
26ca	School district....	....	Dr	.....	4	.....	GI	Cy	.....	W	D	1.4	Inspection hole ...	2,142.94	49.89	Do.
27ba	U.S.G.S.	Nov. 16, 1950	J	17.5	3/4	17.5	GI	N	.....	N	O	2.4	Top of pipe.......	2,097.74	6.62	Oct. 19, 1950
28bb	....do..........	Nov. 15, 1950	J	35.2	3/4	35.2	GI	N	.....	N	O	2.8	....do..........	2,128.42	23.62	Oct. 3, 1950
33aa	....do..........	June 9, 1950	J	10	3/4	10	GI	N	.....	N	O	1.8	....do..........	2,101.16	6.10	Do.
34dd	....do..........	July 21, 1950	J	10	3/4	10	GI	N	.....	N	O	2.0	....do..........	2,085.10	6.77	Oct. 19, 1950
36cc	....do..........	Aug. 20, 1949	J	40	1/2	40	GI	N	.....	N	O	1.0	....do..........	2,119.99	24.02	Oct. 3, 1950
16- 1da	....do..........	July 31, 1950	J	10	3/4	10	GI	N	.....	N	O	1.5	....do..........	2,134.51	5.26	Do.

Sherman County--Continued

16-16- 2ad	U. S. G. S.	July 31, 1950	J	21.4	3/4	21.4	GI	N	.....	N	O	1.8	Top of pipe.......	2,154.00	10.64	Oct. 3, 1950
12bc	Edward Chotkoski.	....1948.....	Dr	124	18	124	GI	T	600	T	I	2.0	Hole in base......	2,186.01	36.60	Do.
12dc	U. S. G. S.	Aug. 22, 1949	J	37	3/4	37	GI	N	.....	N	O	1.0	Top of pipe.......	2,175.64	28.95	Do.
13aa	....do...........	....do.......	Dn	20	3/4	20	GI	N	.....	N	O	1.0	....do...........	2,152.74	15.13	Do.

Valley County

17-16- 3cc	U. S. G. S.	....	J	37	3/4	37	GI	N	.....	N	O	3.2	Top of pipe.......	2,213.24	28.87	Sept. 27, 1950
6bc	Portis Sell.......	....	Dr	.....	.....	.....	..	T	.....	T	I	.0	Hole in base......	2,216.55	22.42	Sept. 28, 1950
7ab	Dale Cookley.....	....1949.....	Dr	120	18	120	GI	T	800	G	I	1.0	....do...........	2,222.34	30.98	Do.
9bd	U. S. G. S.	Aug. 26, 1949	J	14	3/4	14	GI	N	.....	N	O	2.0	Top of pipe.......	2,193.39	10.07	Sept. 27, 1950
10dd	....do...........	July 25, 1950	J	32	3/4	32	GI	N	.....	N	O	1.8	....do...........	2,194.11	13.13	Do.
17ac	....do...........	Aug. 25, 1949	J	20.3	3/8	20.3	GI	N	.....	N	O	2.0	....do...........	2,181.62	6.16	Sept. 28, 1950
21da	....do...........	Nov. 28, 1949	J	7	3/4	7	GI	N	.....	N	O	1.6	....do...........	2,161.18	2.30	Do.
25aa	....do...........	Aug. 24, 1949	J	25	1/2	25	GI	N	.....	N	O	1.0	....do...........	2,161.40	9.92	Sept. 27, 1950
25cb	....do...........	....do.......	Dn	10.5	3/4	10.5	GI	N	.....	N	O	2.0	....do...........	2,147.10	4.80	Do.
26dc	....do...........	Nov. 6, 1943	Du, Dr	.....	12	.....	GI	N	.....	N	O	1.3	Top of casing.....	2,152.62	......	
34aa	....do...........	Aug. 23, 1949	Dn	.....	16	16	GI	N	.....	N	O	1.0	Top of pipe.......	2,170.33	10.65	Sept. 28, 1950
18-16-30cc	....do...........	Aug. 25, 1949	Dn	14	3/4	14	GI	N	.....	N	O	2.0	....do...........	2,219.61	6.37	Sept. 27, 1950

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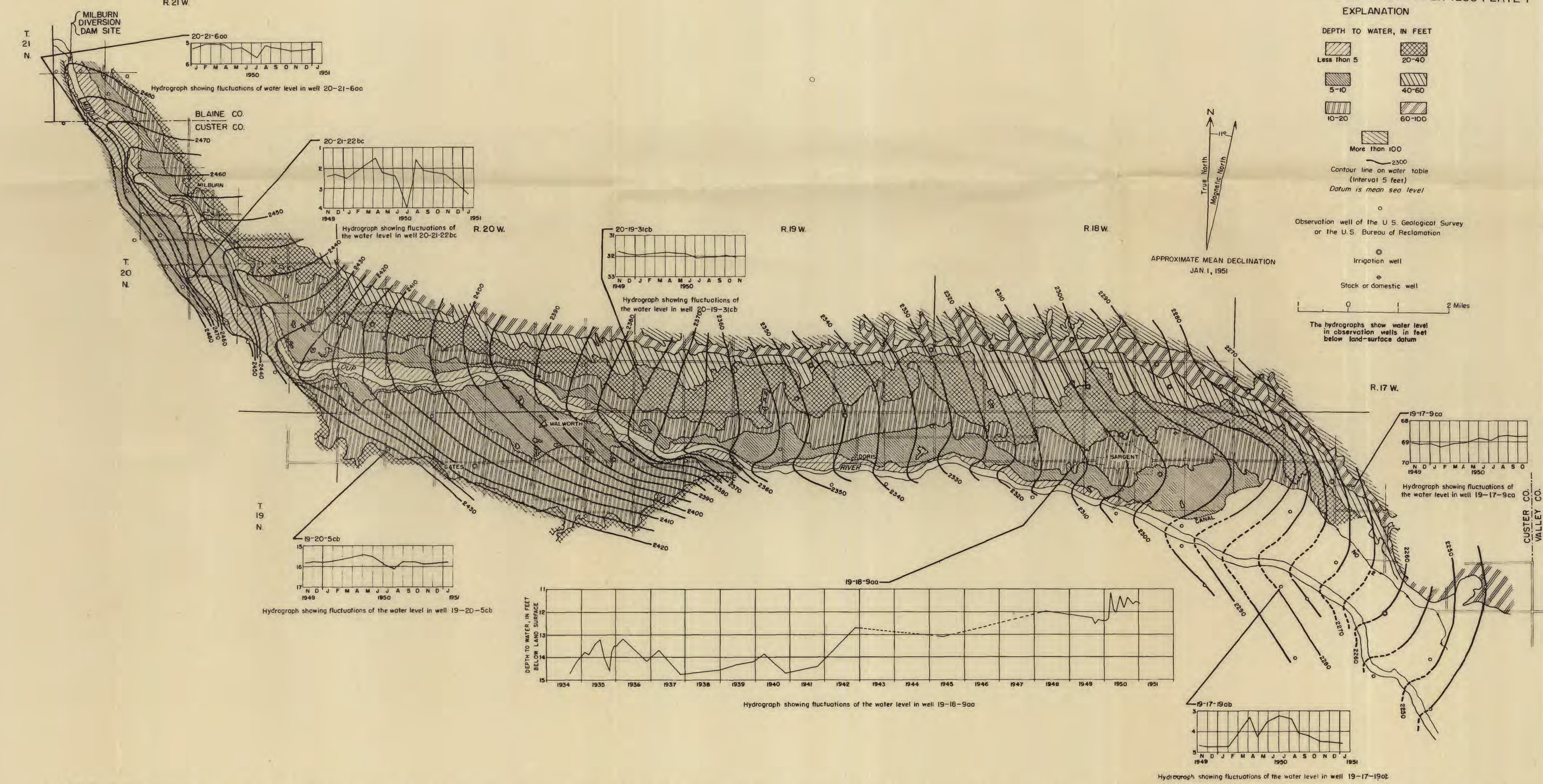
UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WATER SUPPLY PAPER 1258 PLATE 1



MAP OF THE SARGENT UNIT, NEBRASKA, SHOWING LOCATION OF WELLS, DEPTH TO WATER, AND CONTOURS OF THE WATER TABLE, OCTOBER 1950

322784 O - 55 (In pocket) No. 1

MAP OF THE LOWER LOUP RIVER VALLEY, NEBRASKA SHOWING DEPTH TO WATER AND THE CONTOUR OF THE WATER TABLE, 1950