CANADA

DEPARTMENT OF MINES

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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF MANKOTA No. 45 SASKATCHEWAN

BY

B. R. MacKay, H. H. Beach & E. L. Ruggles

Water Supply Paper No. 87

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INTRODUCTION

Lack of rainfall during the years 1930 to 1934 over a large part of the Prairie Provinces brought about an acute shortage both in the larger supplies of surface water used for irrigation and the smaller supplies of ground water required for domestic purposes and for stock. In an effort to relieve the serious situation the Geological Survey began an extensive study of the problem from the standpoint of domestic uses and stock raising. During the field season of 1935 an area of 80,000 square miles, comprising all that part of Saskatchewan south of the north boundary of township 32, was systematically examined, records of approximately 60,000 wells were obtained, and 720 samples of water were collected for analyses. The facts obtained have been classified and the information pertaining to any well is readily accessible. The examination of so large an area and the interpretation of the data collected were possible because the bedrock geology and the Pleistocene deposits had been studied previously by McLearn, Warren, Rose, Stansfield, Wickenden, Russell, and others of the Geological Survey. The Department of Natural Resources of Saskatchewan and local well drillers assisted considerably in supplying several hundred well records. The base maps used were supplied by the Topographical Surveys Branch of the Department of the Interior.

Publication of Results

The essential information pertaining to the ground water conditions is being published in reports, one being issued for each municipality. Copies of these reports are being sent to the secretary treasurers of the municipalities and to certain Provincial and Federal Departments, where they can be consulted by residents of the municipalities or by other persons, or they may be obtained by writing direct to the Director, Bureau of Economic Geology, Department of Mines, Ottawa. Should anyone require more detailed information than that contained in the reports such additional information as the Geological Survey possesses can be obtained on application to the director. In making such request the applicant should indicate the exact location of the area by giving the quarter section, township, range, and meridian concerning which further information is desired.

The reports are written principally for farm residents, municipal bodies, and well drillers who are either planning to sink new wells or to deepen existing wells. Technical terms used in the reports are defined in the glossary.

How to Use the Report

Anyone desiring information about ground water in any particular locality should read first the part dealing with the municipality as a whole in order to understand more fully the part of the report that deals with the place in which he is interested. At the same time he should study the two figures accompanying the report. Figure 1 shows the surface and bedrock geology as related to the ground water supply, and Figure 2 shows the relief and the location and type of water wells. Relief is shown by lines of equal elevation called "contours". The elevation above sea-level is given on some or all of the contour lines on the figure.

If one intends to sink a well and wishes to find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are give on the figure. Where contour lines are not shown on the figure, the elevations of adjacent wells as indicated in the Table of Well Records accompanying each report can be used. The approximate elevation of the water-bearing horizon at the well-site can be obtained from the Table of Well Records by noting the elevation of the water-bearing horizon in surrounding wells and by estimating from these known elevations its elevation at the well-site.[1] If the water-bearing horizon is in bedrock the depth to water can be estimated fairly accurately in this way. If the water-bearing horizon is in unconsolidated deposits such as gravel, sand, clay, or glacial debris, however, the estimated elevation is less reliable, because the water-bearing horizon may be inclined, or may be in lenses or in sand beds which may lie at various horizons and may be of small lateral extent. In calculating the depth to water, care should be taken that the water-bearing horizons selected from the Table of Well Records be all in the same geological horizon either in the glacial drift or in the bedrock. From the data in the Table

[1] If the well-site is near the edge of the municipality, the map and report dealing with the adjoining municipality should be consulted in order to obtain the needed information about nearby wells.

of Well Records it is also possible to form some idea of the quality and quantity of the water likely to be found in the proposed well.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground waters. In the Prairie Provinces a water is usually described as "alkaline" when it contains a large amount of salts, chiefly sodium sulphate and magnesium sulphate in solution. Water that tastes strongly of common salt is described as "salty". Many "alkaline" waters may be used for stock. Most of the so-called "alkaline" waters are more correctly termed "sulphate waters".

Alluvium. Deposits of earth, clay, silt, sand, gravel, and other material on the flood-plains of modern streams and in lake beds.

Aquifer or Water-bearing Horizon. A water-bearing bed, lens, or pocket in unconsolidated deposits or in bedrock.

Buried pre-Glacial Stream Channels. A channel carved into the bedrock by a stream before the advance of the continental ice-sheet, and subsequently either partly or wholly filled in by sands, gravels, and boulder clay deposited by the ice-sheet or later agencies.

Bedrock. Bedrock, as here used, refers to partly or wholly consolidated deposits of gravel, sand, silt, clay, and marl that are older than the glacial drift.

Coal Seam. The same as a coal bed. A deposit of carbonaceous material formed from the remains of plants by partial decomposition and burial.

Contour. A line on a map joining points that have the same elevation above sea-level.

Continental Ice-sheet. The great ice-sheet that covered most of the surface of Canada many thousands of years ago.

Escarpment. A cliff or a relatively steep slope separating level or gently sloping areas.

Flood-plain. A flat part in a river valley ordinarily above water but covered by water when the river is in flood.

Glacial Drift. The loose, unconsolidated surface deposits of sand, gravel, and clay, or a mixture of these, that were deposited by the continental ice-sheet. Clay containing boulders forms part of the drift and is referred to as glacial till or boulder clay. The glacial drift occurs in several forms:

(1) Ground Moraine. A boulder clay or till plain (includes areas where the glacial drift is very thin and the surface uneven).

(2) Terminal Moraine or Moraine. A hilly tract of country formed by glacial drift that was laid down at the margin of the continental ice-sheet during its retreat. The surface is characterized by irregular hills and undrained basins.

(3) Glacial Outwash. Sand and gravel plains or deltas formed by streams that issued from the continental ice-sheet.

(4) Glacial Lake Deposits. Sand and clay plains formed in glacial lakes during the retreat of the ice-sheet.

Ground Water. Sub-surface water, or water that occurs below the surface of the land.

Hydrostatic Pressure. The pressure that causes water in a well to rise above the point at which it is struck.

Impervious or Impermeable. Beds, such as fine clays or shale, are considered to be impervious or impermeable when they do not permit of the perceptible passage or movement of the ground water.

Pervious or Permeable. Beds are pervious when they permit of the perceptible passage or movement of ground water, as for example porous sands, gravel, and sandstone.

Pre-Glacial Land Surface. The surface of the land before it was covered by the continental ice-sheet.

Recent Deposits. Deposits that have been laid down by the agencies of water and wind since the disappearance of the continental ice-sheet.

Unconsolidated Deposits. The mantle or covering of alluvium and glacial drift consisting of loose sand, gravel, clay, and boulders that overlie the bedrock.

Water Table. The upper limit of the part of the ground wholly saturated with water. This may be very near the surface or many feet below it.

Wells. Holes sunk into the earth so as to reach a supply of water. When no water is obtained they are referred to as dry holes. Wells in which water is encountered are of three classes.

(1) Wells in which the water is under sufficient pressure to flow above the surface of the ground. These are called Flowing Artesian Wells.

(2) Wells in which the water is under pressure but does not rise to the surface. These wells are called Non-Flowing Artesian Wells.

(3) Wells in which the water does not rise above the water table. These wells are called Non-Artesian Wells.

NAMES AND DESCRIPTIONS OF GEOLOGICAL FORMATIONS, REFERRED TO IN THESE REPORTS

Wood Mountain Formation. The name given to a series of gravel and sand beds which have a maximum thickness of 50 feet, and which occur as isolated patches on the higher parts of Wood mountain. This is the youngest bedrock formation and, where present, overlies the Ravenscrag formation.

Cypress Hills Formation. The name given to a series of conglomerates and sand beds which occur in the southwest corner of Saskatchewan, and rest upon the Ravenscrag or older formations. The formation is 30 to 125 feet thick.

Ravenscrag Formation. The name given to a thick series of light-coloured sandstones and shales containing one or more thick lignite coal seams. This formation is 500 to 1,000 feet thick, and covers a large part of southern Saskatchewan. The principal coal deposits of the province occur in this formation.

Whitemud Formation. The name given to a series of white, grey, and buff coloured clays and sands. The formation is 10 to 75 feet thick. At its base this formation grades in places into coarse, limy sand beds having a maximum thickness of 40 feet.

Eastend Formation. The name given to a series of fine-grained sands and silts. It has been recognized at various localities over the southern part of the province, from the Alberta boundary east to the escarpment of Missouri coteau. The thickness of the formation seldom exceeds 40 feet.

Bearpaw Formation. The Bearpaw consists mostly of incoherent dark grey to dark brownish grey, partly bentonitic shales, weathering light grey, or, in places where much iron is present, buff. Beds of sand occur in places in the lower part of the formation. It forms the uppermost bedrock formation over much of western and southwestern Saskatchewan and has a maximum thickness of 700 feet or somewhat more.

Belly River Formation. The Belly River consists mostly of non-marine sand, shale, and coal, and underlies the Bearpaw in the western part of the area. It passes eastward and northeastward into marine shale. The principal area of transition is in the western half of the area where the Belly River is mostly thinner than it is to the west and includes marine zones. In the southwestern corner of the area it has a thickness of several hundred feet.

Marine Shale Series. This series of beds consists of dark grey to dark brownish grey, plastic shales, and underlies the central and northeastern parts of Saskatchewan. It includes beds equivalent to the Bearpaw, Belly River, and older formations that underlie the western part of the area.

WATER-BEARING HORIZONS OF THE MUNICIPALITY

The rural municipality of Mankota is an area of 324 square miles in the western part of southern Saskatchewan.. The centre of the municipality is 27 miles north of the International Boundary, approximately 95 miles southwest of Moose Jaw, and 70 miles southeast of Swift Current. The municipality consists of a square block of nine townships, described as tps. 4, 5, and 6, ranges 7, 8, and 9, W. 3rd mer. The Assiniboia-Mankota branch of the Canadian Pacific railway enters the area at the eastern boundary in sec. 36, tp. 5, range 7, and continues up the valley of McDonald creek to the village of Mankota, the terminus of the line. The villages of Ferland and McCord, the only other centres of population in the area lie to the east of Mankota on the same railway line.

A northwesterly trending range of hills known as Pinto Butte extends across the extreme southwest corner of the municipality and the northeasterly trending Wood mountain cuts across the southeast corner of the area. The greater part of the municipality lies on the northern slopes of these two uplands. The surface of the area is gently rolling. Wood river and McDonald creek traversing the municipality in a northeasterly direction occupy wide, flat valleys throughout the greater part of their lengths. From an average elevation of 2,600 feet above sea-level in the stream valleys, the land surface rises uniformly to elevations exceeding 2,800 feet at points a mile or so due north of Mankota, and to similar elevations in the upland intervening between the above-mentioned streams. South of Wood river the elevations rise uniformly from the valley to approximately 3,000 feet above sea-level along the southern border and reach the highest point of the municipality in the southwest corner at an elevation of 3,125 feet above sea-level.

Only in restricted areas in the municipality is the water supply considered to be sufficient for local requirements. The water is being derived from the Recent stream deposits in the valleys, from the glacial drift that covers all other parts of the municipality, and from the underlying bedrock formations.

Water-bearing Horizons in the Unconsolidated Deposits

Thin layers of Recent stream silts, sands, and gravels occur along the valleys of Wood river and McDonald creek. These deposits are found adjacent to the watercourses and probably do not cover any great width in the valley. A well on the SE.$\frac{1}{4}$, sec. 36, tp. 4, range 7, is the only one in the municipality that is located in these deposits. This 14-foot well provides a supply of good water sufficient for 40 head of stock. No definite sand or gravel aquifer was encountered in this well. In other places, however, fairly extensive layers of water-bearing gravels may be found interbedded in the sands and silts at shallow depths.

The glacial drift covering the greater part of the municipality as a mantle of varying thickness was deposited many thousands of years ago by a great continental ice-sheet that moved in a southwesterly direction across the province of Saskatchewan. As it advanced it deposited a layer of boulder clay or till composed essentially of bluish grey, compact clay in which are embedded scattered boulders and also occasional pockets of sands and gravels. The latter exhibit great variation in their areal extent and thickness. This boulder clay covers the bedrock of the northern townships to depths of 40 to 50 feet, but thins to less than 20 feet along the slopes of the creeks and over the uplands of the southwest and southeast corners. With the gradual melting of the ice, the front of the ice-sheet retreated to the northeast across the area. At places where the retreating front paused for a considerable period a greater accumulation and a more heterogeneous deposit of sand and gravel intermixed with the boulder clay was laid down. This type of deposit is known as "moraine". In this municipality it is confined to comparatively limited areas along the summit of the uplands north of McDonald creek, and to smaller areas north and south of Wood river in township 4, ranges 8 and 9, and township 5, range 9. The surface of the moraine is rough and hillocky and undrained depressions are common.

With further melting and retreat of the ice a long narrow lake was formed extending along the valley of Wood river and to a limited extent along the lower reaches of McDonald creek. Fine silt washed into this lake accumulated to form a compact bluish grey lake clay. The present areal extent of the lake clays, as well as the other forms of the glacial drift is shown on Figure 1 of the map accompanying this report.

The lake clays are usually dark in colour and of a heavy, impervious nature. However, in some parts they are more sandy and are lighter in colour. Little ground water is found in the clays, but sand and gravel beds which lie immediately below the lake clays are water-bearing. These gravels were probably deposited shortly after the till sheet and were later covered by the lake clays. They are not thought to form one continuous traceable horizon although their occurrence beneath the clay is quite general. These sand and gravel pockets have been located in many wells ranging from 12 to 40 feet deep. The water obtained is hard and with few exceptions is of good quality. Water supplies sufficient only for household needs are obtained from a few wells, but most of the wells yield quantities ample for 10 to 70 head of stock. Residents in the lake clay covered area should have no difficulty in locating further water supplies with wells similar to those already in use.

Throughout the small, irregularly surfaced area of moraine, the ground water is confined to the pockets of sands and gravels scattered through the boulder clay. The size of these porous beds varies considerably and a corresponding variation is noted in the yield of ground water from the wells penetrating them. This variation is particularly noticeable in the shallow wells. In some places individual wells produce only enough water for household use and 5 or 6 head of stock, whereas the yield from other wells is ample for 30 head of stock or more. Due probably to the rough topography of the moraine and its inadaptibility to farming few wells have as yet been dug in these areas. Further exploration, however, in most localities will probably locate water supplies. The depth of wells necessary should nowhere exceed 40 feet.

The remainder of the municipality is covered by glacial till, or boulder clay, in which ground water is found under conditions similar to those of the moraine deposits. The sand and gravel pockets in the glacial till occur much more sparingly, however, than in the moraine covered areas. The pockets show little or no consistency in the depths at which they occur. They have been tapped in wells at depths ranging from 6 to 65 feet from the surface, and at some places several wells have been dug or bored without obtaining water. Due to the irregularity of the distribution of the pockets, however, the sinking of several dry holes must not be taken as absolutely conclusive evidence of the lack of water-bearing beds in an area. On account of the relatively larger catchment area presented, wells sunk near the bottoms of slopes are sometimes more productive than wells sunk on the plains. Low gravel knolls and ridges have also formed good well sites in some areas. The yield from different wells varies from barely sufficient for household needs to sufficient for 50 to 60 head of stock. One well, located on sec. 3, tp. 5, range 7, yields enough water for 76 head of stock. The quality of water from wells encountering the productive beds close to the surface is generally good. At greater depths the water is more highly mineralized and in a few wells the water is reported to be so highly "alkaline" as to be unfit for drinking.

Water-bearing Horizons in the Bedrock

Three bedrock formations, referred to as the Ravenscrag, Eastend, and Bearpaw, underlie the glacial drift in different parts of the municipality. All three formations at one time probably extended over the entire municipality, with the Ravenscrag beds uppermost. This is underlain by the Eastend and it in turn is underlain by the Bearpaw formation. Erosion over long periods of time prior to the glacial period has removed the two upper formations from all but the uplands of the southwestern and southeastern corners. Throughout the remainder of the area the Bearpaw formation immediately underlies the glacial drift. The areal distribution of these formations beneath the drift is shown on the accompanying map, Figure 1.

The Ravenscrag formation is composed of light greenish grey and grey sands and sandstones, and in places of finer sands and silts with bands of clay ironstone. At some places the sands give way to light-and dark-coloured clays and shaly silts. Four wells in the area have penetrated the formation and found sand or sandy clay aquifers at depths ranging from 12 to 22 feet in the southwestern area and at a depth of 63 feet in the one well in the southeast. Two wells yield soft water and two yield hard water, but all supplies are of good quality. The well on the SW. 1/4, sec. 21, tp. 4, range 9, encountered clay, and as is to be expected from such a relatively impervious aquifer the yield of water is small. The sandy aquifers in the other wells produce supplies ample for 25 to 35 head of stock. Ground water conditions will probably be fairly uniform throughout the formation. Little difficulty should be experienced in obtaining water supplies at depths less than 70 feet in the northern part of the area underlain by the Ravenscrag and at slightly greater depths on the higher land to the south of the present wells sunk into the formation.

No wells in this municipality have tapped the Eastend formation, which consists of yellowish and yellowish green, very fine sands and coarse silts, and grey arenaceous shales. Throughout most of its extent in this municipality the Eastend is overlain by the Ravenscrag formation. Since water has been found in the overlying beds there has been no necessity for drilling into the Eastend formation. Water-bearing horizons probably do exist in this formation, however, particularly as it is composed so largely of sands. No information is available regarding the quality or quantity of water to be expected from these beds in this municipality, but in other places water from the Eastend formation is highly mineralized but is usually drinkable.

The Bearpaw formation underlies the Eastend formation in the area in which the latter occurs, and lies directly beneath the glacial drift in all other parts of the municipality. It consists largely of compact, dark grey to brownish grey shales. Beds of light grey or buff-coloured, fine sand and coarse silt are common at some localities. The shale is readily recognizable in drilling by its colour and soapy feel, and by the small roughly cubical fragments into which it crumbles upon weathering. The glacial drift covering over the shale is usually about 40 feet thick, but is found to range from 5 feet or less along the slopes of the upper reaches of the creeks to nearly 90 feet in thickness in some parts of the northern townships.

Little water can be expected from the compact shale, but wells that have tapped the sandy beds yield varying amounts in different localities, from seepages barely sufficient for household use to quantities amply sufficient for 35 or more head of stock. Much of the water from this formation contains large quantities of mineral salts in solution, and in some places it is unfit either for household or stock use. In township 4, ranges 8 and 9, and in township 5, range 7, due to the presence of more porous sandy beds, fairly large supplies of water of somewhat better quality are obtained from this formation. Here, as in other parts of the area, the water from the shale is quite highly mineralized, but it is being used in the households. Deep drilling into the shale in any part of the municipality is not recommended. Residents are better advised to attempt to find water by testing in the overlying glacial deposits before sinking wells into the underlying Bearpaw.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 4, Range 7

Adequate supplies of ground water are being obtained in this township from wells sunk into the Recent alluvium that floors the valleys, the glacial drift covering the greater part of the area, and the underlying Ravenscrag and Bearpaw bedrock formations.

Recent alluvial sands and silts have been deposited along the stream channels in the northwest and northeast corners of the township. A well on section 36 was sunk 14 feet into the silts and yields a supply of water ample for 40 head of stock. The water is hard and has a high dissolved mineral salt content. Generally, however, the silts are too compact to yield more than small supplies of ground water. Systematic prospecting at shallow depths in the narrow areas along the creeks in which these deposits occur, particularly along the southern branch and main valley of Wood river, should encounter beds of sands and gravels interbedded in the silts from which larger supplies of water of fairly good quality are to be expected.

A layer of compact dark grey lake clay covers the greater part of the valley floor of Wood river. The clay itself is almost entirely non-water-bearing. Thin beds of sands occur interspersed through the clay, but are not sufficiently numerous to constitute continuous horizons over a large area.

Beds of water-bearing gravels have been encountered beneath the lake clays at a few points in the valley. Sufficient testing has not been done as yet to determine the actual areal extent of the gravels beneath the clays. It is probable, however, that the gravels will form much more dependable sources of water than any sand beds that might occur interspersed in the clay. Depths to the gravels undoubtedly vary. One well, located on the

SW. $\frac{1}{4}$, section 30, tapped this horizon at a depth of 28 feet. Other wells in the township to the north suggest that the gravels are even nearer the surface along the margins of the stream valley. The yield from the well referred to is sufficient for watering 70 head of stock, and the water is of suitable quality for household use. The glacial till, or boulder clay, forms the surface covering over all parts of the area remote from the stream channel and probably does not exceed 30 feet in thickness in most places. Little water is obtained from wells penetrating only boulder clay, and the water is highly mineralized. Sand and gravel pockets scattered through the clay at depths less than 30 feet are usually water-bearing. Individual wells produce supplies of water sufficient for 6 to 70 head of stock, depending on the porosity, areal extent, and thickness of the bed tapped. The water was reported to be of good quality from all wells of this type that were investigated. Little difficulty was experienced in locating these pockets, even though their presence is not always indicated on the surface. Such pockets are probably quite general in their occurrence, but at some points it may be necessary to sink several test holes before an adequate water supply is obtained.

In the southeastern corner of the township the Ravenscrag formation occurs immediately below the glacial drift, This area is indicated on the accompanying map, Figure 1. Only one well located on the SE.$\frac{1}{4}$, section 12, has as yet been sunk into this formation in this area. This well is 63 feet deep and derives a supply of soft water ample for 25 head of stock from the sand beds near the base of the formation, at an elevation of 2,872 feet above sea-level. Water of good quality should be found at approximately this same horizon in other parts of this area.

No information has been obtained regarding the water producing properties of the Eastend formation which underlies the Ravenscrag formation. Findings in other municipalities would suggest that water should be found in the formation, but it will be inferior in quality to the water found in the Ravenscrag. In the southern uplands it is unlikely that the necessity of drilling into the Eastend formation will arise, as the overlying Ravenscrag is undoubtedly the more productive formation.

Throughout the remainder of the township the Bearpaw formation lies directly beneath the glacial deposits. The shale that comprises the greater part of the formation yields very little water. Throughout this township the upper part of the formation is quite sandy. Wells located on sections 5, 8, 17, and 33 derive their supply from a sandy clay or shale believed to represent the Bearpaw, at depths not exceeding 30 feet from the surface. The yield from each well is sufficient for at least 15 head of stock. The water generally contains considerable amounts of dissolved mineral salts, but in only one place was it considered to be unfit for household use. On section 22 it was found necessary to sink a well 90 feet before water was obtained in the shale. The yield from this well is reported to be sufficient for 15 head of stock and although "alkaline" the water is drinkable.

No wells have been sunk to greater depths into the shale, but it is improbable that water conditions will be found to be any better at such depths.

Township 4, Range 8

The supply of ground water derived from wells in this township is not sufficient for all local requirements, but in many places the supply is increased to adequate amounts by water from several springs and from Wood river. Producing wells have been sunk into the glacial drift that mantles the area and into the underlying Bearpaw formation.

Wells dug close to the river and the creek can be expected to strike water in the Recent alluvial deposits of silts, sands, and gravels which occur adjacent to the stream channels. These deposits probably do not exceed 10 to 15 feet in thickness at any place along the stream courses. Where pockets of sands or gravels are encountered in the silts fairly good supplies should be obtained.

Glacial lake clays cover an extensive area of lowlands adjacent to Wood river. Although these deposits are possibly more sandy than the clays occurring farther down the river in the township to the east, they cannot be regarded as a source of more than small seepages of water. Sand beds probably do occur at intervals scattered through the clays. An 8-foot well dug on the NW.$\frac{1}{4}$, section 24, derives a supply of water sufficient for 25 head of stock from such a pocket. Beds of gravel occurring beneath the lake clays offer better possibilities of obtaining water supplies. These gravel beds do not form a continuous horizon nor do they occur at the same elevations at different places, but they presumably conform to the channel of a larger, pre-existing watercourse. A well located on the SW.$\frac{1}{4}$, section 22, encountered gravels lying on the top of the bedrock at a depth of 56 feet. The water is drinkable and in sufficient quantities for local needs. It is probable that these gravels will be found at depths not greatly exceeding 30 feet along the marginal parts of the lake clay covered areas.

An area of moraine covers parts of section 4, 5, 6, 7, 8, and 9. The moraine consists essentially of sandy boulder clay interspersed with sand and gravel pockets. The quality of this ground water has not been tested, but the sand and gravel pockets encountered within 30 feet of the surface should contain water of fairly good quality. At greater depths the water may prove to be "alkaline". The sands and gravels do not form continuous horizons over large areas, so that some holes may encounter only clays.

Less porous material in the form of glacial till, or boulder clay deposits, covers the remainder of the township. The clays are more compact and the sand and gravel deposits occur more sparingly than in the moraine deposits. However, several wells have tapped sand or gravel pockets and are deriving small supplies of water from them. In some instances the gravel is found resting directly on the underlying Bearpaw formation. The aquifers have been encountered at depths ranging from 15 to 60 feet. The average depth required at most points does not generally exceed 40 feet. The water from each well is of good quality, but the supplies are inadequate for local requirements. It is possible that further testing throughout the area will locate more extensive pockets from which adequate supplies would be obtained.

No wells have been sunk into the Ravenscrag and Eastend formations which underlie the glacial drift in a small area along the southern edge of the township, as shown on the map, Figure 1. Usable water may be expected from the sandy beds in either of these formations. The depths of wells necessary to tap water-bearing horizons in these formations have not been determined, since the thickness of the overlying glacial drift is not known. It is probable, however, that moderately large supplies of water will be found within 60 feet from the surface.

The Bearpaw formation lies directly below the glacial drift throughout the remainder of the township. Water-bearing sand beds have been tapped in several wells, whereas in other wells the water is drawn from the shales near the top of the formation. The depth of well required depends on the thickness of the overlying glacial deposits. In this township the formation has been encountered at depths ranging from 8 to 60 feet, and at some points along the slopes of the valleys the Bearpaw shales are exposed at the surface. The water obtained has a high content of dissolved mineral salts, but no wells have been reported from which the water is not usuable for all farm purposes. Only very small supplies are obtained from the Bearpaw formation in some places, but most of the wells in this township yield ample quantities of water for 10 to 25 head of stock. One well located on the SE.$\frac{1}{4}$, section 33, is reported to yield a supply sufficient for 110 head of stock from sandy shale below a band of hard blue clay at a depth of 40 feet. The water from this well contains a high percentage of Epsom salts ($MgSO_4$) in solution and has a decided laxative effect upon humans.

Township 4, Range 9

The glacial drift is thin throughout the greater part of this township, and hence the bedrock formations are the source of the greater amount of the ground water used in the township.

Along the valleys and close to the creeks are found Recent stream deposits consisting of silts, interbedded with layers of sands and gravels. Although no water is at present being drawn from these deposits, wells tapping the sand and gravel beds can be expected to yield moderately large supplies of drinkable water. In some of the smaller coulées the supply obtainable will be sufficient for household needs. These deposits are not thick and water probably lies within 15 feet from the surface.

Glacial lake clays cover the bottom of the valley in the northeastern part of the township, as shown on the accompanying map, Figure 1. In this region the clays may be sandy, thus increasing the possibility of obtaining water supplies, but the water resources of these clays have not as yet been determined. Little water can be expected from the clays, but at least small supplies should be found in the sandy pockets. Gravels yielding large quantities of ground water have been found beneath the clays in townships to the east and testing may reveal their presence in this township.

A narrow belt of moraine deposits extends from sections 19 and 30 in an easterly direction across sections 20, 16, and 15, to section 14. This area is shown on the map, Figure 1. The moraine is quite porous, due to the sandy nature of the clays and the presence of pockets of sand and gravel. These deposits offer possibilities of yielding moderate supplies of water at depths less than 30 feet from the surface. The glacial drift covering the remaining part of the township is in nearly all places less than 40 feet thick. The sand and gravel pockets interspersed through the boulder clay are less numerous in this glacial till covered area than they are in moraine deposits. Several shallow test holes may be necessary before even a small supply of water is obtained. The gravel deposits may be more plentiful on the uplands, as one well located on section 4 encountered a 20-foot bed of gravel after passing through 36 feet of boulder clay. This well yields soft water in sufficient quantities for at least 25 head of stock, and by using several small springs in the neighbourhood the resident has been able to water 50 head. Such a large supply of water is not to be expected, however, from the drift in most parts of the township. Residents failing to obtain an adequate water supply in the glacial deposits are well advised to extend their wells into the underlying bedrock formations.

Three bedrock formations, the Ravenscrag, Eastend, and Bearpaw, occur immediately below the glacial drift in various parts of the township, as shown on the accompanying map, Figure 1. The uppermost formation, the Ravenscrag, is found throughout the western part of the township and has been penetrated by two wells on section 21 and one well on section 30. In each well the sandy aquifer lies close to the top of the formation. The glacial covering is quite thin, as the wells are from 12 to 22 feet deep. The water in each instance is of good quality. The supply from one well is sufficient for only 8 head of stock, whereas from the other a supply ample for 35 head is obtained. The drift increases in thickness towards the south, so that greater depths will be required to contact the Ravenscrag formation in the sections in the extreme southwest corner of the township. The sand beds are believed to be numerous and of considerable areal extent in this area. Hence adequate ground water supplies are to be expected at depths considerably less than 100 feet throughout the area underlain by the Ravenscrag formation.

The Eastend formation underlies the Ravenscrag and is the uppermost bedrock formation in a narrow zone not exceeding one-half mile in width extending from the NE.$\frac{1}{4}$, section 32, in a south-southeasterly direction across the township to the SW.$\frac{1}{4}$, section 2, and thence across the southern half of section 1. Elsewhere the Eastend is overlain by the beds of the Ravenscrag formation. The Eastend consists largely of beds of very fine sand, which although not as porous as the beds of the overlying Ravenscrag, should yield supplies of ground water. No wells have as yet been sunk into this formation, but elsewhere in the municipality water from the Eastend although highly mineralized is drinkable.

The Bearpaw formation underlies the entire township. It occurs immediately beneath the glacial deposits in all parts except where overlain by the Eastend and Ravenscrag formations. Several wells in the northeastern part of the township are deriving water from the sands and shales at or near the top of the Bearpaw formation. No continuous water-bearing horizons can be traced and the aquifers have been found at elevations ranging from 2,787 to 2,930 feet above sea-level, apparently following the surface elevations. The surface covering of unconsolidated deposits is found to range from 5 to 30 feet. The water from each well is usuable, although in most places it has a high mineral salt content. Supplies from a few of the wells are very small but most of them yield enough water for 10 to 25 head of stock.

Township 5, Range 7

Wells dug both into the glacial deposits and into the Bearpaw formation in this township provide ample supplies of ground water. No wells have as yet been sunk into the Recent stream deposits lying along the sides of Wood river, but water supplies may be expected from sand or gravel aquifers at shallow depths in these deposits.

Glacial lake clays cover the greater part of the wide valley bottom of Wood river, as shown on the municipality map. The lake clay is more or less impervious to the passage of ground water, but sandy phases of the clay and even thin pockets of sand are common generally over the area. Shallow wells less than 20 feet in depth encountering these pockets yield sufficient quantities of ground water for household requirements and for 10 to 15 head of stock. Beds of gravel are known to underlie the lake clays in some localities. These gravels probably do not form continuous horizons over large areas, but are sufficiently extensive to assure their being struck over the greater part of the flat lowland area after a few test holes have been sunk. These gravels have been tapped in wells ranging between 30 and 40 feet in depth in sections 34, 35, and 36, and at a depth of 18 feet upstream in section 5. The yield from these gravels is generally amply sufficient for local stock requirements. The water is of good quality and is used for drinking.

Ground water conditions in the glacial till which covers the upland areas remote from the broad valley, are somewhat similar to those in the lake clay deposits. Small supplies are obtained from the clays, but considerably larger supplies are found in gravel or sand pockets scattered through it. The pockets do not form continuous aquifers, but are encountered at various depths in different parts of the area. Shallow wells encountering porous beds serve as sources of household supply. The majority of wells used for watering any large number of stock, however, have been sunk to depths ranging from 30 to 60 feet. In most wells the water is usable for the household but the water from two wells, one on section 6, and the other on section 22, is reported to be fit for stock only. Individual wells yield supplies ample for 8 to 100 head of stock. Springs deriving their supply as seepage from the glacial till occur on sections 3 and 29 and form auxiliary supplies of water for stock in these areas.

A well on the NW.$\frac{1}{4}$, section 20, is drawing water from the Bearpaw formation. The water from this well is of fairly good quality and the supply is sufficient to water 25 head of stock. Continuous water-bearing horizons probably do not exist in the bedrock, but water is generally found near the top of the Bearpaw formation. As the thickness of the unconsolidated deposits varies over the area, the depth at which the bedrock will be encountered can not be pre-determined. In the above-mentioned well the top of the bedrock lies 42 feet below the ground surface, but on section 22 the glacial deposits are known to be at least 64 feet thick. Although thin sand beds and sandy shales form much of the Bearpaw formation in this municipality, dark grey, impervious shales are present in some localities. Such shales were encountered in a well 112 feet deep on section 31. No water was obtained from this well.

In most parts of this township it should not be necessary to seek ground water from the Bearpaw formation, as good supplies can be obtained from shallower wells in the glacial deposits. Deep drilling into the Bearpaw formation below an approximate depth of 50 feet from the point where the shales are encountered, does not seem to be advisable in this township. Very little water can be expected and such as is found undoubtedly will be very highly mineralized.

Township 5, Range 8

Ground water supplies in this township are being derived from the glacial drift, and from the underlying Bearpaw formation. Good supplies are not found in all parts of the township. Recent stream deposits adjacent to McDonald creek will probably be water-bearing and shallow wells should derive supplies of good water from them. There has been some difficulty in obtaining water supplies from the glacial till, or boulder clay, that covers the remaining parts of the township. Water has been found in each well dug, but supplies are often small and the quality of the water is unsatisfactory in some places. Generally the compact boulder clay is not very productive, but on the NW.$\frac{1}{4}$, section 30, a large supply is reported to come from the clay. Sand and gravel pockets scattered through the clay are water-bearingand have been tapped by a few of the wells. The supplies from the sand beds are found to be sufficient for 6 to 30 head of stock. The gravels are usually more productive and produce supplies ample for 20 to 100 head of stock. All water from the sands and gravels is of fairly good quality. A few wells sunk into the clay and encountering only very small beds of sands yield highly mineralized water which is not suitable for domestic purposes. It is probable that throughout the township more water would be obtained from the glacial drift if systematic testing were carried out to locate the sand or gravel reservoirs. The glacial deposits seem to range in thickness from about 25 to 100 feet, and the water may generally be expected within 40 feet of the surface.

Several wells are deriving water from the Bearpaw formation which underlies the glacial drift throughout the township. No definite sand beds have been encountered in the formation in this area and sandy phases of the clays and shales serve as aquifers. The water has a high content of dissolved mineral salts, which renders it unsuitable for household use and in some instances unfit for stock. It is, therefore, advisable to test thoroughly in the glacial deposits for ground water before digging to the Bearpaw shales. Deep drilling in this township cannot be expected to yield adequate supplies of water suitable for farm requirements.

Township 5, Range 9

The ground water obtained in many parts of this township is of very poor quality.

Recent stream deposits occurring along the courses of McDonald creek and its tributaries probably contain some thin beds of sand and gravel mixed with the clays and silts. A few of the wells located along the valleys may derive their small supplies from these deposits rather than from the glacial till covering the valley slopes and upland areas.

Porous moraine forms the glacial drift in a small area in the northwest corner of the township and in a more extensive area covering the south-central sections, as shown on the accompanying map, Figure 1. Deposits of this nature are usually quite productive of water, due to the numerous sand and gravel pockets irregularly interspersed through the clay. In this township, however, only small supplies of water have been obtained from them. As only a few wells have as yet been sunk in these areas, further tests may show the presence of more water. Gravel or sand pockets have been found mostly in the valleys and coulées in the glacial till, or boulder clay, which covers the remaining upland parts of the township. These aquifers are encountered within 40 feet of the surface. In most localities the water is of good quality, but in isolated cases it is too highly mineralized to be usable in the household. Supplies are ample for 10 to 40 head of stock. In wells where sand or gravel are not encountered the yield from the clay is generally small.

Sands, clays, and shale beds of the Ravenscrag and Eastend formations are present beneath a thin layer of glacial drift in the upland areas of sections 5, 6, 7, and 8. Two wells sunk to depths of 30 and 35 feet on the NW. and NE.¼'s, section 7, are believed to obtain their supply from the Eastend or the upper part of the Bearpaw formation. The water has a high iron content and is unsatisfactory for household use. The yield from each well is sufficient for at least 15 head of stock. It is probable that water of better quality will be found at similar depths on section 6, where less of the Ravenscrag formation has been eroded away.

A number of wells are tapping the Bearpaw formation, which occurs immediately below the drift over the greater part of the township, at depths ranging from 10 to 60 feet. Sand beds serve as aquifers in a few wells and the clays and shales in others. Individual wells yield quantities of water sufficient for 10 to 40 head of stock. The water contains large amounts of mineral salts in solution and is usually unfit for household use, but is usable for stock. Supplies of stock water may be expected from the bedrock at depths not exceeding 75 feet in nearly all parts of the township, but where water for household use is desired the search should be confined to the overlying glacial deposits.

Township 6, Range 7

Most of the ground water supply in this township is derived from the glacial drift. A few wells have passed through the drift to obtain water in the underlying Bearpaw formation. In general the water supply is adequate for local requirements.

McDonald creek crosses the southern sections of the area and Recent stream deposits occur in the valley in the vicinity of the creek. Water supplies should be obtainable from shallow wells striking sands or gravels interbedded in the silts that form the greater amount of these deposits.

Glacial deposits of three types are found covering the bedrock throughout the township. The lowland in the southeast and along the southern part of the township is covered by glacial lake deposits composed largely of clays. A few of the shallower wells have tapped sand and gravel pockets interspersed through the clay. The majority of the wells in this lowland area have been sunk through the lake clays into beds of sands and gravels that underlie the clays to form a more or less general water-bearing horizon. These wells vary in depth, depending upon the thickness of the overlying clay, but are generally between 15 and 35 feet deep. With the exception of the well on section 11, the water from all the wells is of good quality and supplies are ample for 10 to 30 head of stock. On section 2, a well 30 feet deep is obtaining water from the clay. This water is satisfactory for stock use, but is not usable for domestic purposes. It is unlikely that there will be any difficulty in obtaining further water supplies at shallow depths in the area of the lake clays.

Glacial moraine consisting of sandy clay interspersed with sand and gravel pockets, occurs in the northwest corner of the township. A well dug on section 29 is the only one that has as yet been sunk in this region. The well taps a gravel pocket at a depth of 10 feet and yields a supply of good water adequate for 80 head of stock. Due to the heterogeneous mixture of the deposits individual aquifers do not extend over large areas, but moderate supplies of water of good quality should be found in other places within the area of the moraine.

The remainder of the township is mantled by glacial boulder clay, or till. Good water supplies are also obtained in the area from sand and gravel pockets which are tapped at depths ranging from 10 to 50 feet. Water from the well on section 20 is too highly mineralized for household use, but is suitable for stock. All other wells now producing from the till yield a drinkable water. A well on section 18 and another on section 26 give only small supplies, but from other wells the yield is sufficient for 20 to 76 head of stock.

Five wells in the township have been sunk through the overlying drift and have penetrated the Bearpaw formation at depths ranging from 28 to 60 feet from the surface. The water supplies obtained from individual wells are sufficient for 10 to 30 head of stock. The water has a high content of dissolved mineral salts, and two wells yield water that is unsuited for domestic use. Evidently the Bearpaw formation is not productive at all points in the township, as a hole dug 95 feet deep on section

19 failed to obtain water. Since the glacial deposits throughout the greater part of the township appear to be water-bearing it is advisable to test them thoroughly before sinking deeper wells to the Bearpaw formation. In isolated localities the drift may be too thin to serve as reservoirs for any large amounts of water, in which case the deeper wells become necessary. It is improbable that the Bearpaw formation, due to its impervious nature at depth, will yield more than small seepages of highly mineralized water at depths exceeding 75 feet from the surface in any part of the area.

Township 6, Range 8

Both the glacial drift and the underlying Bearpaw formation are sources of ground water in this township. Recent stream deposits occur close to McDonald creek in the southeast corner of the township, and would probably yield water if shallow wells were dug into them. The greater part of the valley bottom in this corner is covered by glacial lake deposits. Similar deposits are found in the northwest corner of the township. The clays themselves yield very little water, but the sand and gravel lenses that occur below the clays have proved to be good water producers. Wells 18 to 32 feet deep in this area encounter the pockets and yield supplies of good water in quantities sufficient in each case for at least 10 head of stock.

As shown on the map, Figure 1, a belt of moraine about 2 miles wide extends from the northeast corner to the southwestern corner of the township. Such a deposit although composed largely of boulder clay includes numerous sand and gravel pockets and is generally considered as being a fairly good source of ground water. Only a few wells have been sunk in this part of the township. The water has been found in sand at depths of 15 to 25 feet in each well. The water is generally of good quality. Wells located on the

NW.$\frac{1}{4}$, section 15, and the NW.$\frac{1}{4}$, section 23, yield only small supplies, but the well on section 9 produces enough water for 26 head of stock. Fairly good supplies should be readily located throughout the area of moraine. In some places several test holes may be necessary, as the individual aquifers are by no means continuous over large areas. The remainder of the township is covered by glacial till. Very little water will be found in the boulder clay, but sand and gravel pockets which occur sparingly in the clay will contain water. Most of the wells in the till covered areas have passed through the drift and are drawing their water from the bedrock. However, a few wells are receiving small supplies from the clay and others have tapped sand or gravel pockets and contain better supplies. Doubtless other similar reservoirs could be located by testing within 45 feet of the ground surface. The quality of the water is good but the quantity available is variable, some wells producing only sufficient water for household use. One well sunk on the NW.$\frac{1}{4}$, section 18, supplies 45 head of stock. On section 35 the water in a well 20 feet deep rises above the ground level, due to hydrostatic pressure.

The Bearpaw formation that underlies the glacial deposits throughout the township has been penetrated by wells at various points, at depths ranging from 27 to 90 feet. Much of the water, particularly from the deeper wells, is of very poor quality due to the presence of excessive amounts of dissolved mineral salts and in some instances cannot be used even for stock watering. The quantities of water found is variable. Several wells yield sufficient water for local stock requirements, whereas others yield only small seepages. Thorough testing for water in the glacial deposits is advised before extending wells to greater depths into the Bearpaw formation.

Township 6, Range 9

Ground water conditions vary considerably within this township. From approximately one-half of the wells satisfactory supplies are obtained, whereas from the others either the supply is inadequate or the water is of poor quality. Wells in which poor water conditions have been found are not confined to any definite areas, but rather are scattered throughout the township. Three types of glacial deposits constitute the surface covering over the township. The distribution of the different types is shown on the municipality map (Figure 1). Glacial lake deposits cover an area of approximately 3 square miles in the northeast corner of the township. A well on the SE.$\frac{1}{4}$ section 35, is the only one deriving water from these deposits, as the other wells in this locality are deeper and derive their supplies from the underlying Bearpaw formation. This well is 16 feet deep and draws a supply of good water, sufficient for 15 head of stock, from a sand bed. Evidence found in adjoining townships suggests that similar beds of sand or gravel will be found immediately below the lake clays at depths not exceeding 35 to 40 feet in this part of the township.

Deposits of moraine cover a narrow strip of land extending from sections 29 and 30 southward to section 8 and thence eastward to sections 12 and 13. These deposits are usually found to consist of sandy clays in which occur pockets of water-bearing sands and gravels. Little testing has been done in the areas, so that definite information is lacking. Wells dug on sections 3 and 9 are believed to derive their supplies from porous beds in the moraine. A good supply is obtained from the well on the NE.$\frac{1}{4}$, section 9, but the water from the other well on this section is "alkaline" and unsuitable for drinking. A small amount of testing in the moraine covered area should reveal moderately large water supplies at depths within 40 feet of the surface.

A number of wells are deriving water from the sand and gravels which occur sparingly in the glacial till covering the remaining parts of the township. These aquifers have been found at depths ranging from 14 to 30 feet and generally yield good water. Individual wells supply sufficient water for at least 15 head of stock. A well on section 28 gives a supply which is more than sufficient for 22 head of stock, but the water is of poor quality and cannot be used for the household. Smaller supplies are obtained from wells that do not strike definite sand or gravel aquifers. In some places the water contains dissolved mineral salts in such concentrations that the water is useless for any farm purposes. Although the sand and gravel pockets are not numerous in the till it is probable that small to moderately large supplies of water could be obtained from aquifers that are yet untapped. A number of test holes may be sunk, however, before an aquifer is found. Testing should not be carried deeper than 35 feet. The bottoms of slopes, low knolls and ridges, and coulée bottoms have all proved to be suitable well sites at many farms.

Six wells in the township are deriving water from the Bearpaw formation which underlies the glacial drift throughout the township at depths ranging from 40 to 50 feet. Clays and shales in which occur thin beds of sand form the aquifers. Supplies from individual wells are ample for 10 to 20 head of stock, but the water from four wells is too highly mineralized to be used for stock. The water from the other two wells also has a high mineral content but it is used for domestic purposes and for stock. Neither larger supplies nor water of better quality can be expected by drilling to greater depths in the Bearpaw formation. It is advisable to carry out exhaustive tests in the glacial drift before digging into the underlying bedrock.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF MANKOTA, NO. 45, SASKATCHEWAN

Township	4	4	4	5	5	5	6	6	6	Total No. in Municapility
West of 3rd mer. Range	7	8	9	7	8	9	7	8	9	
Total No. of Wells in Township	25	46	24	33	34	49	33	35	39	318
No. of wells in bedrock	12	31	19	2	6	14	5	11	6	106
No. of wells in glacial drift	12	15	5	31	28	35	28	24	33	211
No. of wells in alluvium	1	0	0	0	0	0	0	0	0	1
Permanency of Water Supply										
No. with permanent supply	25	35	23	32	33	49	32	34	39	302
No. with intermittent supply	0	0	0	0	0	0	0	1	0	1
No. dry holes	0	11	1	1	1	0	1	0	0	15
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	1	0	1
No. of non-flowing artesian wells	5	1	0	10	8	11	9	12	15	71
No. of non-artesian wells	20	34	23	22	25	38	23	22	24	231
Quality of Water										
No. with hard water	24	26	16	26	30	37	28	29	36	252
No. with soft water	1	9	7	6	3	12	4	6	3	51
No. with salty water	0	0	0	1	0	0	0	0	2	3
No. with "alkaline" water	9	2	2	7	7	20	16	17	20	100
Depths of Wells										
No. from 0 to 50 feet deep	23	31	22	29	30	45	29	32	39	280
No. from 51 to 100 feet deep	2	15	2	3	4	4	4	3	0	37
No. from 101 to 150 feet deep	0	0	0	1	0	0	0	0	0	1
No. from 151 to 200 feet deep	0	0	0	0	0	0	0	0	0	0
No. from 201 to 500 feet deep	0	0	0	0	0	0	0	0	0	0
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
How the water is used										
No. usable for domestic purposes	20	32	23	28	26	29	24	21	26	229
No. not usable for domestic purposes	5	3	0	4	7	20	8	14	13	74
No. usable for stock	24	34	23	32	29	41	32	30	29	274
No. not usable for stock	1	1	0	0	4	8	0	5	10	29
Sufficiency of Water Supply										
No. sufficient for domestic needs	25	34	23	32	33	49	32	34	39	301
No. insufficient for domestic needs	0	1	0	0	0	0	0	1	0	2
No. sufficient for stock needs	22	26	18	27	22	37	27	26	33	238
No. insufficient for stock needs	3	9	5	5	11	12	5	9	6	65

ANALYSES AND QUALITY OF WATER

General Statement

Samples of water from representative wells in surface deposits and bedrock were taken for analyses. Except as otherwise stated in the table of analyses the samples were analysed in the laboratory of the Borings Division of the Geological Survey by the usual standard methods. The quantities of the following constituents were determined; total dissolved mineral solids, calcium oxide, magnesium oxide, sodium oxide by difference, sulphate, chloride, and alkalinity. The alkalinity referred to here is the calcium carbonate equivalent of all acid used in neutralizing the carbonates of sodium, calcium, and magnesium. The results of the analyses are given in parts per million--that is, parts by weight of the constituents in 1,000,000 parts of water; for example, 1 ounce of material dissolved in 10 gallons of water is equal to 625 parts per million. The samples were not examined for bacteria, and thus a water that may be termed suitable for use on the basis of its mineral salt content might be condemned on account of its bacteria content. Waters that are high in bacteria content have usually been polluted by surface waters.

Total Dissolved Mineral Solids

The term "total dissolved mineral solids" as here used refers to the residue remaining when a sample of water is evaporated to dryness. It is generally considered that waters that have less than 1,000 parts per million of dissolved solids are suitable for ordinary uses, but in the Prairie Provinces this figure is often exceeded. Nearly all waters that contain more than 1,000 parts per million of total solids have a taste due to the dissolved mineral matter. Residents accustomed to the waters may use those that have much more than 1,000 parts per million of dissolved solids without any marked inconvenience, although most persons not used to highly mineralized water would find such waters highly objectionable.

Mineral Substances Present

Calcium and Magnesium

The calcium (Ca) and magnesium (Mg) content of water is dissolved from rocks and soils, but mostly from limestone, dolomite, and gypsum. The calcium and magnesium salts impart hardness to water. The magnesium salts are laxative, especially magnesium sulphate (Epsom salts, $MgSO_4$), and they are more detrimental to health than the lime or calcium salts. The calcium salts have no laxative or other deleterious effects. The scale found on the inside of steam boilers and tea-kettles is formed from these mineral salts.

Sodium

The salts of sodium are next in importance to those of calcium and magnesium. Of these, sodium sulphate (Glauber's salt, Na_2SO_4) is usually in excess of sodium chloride (common salt, NaCl). These sodium salts are dissolved from rocks and soils. When there is a large amount of sodium sulphate present the water is laxative and unfit for domestic use. Sodium carbonate (Na_2CO_3) "black alkali", sodium sulphate "white alkali", and sodium chloride are injurious to vegetation.

Sulphates

Sulphates (SO_4) are one of the common constituents of natural water. The sulphate salts most commonly found are sodium sulphate, magnesium sulphate, and calcium sulphate ($CaSO_4$). When the water contains large quantities of the sulphate of sodium it is injurious to vegetation.

Chlorides

Chlorides are common constituents of all natural water and are dissolved in small quantities from rocks. They usually occur as sodium chloride and if the quantity of salt is much over 400 parts per million the water has a brackish taste.

Iron

Iron (Fe) is dissolved from many rocks and the surface deposits derived from them, and also from well casings, water pipes, and other fixtures. More than 0.1 part per million of iron in solution will settle as a red precipitate upon exposure to the air. A water that contains a considerable amount of iron will stain porcelain, enamelled ware, and clothing that is washed in it, and when used for drinking purposes has a tendency to cause constipation, but the iron can be almost completely removed by aeration and filtration of the water.

Hardness

Calcium and magnesium salts impart hardness to water. Hardness of water is commonly recognized by its soap-destroying powers as shown by the difficulty of obtaining lather with soap. The total hardness of a water is the hardness of the water in its original state. Total hardness is divided into "permanent hardness" and "temporary hardness". Permanent hardness is the hardness of the water remaining after the sample has been boiled and it represents the amount of mineral salts that cannot be removed by boiling. Temporary hardness is the difference between the total hardness and the permanent hardness and represents the amount of mineral salts that can be removed by boiling. Temporary hardness is due mainly to the bicarbonates of calcium and magnesium and iron, and permanent harness to the sulphates and chlorides of calcium and magnesium. The permanent hardness can be partly eliminated by adding simple chemical softeners such as ammonia or sodium carbonate, or many prepared softeners. Water that contains a large amount of sodium carbonate and small amounts of calcium and magnesium salts is soft, but if the calcium and magnesium salts are present in large amounts the water is hard. Water that has a total hardness of 300 parts per million or more is usually classed as excessively hard. Many of the Saskatchewan water samples have a total hardness greatly in excess of 300 parts per million; when the total hardness exceeded 3,000 parts per million no exact hardness determination was made. Also no determination for temporary hardness was made on waters having a total hardness less than 50 parts per million. As the determinations of the soap hardness in some cases were made after the samples had been stored for some time, the temporary hardness of some of the waters as they come from the wells probably is higher than that given in the table of analyses.

Analyses of Water Samples from the Municipality of Mankota, No. 45, Saskatchewan

LOCATION						Depth of Well, Ft.	Total dis'vd solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS								Source of Water
No.	Qtr.	Sec.	Tp.	Rge.	Mer.			Total	Perm.	Temp.	Cl.	Alkalinity	CaO	MgO	SO_4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	
1	SE	33	4	8	3	40	2,980	1,800	1,700	100	43	370	380	382	1,790	417	2,869	370	420		1,138		870	71	x2
2	SW	36	5	7	3	30	1,120												(2)		(4)	(3)	(1)	(5)	x1
3	SE	16	6	7	3	27	1,763												(1)		(2)	(3)		(4)	x1
4	NE	1	6	8	3	23	1,500																		x1
5	NE	34	6	8	3	27	8,060	3,000+	3,000+	n.d.	85	365	1,630	637	4,863	654	7,203	365	3,462		1,902		1,334	140	x2

Water samples indicated thus, x1, are from glacial drift.
Water samples indicated thus, x2, are from bedrock, Bearpaw formation.
Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5) are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water.
Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).
Analyses Nos. 2,3, and 4, by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

The ground water derived from the Recent deposits bordering the creeks resembles to a large extent waters from the creek itself. This is particularly true of supplies from the gravels and coarse sand beds. The water is generally hard and suitable for drinking. A much higher concentration of dissolved mineral salts, largely sulphates, is noted in places where the water is derived from the fine-grained silts rather than the more porous beds. Such conditions were noted in the well located on SE.$\frac{1}{4}$, sec. 36, tp. 4, range 7. In general, however, the stream deposits both along the larger creeks and in the coulées yield water that is suitable for domestic use. Water in shallow wells in coulées is readily contaminated by sewage or decaying organic matter, which is allowed to accumulate in the vicinity of the well and is carried into it by surface waters.

Considerable variations in the character of the different types of glacial deposits occurring in the municipality are noted in very small areas. Correspondingly large variations are to be expected in the qualities of the ground waters found over these areas. Water in gravel or coarse sand beds at very shallow depths is in some places quite soft. This is to be expected as the water percolating down from the surface has had little opportunity to take any large amount of mineral salts into solution. At greater depths in the drift the dissolved mineral salt content increases. Supplies derived as seepages from boulder clay or from porous beds of limited areal extent at depths below 30 feet in many places are so highly charged with mineral salts in solution as to be unfit for either household or stock use. Glauber's salt (Na_2SO_4) is generally present in the greatest amounts. Epsom salts ($MgSO_4$) is another common constituent of the total dissolved solids. Water from more extensive beds of sands and gravels is less highly mineralized. Analyses 2, 3, and 4, on the accompanying table, are representative of the more general characteristics of water derived from the drift. The total solid content averages approximately 1,400 parts per million. The sulphates of sodium, calcium, and magnesium form the greater part of these totals. Such waters may prove to be laxative to persons unaccustomed to their use and are reported to have an "alkaline" taste. Common salt is recorded as being present in samples 2 and 3, but is not in sufficient concentration to give the water a distinctly salty taste. Water from the lake clay resembles water from the boulder clay in that it contains a high concentration of mineral salts. Porous sandy beds are common in the lake clays, however, and yield water of better quality. The water from the gravels beneath the clay is hard and not highly mineralized and hence in nearly all cases is of suitable quality for household use.

Water from the Bedrock

No samples of ground water were taken from any of the four wells known to be deriving their supply from the Ravenscrag formation. Of these wells the two shallower ones are reported to yield hard water, whereas the water from two deeper wells is soft. These findings are in keeping with water conditions found in the Ravenscrag formation generally throughout the southern municipalities. Water in the upper beds has seeped downward through the drift from which it has dissolved mineral salts, particularly sulphates. The water, therefore, is hard and may be "alkaline". At greater depths changes in the chemical composition of the mineral salts is believed to take place after a period of time, and some of the sodium sulphate is changed over to the carbonate form causing the water to be soft and in some places quite highly charged with "soda", giving the water a flat taste. Such conditions are expected to prevail generally through the Ravenscrag of this municipality, although exceptions to this general relationship regarding depth and character of the water are by no means uncommon.

The characteristics of the water from the Eastend formation in this district are not known, as no water is being obtained from the formation. Two samples of water taken from wells in the municipality to the east show appreciable differences in the composition of the dissolved mineral salts. Both waters contain considerable amounts of sodium carbonate in solution, but one sample showed a high sulphate content and was much harder than the other.

Ground water from the Bearpaw formation is generally highly mineralized and resembles in character the small seepages of water derived from the compact boulder clay of the glacial drift. It is presumed that surface water percolating downward through the drift takes mineral salts into solution and these become concentrated in the more porous beds of the underlying Bearpaw formation. Sand beds are more common in the Bearpaw in the southern townships than in the northern parts of the municipality. The sand beds are believed to contain lesser amounts of dissolvable mineral salts than the shales. Analyses 1 and 5 are both of waters from the Bearpaw formation. It will be noted that both the type and relative amounts of the individual salts present in solution in the two waters are similar. The first analysis is considered to be typical of the waters from the sandy beds of the formation. This water is very hard. It would undoubtedly prove to be laxative to persons unaccustomed to its use, due to the high concentration of Epsom salts ($MgSO_4$) and Glauber's salt (Na_2SO_4) present. Such waters should not be used for drinking if supplies of better quality are within reasonable hauling distance. This water could be used for stock watering, and during periods when dry fodder is being fed the laxative effect of the water is not particularly harmful. The second analysis if of water derived from the shale in NE.$\frac{1}{4}$, sec. 34, tp. 6, range 8. This water is unfit for either household or stock use since it contains 8,060 parts per million of dissolved mineral salts. The water is excessively hard, the hardness being in excess of 3,000 parts per million. Calcium sulphate ($CaSO_4$), magnesium sulphate ($MgSO_4$), and sodium sulphate ($NaSO_4$) are the predominant salts present in solution. The presence of calcium sulphate is not in itself detrimental to man or animals, but contributes largely to the hardness of the waters. The other two sulphates, particularly $MgSO_4$, cause the decided laxative effect which this water has. This latter water is probably more highly mineralized than is general even in the shale. It is improbable, however, that should water be found at greater depths in the shale it will be of appreciably better quality.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (−) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	NE.	5	4	7	3	Dug	20	2,800	− 16	2,784	20	2,780	Bearpaw sand	Hard, slightly "alkaline", clear		D, S	Sufficient for 15 head stock.
2	SE.	6	"	"	"	Dug	8	2,710	− 2	2,708	5	2,705	Glacial gravel	Hard, clear		D, S	Only sufficient for 6 head stock.
3	NE.	8	"	"	"	Dug	30	2,790	− 26	2,764	30	2,760	Bearpaw clay	Hard, "alkaline", clear		D, S	Sufficient for 15 head stock.
4	NW.	10	"	"	"	Dug	11	2,840	− 5	2,835	5	2,835	Glacial clay	Hard, clear		D, S	Sufficient for 15 head stock.
5	SE.	12	"	"	"	Bored	63	2,935	− 43	2,892	63	2,872	Ravenscrag sand	Soft, clear		D, S	Sufficient for 25 head stock. A number of springs in the coulée.
6	SW.	15	"	"	"	Dug	15	2,845	− 10	2,835	10	2,835	Glacial clay	Hard, clear		D, S	Sufficient for 10 head stock. Second 16-foot well with "alkaline" water.
7	SE.	17	"	"	"	Dug	30	2,794	− 27	2,767	27	2,767	Bearpaw clay	Hard, "alkaline"		S	Only sufficient for 6 head stock. Second similar well used for stock.
8	SE.	19	"	"	"	Bored	16	2,600	− 12	2,588	14	2,586	Glacialsand, gravel	Hard, clear		D, S	Sufficient for 32 head stock.
9	SW.	22	"	"	"	Bored	90	2,800	− 74	2,726	90	2,710	Bearpaw shale	Hard, clear, slightly "alkaline"		D, S	Sufficient for 15 head stock. A second well.
10	NW.	25	"	"	"	Dug	25	2,625	− 15	2,610	24	2,601	Glacial gravel	Hard, clear		D, S	Sufficient for 10 head stock. Spring in coulée used for stock.
11	SW.	30	"	"	"	Bored	28	2,580	− 10	2,570	25	2,555	Glacial gravel	Hard, clear		D, S	Sufficient for 70 head stock. Second well.
12	NE.	33	"	"	"	Dug	22	2,655	− 12	2,643	16	2,639	Bearpaw clay	Hard, clear		D, S	Sufficient for 15 head stock
13	SW.	34	"	"	"	Dug	8	2,710	− 2	2,708	6	2,704	Glacial gravel	Hard, clear		D, S	Sufficient supply.
14	SE.	36	"	"	"	Dug	14	2,582	− 6	2,576			Recent alluvial clay	Hard, "alkaline"		S	Sufficient for 40 head stock.
1	NE.	1	4	8	3	Bored	55	2,730	− 22	2,708	36	2,694	Glacial gravel	Soft, clear		D	Insufficient supply.
2	NE.	1	"	"	"	Bored	100	2,730					Bearpaw shale?				Seven dry holes 100 feet deep.
3	NE.	9	"	"	"	Dug	20	2,830	− 4	2,826	20	2,810	Bearpaw sands?	Hard, clear		D, S	Sufficient for 20 head stock. Several similar wells.
4	SW.	15	"	"	"	Dug	22	2,825	− 10	2,815	20	2,805	Glacial sand	Soft, clear		D, S	Sufficient supply; a second similar well.
5	SE.	18	"	"	"	Bored	38	2,880	− 36	2,844	38	2,842	Bearpaw sand	Hard, clear		D, S	Insufficient alone, but second 15-foot well gives adequate supply.
6	NE.	18	"	"	"	Bored	45	2,824	− 35	2,789	35	2,789	Glacial gravel	Hard, "alkaline"#		D, S	Sufficient for 20 head stock.
7	NW.	20	"	"	"	Bored	25	2,748	− 12	2,736	12	2,736	Bearpaw sand	Hard, clear		D, S	Sufficient for 30 head stock, Second well gives large supply.
8	SE.	20	"	"	"	Bored	32	2,770	− 18	2,752	18	2,752	Glacial gravel	Hard, clear		D	Insufficient alone, but springs and second well in coulée are enough.
9	SW.	22	"	"	"	Bored	60	2,738	− 51	2,687	51	2,687	Glacial gravel	Hard, clear		D, S	Sufficient for 30 head stock.
10	NW.	22	"	"	"	Bored	35	2,724	− 28	2,696	35	2,689	Bearpaw clay	Hard, clear, iron		S	Only sufficient for 15 head stock. Second seepage well for house.
11	NW.	24	"	"	"	Dug	8	2,620	− 2	2,618	4	2,616	Bearpaw sand	Hard, iron, clear		D, S	Sufficient for 25 head stock. Second similar well.
12	SE.	26	"	"	"	Bored	100						Bearpaw sandstone				Several dry holes.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
13	SW.	27	4	8	3	Bored	57	2,692	- 45	2,647	57	2,635	Bearpaw shale?	Hard		N	Poor quality water.
14	SW.	30	"	"	"	Spring	1	2,730	0	2,730	1	2,729	Bearpaw sand	Soft, clear		D	Sufficient for local needs.
15	SE.	30	"	"	"	Spring	1						Bearpaw sand	Soft, clear		D, S	Supplies 40 head stock.
16	NW.	31	"	"	"	Bored	60	2,830	- 53	2,777	60	2,770	Bearpaw sand	Hard, clear		N	Fair supply.
17	SE.	33	"	"	"	Bored	40	2,710	- 20	2,690	40	2,670	Bearpaw clay	Hard, "alkaline"		S	Sufficient for 110 head stock. #. Unfit for domestic use.
18	NE.	33	"	"	"	Dug	15	2,770	- 9	2,761	9	2,761	Glacial gravel	Soft, clear		D, S	Insufficient supply.
19	SE.	36	"	"	"	Dug	24	2,610	- 12	2,598	12	2,598	Glacial gravel	Hard, clear		D, S	Only sufficient for 6 head stock. Second well is 42 feet deep in sand.
1	SE.	4	4	9	3	Bored	56	3,085	- 36	3,049	36	3,049	Glacial gravel	Soft, clear		D, S	Sufficient for 50 head stock.
2	SW.	10	"	"	"	Spring							Glacial sand	Soft		S	
3	NW.	14	"	"	"	Dug	18	2,940	- 12	2,928			Bearpaw clay	Hard, clear		D, S	Sufficient for 20 head stock.
4	NW.	14	"	"	"	Dug	60	2,940					Bearpaw sand				Small supply.
5	SW.	21	"	"	"	Dug	12	2,970	- 2	2,968			Ravenscrag clay	Hard, clear		D, S	Only sufficient for 8 head stock. Second similar well used for stock.
6	SE.	21	"	"	"	Dug	22	2,975	- 19	2,956	19	2,956	Ravenscrag (?) sand	Soft, clear		D, S	Sufficient supply.
7	SE.	24	"	"	"	Bored	31	2,818	- 28	2,790	31	2,787	Bearpaw sand	Soft, clear		D, S	Only sufficient for 25 head stock.
8	NW.	26	"	"	"	Spring	5	2,790	0	2,790	2	2,788	Bearpaw sand	Hard, clear		D, S	Sufficient for 15 head stock.
9	NW.	30	"	"	"	Dug	15	3,050	- 11	3,039			Ravenscrag sandy clay	Hard, clear		D, S	Sufficient for 35 head stock.
10	SW.	32	"	"	"	Bored	42	2,875	- 26	2,849	26	2,849	Bearpaw sand	Hard, clear		D, S	Sufficient for 25 head stock.
11	NE.	33	"	"	"	Dug	12	2,840	- 9	2,831	9	2,831	Bearpaw sand	Hard, "alkaline"		D, S	Sufficient for 20 head stock.
12	NE.	33	"	"	"	Dug	20	2,840					Bearpaw clay				Dry hole.
13	NW.	34	"	"	"	Dug	12	2,820	- 6	2,814	6	2,814	Bearpaw sand	Hard, clear, "alkaline"		D, S	Sufficient; spring in coulée used for stock.
14	SE.	34	"	"	"	Dug	22	2,806	- 15	2,791	19	2,787	Bearpaw sand	Hard, clear		D, S	Sufficient for 8 head stock only.
15	SW.	35	"	"	"	Bored	13	2,795	- 10	2,785	7	2,788	Bearpaw sand	Hard, clear		D, S	Sufficient for local needs.
1	SW.	2	5	7	3	Dug	20	2,590	- 16	2,574	20	2,570	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
2	SW.	3	"	"	"	Dug	6	2,620	0	2,620	3	2,617	Glacial sand	Hard, clear		D, S	100 head stock watered in normal years.
3	NW.	3	"	"	"	Bored	25	2,560	- 5	2,555			Glacial clay	Hard, clear		D, S	Sufficient for local needs.
4	NW.	5	"	"	"	Dug	18	2,527	- 14	2,513	15	2,512	Glacial gravel	Hard, "alkaline" clear		D, S	Sufficient for local needs.
5	SW.	6	"	"	"	Bored	26	2,610	- 20	2,590	22	2,588	Glacial gravel	Hard, clear		S	Sufficient for 20 head stock. Unfit for humans.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
6	SE.	7	5	7	3	Bored	28	2,592	- 23	2,569	28	2,564	Glacial gravel	Hard, clear		D, S	Waters 16 head stock.
7	SE.	8	"	"	"	Bored	32	2,518	- 16	2,502	21	2,497	Glacial clay	Hard, clear		D, S	Sufficient for local needs.
8	NW.	13	"	"	"	Dug	12	2,515	- 9	2,506	11	2,504	Glacial sand	Hard, "alkaline"		D, S	Sufficient for local needs.
9	SE.	17	"	"	"	Dug	30	2,570	- 28	2,542	28	2,542	Glacial gravel	Hard, clear		D, S	Insufficient in dry years.
10	SW.	17	"	"	"	Dug	55	2,612	- 52	2,560	51	2,561	Glacial gravel	Hard, clear		D, S	Sufficient for 30 head stock. Second similar well used also.
11	SW.	18	"	"	"	Bored	35	2,690	- 27	2,663	29	2,661	Glacial gravel	Soft, clear		D, S	Sufficient for local needs.
12	NW.	18	"	"	"	Bored	25	2,700	- 10	2,690	18	2,682	Glacial gravel	Soft, clear		D, S	Sufficient supply; second similar well.
13	NE.	19	"	"	"	Bored	36	2,625	- 16	2,609			Glacial drift	Hard, clear		D, S	Insufficient in dry years.
14	NW.	20	"	"	"	Bored	42	2,634	- 30	2,604	42	2,592	Bearpaw clay	Hard, iron clear		D, S	Sufficient for 25 head stock.
15	NW.	22	"	"	"	Bored	64	2,565	- 56	2,509	64	2,501	Glacial gravel	Hard, clear		S	Sufficient for 100 head stock; has two other shallow wells.
16	NE.	22	"	"	"	Bored	40	2,526	- 32	2,494	40	2,486	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
17	NE.	23	"	"	"	Bored	18	2,505	- 8	2,497	18	2,487	Glacial clay?	Hard, clear, "alkaline"		S	Sufficient for 15 head stock; a 6-foot well for house use.
18	NW.	24	"	"	"	Dug	14	2,505	- 10	2,495	9	2,496	Glacial gravel, clay	Hard, clear, slightly "alkaline"		D, S	Sufficient for 17 head stock.
19	SW.	27	"	"	"	Bored	30	2,550	- 15	2,535	30	2,520	Glacial clay	Hard, "alkaline"		D, S	Sufficient for 6 head stock.
20	NW.	28	"	"	"	Bored	40	2,555	- 30	2,525	30	2,525	Glacial drift(?)	Hard, clear, iron taste		D, S	Sufficient for 15 head stock.
21	SE.	29	"	"	"	Spring		2,548					Glacial drift	Soft, clear		S	Flows continually; supplies 50 head stock.
22	SE.	30	"	"	"	Bored	50	2,660	- 15	2,645	50	2,610	Glacial sand	Hard, clear		D, S	Sufficient for 25 head stock; second 35-foot well has good supply.
23	SW.	30	"	"	"	Bored	30	2,740	- 9	2,731	28	2,712	Glacial gravel	Soft, clear		S	Sufficient for local stock needs.
24	SE.	31	"	"	"	Bored	112	2,665					Bearpaw				Dry hole.
25	SE.	34	"	"	"	Bored	40	2,495	- 28	2,467	40	2,455	Glacial gravel	Hard, slightly "alkaline"		D, S	Large supply.
26	SE.	35	"	"	"	Bored	37	2,466	- 17	2,449	23	2,443	Glacial gravel	Hard, clear, slightly "alkaline"		D, S	Sufficient for 28 head stock.
27	SW.	36	"	"	"	Bored	30	2,459	- 15	2,444	15	2,444	Glacial sandy clay	Hard, clear		D	Sufficient for domestic use. #.
1	SE.	1	5	8	3	Dug	12	2,604	- 8	2,596	8	2,596	Glacial gravel	Hard, clear		D, S	Sufficient supply.
2	SE.	4	"	"	"	Bored	30	2,820	- 24	2,796	25	2,795	Glacial gravel	Hard, clear		D, S	Sufficient for 100 head stock.
3	NW.	5	"	"	"	Bored	43	2,758	- 33	2,725	43	2,715	Glacial sand	Hard, clear		D, S	Only sufficient for 4 head stock; second similar well used for stock.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
4	SE.	6	5	8	3	Bored	40	2,760	− 30	2,730	40	2,720	Glacial sand	Hard, clear		D, S	Insufficient for 21 head stock.
5	SE.	7	"	"	"	Bored	14	2,810	− 6	2,804	14	2,796	Glacial clay	Hard, clear		D,	Sufficient only for house use.
6	NE.	9	"	"	"	Dug	55	2,820	− 35	2,785	52	2,768	Bearpaw clay	Hard, "alkaline"		N	Unfit for use; second seepage well.
7	NW.	10	"	"	"	Dug	30	2,828	− 24	2,804	30	2,798	Glacial clay	Hard, clear		D, S	Only sufficient for 8 head stock.
8	NE.	13	"	"	"	Spring		2,718	0	2,718			Glacial drift	Soft, clear		D, S	Sufficient supply; flows constantly.
9	SE.	15	"	"	"	Bored	25	2,880	− 15	2,865	25	2,855	Glacial gravel	Hard, clear		D, S	Sufficient for 20 head stock.
10	SW.	20	"	"	"	Dug	35	2,766	− 28	2,738	27	2,739	Bearpaw clay	Hard, clear, "alkaline"		D	Only sufficient for house use; a 25-foot well gave water unfit for use.
11	NE.	22	"	"	"	Bored	75	2,828	− 50	2,778	75	2,753	Glacial sand	Hard, clear		S	Only 3 barrels a day; second 25-foot well supplies house.
12	SW.	23	"	"	"	Bored	32	2,810	− 16	2,794	28	2,782	Glacial sand	Hard, clear		D, S	Fair supply for 11 head stock.
13	NE.	23	"	"	"	Dug	12	2,824	− 7	2,817	12	2,812	Glacial sand, gravel	Soft, clear		D, S	Big supply.
14	SE.	25	"	"	"	Bored	92	2,766	− 86	2,680	92	2,674	Glacial clay	Hard, iron, clear		D, S	Sufficient for 6 horses
15	SW.	27	"	"	"	Spring	3	2,731	0	2,731			Glacial clay	Soft, clear		D	Big supply, furnishing village of Mankota.
16	SE.	28	"	"	"	Dug	40	2,710					Bearpaw soapstone				Dry hole.
17	SW.	30	"	"	"	Bored	40	2,664	− 38	2,626	38	2,626	Bearpaw clay	Hard, "alkaline"		N	Unfit for use.
18	SW.	30	"	"	"	Bored	27	2,652	− 15	2,637	27	2,625	Bearpaw clay	Hard, "alkaline", clear		D, S	Insufficient supply.
19	NW.	30	"	"	"	Bored	40	2,635	− 22	2,613	40	2,595	Glacial clay	Hard, iron, clear, "alkaline"		D, S	Good supply for 65 head stock.
20	NW.	30	"	"	"	Dug	28	2,638	− 22	2,616	22	2,616	Glacial clay	Hard, clear, "alkaline"		D, S	Unfit for drinking.
21	NW.	30	"	"	"	Spring	8	2,610					Glacial sand gravel	Hard, "alkaline", iron, clear		S	Large supply.
22	NW.	31	"	"	"	Dug	22	2,680	− 8	2,672	10	2,670	Glacial gravel	Hard, clear		D, S	Sufficient supply. Three other wells.
23	SW.	34	"	"	"	Bored	39	2,593	− 29	2,564	28	2,565	Glacial sand	Hard, clear		D, S	Only sufficient for 30 head stock.
24	Between 33 & 34		"	"	"	Spring		2,566					Glacial drift	Hard		D	Supply becomes poor in quality in the spring of each year.
25	NE.	36	"	"	"	Bored	45	2,600	− 37	2,563			Glacial drift(?)	Hard, clear		S	Sufficient supply; second 14-foot well with water too highly mineralized for use.
1	NE.	2	5	9	3	Bored	30	2,808	− 15	2,793	15	2,793	Bearpaw sand	Hard, clear		D, S	Sufficient for local needs.
2	SW.	3	"	"	"	Dug	14	2,856	− 12	2,844	12	2,844	Bearpaw sand	Hard, clear		D, S	Sufficient for 15 head stock.
3	SE.	4	"	"	"	Bored	40	2,900	− 20	2,880	22	2,878	Glacial sand	Hard, clear, slightly "alkaline"		D, S	Good supply for 30 head stock; second 30-foot well has small supply.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
4	NW.	4	5	9	3	Bored	30	2,928	− 20	2,908	30	2,898	Glacial clay	Soft, clear		D, S#	Only enough for 6 head stock; second well furnishes inadequate supply.
5	NE.	7	"	"	"	Dug	35	2,916	− 20	2,896	30	2,886	Bearpaw sand	Hard, clear, "alkaline"		D	Sufficient supply, but of poor quality.
6	NW.	7	"	"	"	Bored	30	2,916	− 15	2,901	30	2,886	Bearpaw clay	Hard, iron, "alkaline"		D, S	Sufficient supply but of poor quality for domestic use.
7	SW.	12	"	"	"	Dug	16	2,808	− 13	2,795	13	2,795	Bearpaw sand	Hard, clear		D, S	Sufficient for local needs.
8	NE.	12	"	"	"	Bored	47	2,820	− 35	2,785	37	2,783	Bearpaw clay	Hard, clear, "alkaline"		S	Good supply; Provincial analyst reported the water too highly mineralized for regular stock consumption. Second shallow well.
9	NE.	13	"	"	"	Bored	30	2,788	− 20	2,768			Bearpaw clay	Hard, clear, iron, "alkaline"		S	Sufficient supply; second seepage well for household use.
10	SW.	13	"	"	"	Dug	16	2,818	− 12	2,806	16	2,802	Glacial clay	Soft, clear		D	Only enough for domestic use; second 40-foot well for stock.
11	NE.	14	"	"	"	Dug	16	2,855	− 6	2,849	4	2,851	Glacial sand	Soft, clear		D, S	Sufficient for 12 head stock; second 40-foot well gives water unfit for use.
12	NW.	15	"	"	"	Bored	15	2,770					Glacial clay(?)	Hard, clear, "alkaline"		S	Insufficient in dry years; second well for domestic use .
13	NE.	16	"	"	"	Bored	22	2,790	− 13	2,777	17	2,773	Glacial gravel	Hard, clear, "alkaline"		S	Sufficient for 28 head stock; second similar well for domestic use.
14	NW.	16	"	"	"	Dug	25	2,810	− 10	2,800	21	2,789	Bearpaw clay	Hard, clear		D	Only sufficient for domestic use.
15	SE.	19	"	"	"	Dug	20	2,800	− 16	2,784	15	2,785	Glacial gravel	Hard, clear, "alkaline"		S	Sufficient for 30 head stock.
16	SW.	20	"	"	"	Dug	20	2,812	− 10	2,802	20	2,792	Glacial clay	Hard, clear		D, S	Sufficient for local needs.
17	NE.	20	"	"	"	Bored	24	2,766	− 10	2,756	10	2,756	Glacial gravel	Soft, clear		D, S	More than enough for 14 head stock and two households.
18	NE.	21	"	"	"	Bored	60	2,800	− 30	2,770	60	2,740	Bearpaw soapstone	Hard, red, "alkaline"		S	Large supply; small supply from sand layer at 21 feet.
19	SE.	24	"	"	"	Bored	60	2,790	− 50	2,740	60	2,730	Bearpaw soapstone	Hard, "alkaline"		N	Seepage well and dam supply farm.
20	NE.	24	"	"	"	Dug	20	2,790	− 10	2,780	20	2,770	Glacial clay	Hard, clear		D, S	More than sufficient.
21	NW.	25	"	"	"	Spring		2,638					Glacial gravel	Soft, clear		S	Sufficient for local needs.
22	NW.	25	"	"	"	Dug	7	2,638	0	2,638	4	2,634	Glacial gravel	Soft, clear, slightly "alkaline"		D, S	Large supply for 38 head stock.
23	SE.	27	"	"	"	Bored	50	2,750	− 30	2,720	50	2,700	Glacial clay	Hard, "alkaline" clear		S	Sufficient for 20 head stock.
24	SE.	27	"	"	"	Bored	25	2,750	− 20	2,730	25	2,725	Glacial sand(?)	Hard, clear, iron		D, S	Supplies 20 head stock and two households.
25	NE.	27	"	"	"	Bored	60	2,800	− 20	2,780	60	2,740	Bearpaw soapstone	Hard, clear, iron, "alkaline"		N	Seepage well for stock. Poor quality water obtained in all other attempts.
26	SW.	28	"	"	"	Dug	10	2,800	− 7	2,793	7	2,793	Bearpaw sand	Hard, clear, iron, "alkaline"		S	Sufficient for 10 head stock.
27	SE.	34	"	"	"	Dug	20	2,790	− 17	2,773	2	2,788	Glacial sand	Soft, clear		D, S	Insufficient; second similar well gives poor supply.
1	SW.	1	6	7	3	Bored	50	2,462	− 15	2,447			Glacial drift(?)	Hard, clear		D, S	Good supply.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
2	NW.	2	6	7	3	Bored	30	2,520	- 10	2,510			Glacial clay	Hard, clear, "alkaline"		S	Sufficient for stock; unfit for human consumption.
3	SW.	3	"	"	"	Bored	25	2,500	- 18	2,482	25	2,475	Glacial drift	Hard, "alkaline", clear		D, S	Sufficient for 8 horses.
4	NE.	4	"	"	"	Dug	12	2,520	- 8	2,512	12	2,508	Glacial gravel	Soft, clear,		D, S	Sufficient for local needs.
5	NW.	6	"	"	"	Dug	12	2,535	- 10	2,525	10	2,525	Glacial gravel	Soft, clear		D, S	Sufficient for 30 head stock.
6	SW.	7	"	"	"	Bored	40	2,608	- 30	2,578	34	2,574	Glacial clay	Hard, clear, slightly "alkaline"		D, S	Sufficient for local needs.
7	NE.	8	"	"	"	Bored	52	2,610	- 24	2,586	52	2,558	Glacial clay	Hard, clear		D, S	Sufficient for 30 head stock.
8	NE.	9	"	"	"	Bored	40	2,562	- 32	2,530	40	2,522	Glacial gravel	Hard, clear, slightly "alkaline"		D, S	Sufficient for 39 head stock.
9	NE.	11	"	"	"	Bored	17	2,520	- 4	2,516	4	2,516	Glacial gravel	Hard, clear, slightly "alkaline"		S	Sufficient for local needs.
10	SE.	12	"	"	"	Dug	16	2,450	- 13	2,437	13	2,437	Glacial sand	Hard, clear		S	Sufficient for 20 head stock; second similar well used for house.
11	NE.	12	"	"	"	Bored	25	2,432	- 20	2,412	25	2,407	Glacial sand	Hard, clear, "alkaline"		S	Sufficient supply; seepage well with poor supply used for household.
12	SW.	13	"	"	"	Dug	24	2,510	- 19	2,491	24	2,486	Glacial sand	Hard, clear		D, S	Sufficient for 12 head stock.
13	NE.	14	"	"	"	Bored	36	2,535	- 11	2,524	33	2,502	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
14	NW.	15	"	"	"	Bored	40	2,556	- 20	2,536	38	2,518	Bearpaw clay	Hard, clear, iron, "alkaline"		D, S	Sufficient for 30 head stock.
15	SE.	16	"	"	"	Bored	27	2,548	- 18	2,530	27	2,521	Glacial gravel	Hard, clear		D, S	Excellent supply. #.
16	SW.	18	"	"	"	Bored	20	2,702	- 15	2,687	20	2,682	Glacial sand	Soft, clear		D, S	Insufficient supply.
17	SW.	18	"	"	"	Spring		2,692	0	2,692			Glacial drift	Hard, "alkaline"		S	Sufficient supply; flows continually.
18	NW.	19	"	"	"	Bored	95	2,757					Bearpaw sandstone				Dry hole.
19	SE.	20	"	"	"	Dug	20	2,610	- 17	2,593	17	2,593	Glacial sand	Hard, clear, "alkaline"		S	Sufficient only for 30 head stock.
20	SW.	21	"	"	"	Bored	50	2,590	- 25	2,565	35	2,555	Glacial gravel	Hard, iron, slightly "alkaline", clear		D, S	Sufficient for local needs.
21	SE.	24	"	"	"	Bored	28	2,522	- 12	2,510	20	2,502	Bearpaw sand	Hard, iron, "alkaline", yellow		S	Sufficient for local stock needs.
22	NE.	24	"	"	"	Bored	48	2,532	- 13	2,519	48	2,484	Bearpaw clay	Hard, clear, "alkaline"		D, S	Sufficient for 10 head stock.
23	SE.	25	"	"	"	Bored	60	2,530			60	2,470	Bearpaw soapstone	Hard, "alkaline"		S	Sufficient supply; seepage well used for house.
24	NE.	26	"	"	"	Dug	10	2,520	- 4	2,516	10	2,510	Glacial sand	Hard, clear, "alkaline"		D, S	Varying yield; usually only sufficient for 10 head stock.
25	SE.	27	"	"	"	Dug	17	2,550	- 12	2,538	12	2,538	Glacial gravel	Hard, iron, clear		D, S	Sufficient for 30 head stodk.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
26	SW.	27	6	7	3	Dug	13	2,562	- 7	2,555	13	2,549	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
27	NW.	28	"	"	"	Dug	10	2,638	- 5	2,633			Glacial gravel	Hard, clear		D, S	Insufficient in dry years.
28	NE.	29	"	"	"	Dug	10	2,608	- 2	2,606	2	2,606	Glacial gravel	Hard, clear		D, S	Sufficient for 80 head stock.
29	NE.	36	"	"	"	Bored	51	2,529	- 36	2,493	51	2,478	Glacial gravel	Hard, clear		D, S	Waters 76 head stock in the autumn.
1	NE.	1	6	8	3	Dug	23	2,550	- 19	2,531	20	2,530	Glacial gravel	Soft, clear		D, S	Large supply; #.
2	NE.	1	"	"	"	Dug	22	2,540	- 18	2,522	22	2,518	Glacial sand	Hard, clear		D, S	Sufficient for 15 head stock.
3	NE.	1	"	"	"	Bored	32	2,556	- 28	2,528	32	2,524	Glacial sand	Hard, clear		D	Only sufficient for house use.
4	SW.	1	"	"	"	Spring	3	2,560	0	2,560			Glacial sand	Soft, clear		D	Used only for household.
5	SE.	2	"	"	"	Dug	18	2,560	- 15	2,545	18	2,542	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for 8 head stock.
6	NE.	6	"	"	"	Dug	15	2,810	- 10	2,800	10	2,800	Glacial clay	Hard, clear		D, S	Sufficient for local needs.
7	SW.	6	"	"	"	Bored	30	2,780	- 20	2,760	30	2,750	Glacial clay	Hard, clear, "alkaline"		D, S	Sufficient for 13 head stock.
8	NW.	6	"	"	"	Dug	15	2,776	- 12	2,764	12	2,764	Glacial clay	Hard, clear, bitter, "alkaline"		S	Insufficient supply and of poor quality.
9	SE.	9	"	"	"	Dug	23	2,764	- 5	2,759			Glacial sand	Soft, clear		D, S	Sufficient for 26 head stock.
10	SW.	12	"	"	"	Bored	60	2,632	- 50	2,582			Bearpaw clay	Hard, clear, "alkaline"		S	Supplies 1 barrel an hour; poor quality water.
11	NE.	12	"	"	"	Bored	16	2,700	- 10	2,690			Glacial clay	Hard, clear		D, S	Sufficient for local needs.
12	SW.	15	"	"	"	Bored	24	2,760	- 20	2,740	20	2,740	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
13	NW.	15	"	"	"	Bored	24	2,714	- 9	2,705	24	2,690	Glacial sand	Hard, clear		D, S	Only sufficient for 6 head stock.
14	NW.	18	"	"	"	Dug	28	2,730	- 10	2,720	25	2,705	Glacial gravel	Soft, clear		D, S	Sufficient for 45 head stock.
15	NW.	19	"	"	"	Bored	45	2,620	- 20	2,600	45	2,575	Bearpaw soapstone	Hard, clear, "alkaline"		S	Large supply; second 14-foot well used for household.
16	NW.	22	"	"	"	Bored	42	2,740	- 20	2,720	40	2,700	Glacial gravel	Hard, clear		D, S	Sufficient for 10 head stock.
17	SW.	22	"	"	"	Bored	25	2,740	- 4	2,736			Glacial clay	Hard, clear		D, S	Insufficient in dry years.
18	NW.	23	"	"	"	Bored	26	2,692	- 10	2,682	24	2,668	Glacial sand	Hard, clear, "alkaline"		D, S	Insufficient supply.
19	SE.	24	"	"	"	Bored	40	2,730	- 36	2,694	40	2,690	Glacial sand	Soft, clear		D, S	Sufficient for local needs.
20	NE.	24	"	"	"	Bored	80	2,700			50	2,650	Bearpaw soapstone	Hard, "alkaline"		N	Unfit for use.
21	SW.	27	"	"	"	Bored	40	2,710	- 30	2,680	35	2,675	Bearpaw clay	Hard, yellow, "alkaline"		N	Unfit for use.
22	NW.	27	"	"	"	Bored	45	2,675	- 25	2,650	21	2,654	Bearpaw soapstone	Hard, clear, "alkaline"		S	Sufficient supply but of poor quality.

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WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
23	NW.	31	6	8	3	Bored	46	2,520	− 16	2,504	46	2,474	Bearpaw sand	Hard, clear, "alkaline"		D	Sufficient but of poor quality.
24	NE.	31	"	"	"	Bored	38	2,538	− 13	2,525	38	2,500	Glacial sand	Hard, clear, iron, "alkaline"		N	Sufficient for 10 head stock.
25	SE.	33	"	"	"	Bored	55	2,650	− 39	2,611			Bearpaw clay	Hard, clear, "alkaline"		S	Poor quality of water.
26	SE.	33	"	"	"	Bored	35	2,638	− 19	2,619	35	2,603	Bearpaw sand	Hard, clear, "alkaline"		S	Poor quality of water.
27	SE.	34	"	"	"	Bored	30	2,582	− 15	2,567			Glacial clay	Hard, clear, "alkaline"		S	Sufficient for local stock needs.
28	NE.	34	"	"	"	Bored	27	2,565	− 16	2,549	27	2,538	Bearpaw sand	Hard, clear, "alkaline"		N	Water develops bad odour upon standing; #.
29	NE.	35	"	"	"	Bored	20	2,536	0	2,536	20	2,516	Glacial gravel	Soft, clear		D, S	Sufficient supply; second similar well.
1	NE.	1	6	9	3	Bored	16	2,800	− 6	2,794	6	2,794	Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local stock needs.
2	NW.	3	"	"	"	Bored	35	2,820	− 29	2,791	35	2,785	Glacial drift	Hard, clear, "alkaline"		S	Poor quality water; second well used for household.
3	SE.	4	"	"	"	Dug	14	2,810	− 10	2,800	10	2,800	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for 20 head stock.
4	NE.	6	"	"	"	Dug	19	2,760	− 14	2,746	19	2,741	Glacial sand	Hard, clear		D, S	Sufficient for 15 head stock.
5	SW.	7	"	"	"	Dug	35	2,745	− 20	2,725	35	2,709	Glacial clay	Hard, clear		D, S	Sufficient for local needs.
6	SW.	8	"	"	"	Bored	20	2,795	− 10	2,785	20	2,775	Glacial sand	Soft, clear		D, S	Sufficient for local needs.
7	NW.	9	"	"	"	Dug	18	2,710	− 15	2,695	−10	2,700	Glacial clay	Hard, clear, "alkaline"		D, S	Insufficient supply.
8	NE.	9	"	"	"	Bored	40	2,700	− 10	2,690	10	2,690	Glacial clay	Hard, clear, slightly "alkaline"		D, S	Sufficient for local needs.
9	NW.	14	"	"	"	Bored	40	2,665	− 10	2,655	15	2,650	Glacial clay	Hard, clear, "alkaline"		S	Water of very poor quality.
10	SW.	16	"	"	"	Bored	35	2,684	− 15	2,669	15	2,669	Glacial clay	Hard, clear		D, S	Sufficient for 10 head stock.
11	SW.	18	"	"	"	Bored	30	2,600	− 15	2,585	30	2,570	Glacial drift	Hard, "alkaline"		N	Several similar wells, unfit for use.
12	SW.	21	"	"	"	Bored	45	2,698	− 25	2,673	45	2,653	Bearpaw soapstone	Hard, iron, "alkaline", cloudy		N	Poor supply of water, unfit for use.
13	NE.	21	"	"	"	Bored	40	2,674			40	2,634	Bearpaw(?)	Hard, clear, "alkaline"		D	Sufficient for stock.
14	SE.	22	"	"	"	Bored	28	2,566	− 14	2,552	28	2,538	Glacial sand, gravel	Hard, clear		D	Sufficient for household needs.
15	NE.	22	"	"	"	Dug	14	2,570	− 1	2,569	14	2,556	Glacial sand	Soft, clear		D	Sufficient for household needs.
16	NW.	23	"	"	"	Bored	50	2,525			45	2,480	Bearpaw soapstone	Hard, "alkaline"		N	Water unfit for use; well filled in.
17	SW.	25	"	"	"	Bored	35	2,589	− 21	2,568	31	2,558	Bearpaw soapstone	Hard, clear, "alkaline"		S	Unfit for use.
18	SW.	25	"	"	"	Bored	20	2,589	− 10	2,579	12	2,577	Glacial clay	Hard, clear		D, S	Insufficient supply.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of MANKOTA, NO. 45, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
19	NE.	28	6	9	3	Dug	24	2,600	- 14	2,586	24	2,576	Glacial sand	Hard, clear, "alkaline"		D, S	Good supply for 22 head stock.
20	NE.	31	"	"	"	Dug	22	2,570	- 18	2,552	22	2,548	Glacial clay	Hard, clear, "alkaline"		D, S	Sufficient for 15 head stock.
21	NW.	34	"	"	"	Bored	50	2,582	- 34	2,548	21	2,561	Bearpaw soap-stone	Hard, clear, iron, "alkaline"		D, S	Sufficient for 20 head stock.
22	SE.	34	"	"	"	Bored	20	2,510	- 10	2,500	10	2,500	Glacial clay	Hard, clear		D, S	Sufficient for local needs.
23	NW.	35	"	"	"	Bored	32	2,530	- 14	2,516	32	2,498	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient supply; second seepage well.
24	SE.	35	"	"	"	Dug	16	2,530	- 10	2,520	16	2,514	Glacial sand	Hard, clear		D, S	Sufficient for 15 head stock.
25	SW.	36	"	"	"	Bored	40	2,520	- 30	2,490	40	2,480	Bearpaw shale(?)	Hard, salty, dark, "alkaline"		N	Unfit for use; two other wells give fair supply.

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(#) Sample taken for analysis.