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DEPARTMENT OF MINES

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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF LAKE ALMA No. 8 SASKATCHEWAN

BY

B.R.MacKay, H. H. Beach & J. M. Cameron

Water Supply Paper No. 41

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GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF LAKE ALMA, NO. 8, SASKATCHEWAN

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

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[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 Lake Alma covers an area of 324 square miles just north of the International Boundary in the south-central part of Saskatchewan. The area is comprised of nine townships, described as tps. 1, 2, and 3, ranges 16, 17, and 18, W. 2nd mer. The village of Lake Alma is situated in the approximate centre of the area.

The municipality lies in the elevated plains area of the Missouri coteau. The ground surface is gently rolling and in many places quite hummocky. In periods of ample rainfall small lakes occur in the numerous undrained depressions that dot the surface of the area. The majority of these lakes become dry, however, during extended drought periods. From a low elevation of 2,250 feet above sea-level at several localities along the International Boundary the ground surface rises gently and fairly uniformly in a northerly direction to approximately 2,400 feet along the southern boundary of the three northern townships. From this line the elevations increase gradually to the crest of a southeasterly trending ridge which exceeds 2,500 feet above sea-level in the extreme northwest corner, whereas its northeasterly flank falls off to approximately 2,200 feet in the northeast corner of the municipality. The ground water supply of this municipality is derived from two sources, namely, the glacial drift that covers the entire area as a blanket of varying thickness ranging from 10 feet or less along the International Boundary to 200 feet or more in the northern townships, and the sand beds and coal seams in the underlying bedrock formation.

Water-bearing Horizons in the Unconsolidated Deposits

The changes in the water conditions throughout the municipality appear to be related in general to changes that occur in the character of the glacial drift comprising the unconsolidated deposits. These changes are due essentially to

differences in the manner in which the deposits were originally laid down. Many thousands of years ago one or more continental ice-sheets moved in a southwesterly direction over the province of Saskatchewan. As each ice-sheet progressed it deposited a layer of till or boulder clay upon the bedrock surface of the region. This till deposit is composed essentially of yellowish clay, becoming bluish grey at greater depths. Irregular pockets of sands and gravels, generally of limited areal extent, are interspersed through the boulder clay. With the melting of the ice and the gradual northeasterly retreat of the ice front a more porous layer of glacial drift was deposited. In the areas where the retreating ice front paused for a considerable period of time the accumulation of drift formed belts of hillocky topography known as "moraine". The moraine is composed of a greater accumulation of boulder clay in which the pockets of sands and gravels are generally more numerous and generally of wider areal extent than in the underlying boulder clay. Such deposits cover the greater part of this municipality, as shown on the map accompanying this report (Figure 1). In two small areas located along the western border of township 1, range 18, and in the northeast corner of township 2, range 17, fairly extensive beds of glacial sands and gravels occur. These beds, usually termed "outwash gravels", were deposited by streams formed by the melting ice-sheet.

In general the glacial till is the least productive of the three types of glacial deposits described above. The water is confined almost entirely to the small pockets of sand and gravels encountered in it within 80 feet of the surface. The water is hard and contains varying amounts of mineral salts in solution. In some places these salts are present in the water in sufficient concentration to render it unsuitable for drinking. In some places it was found necessary to sink several holes before a productive pocket was penetrated. On several farms in the areas where the boulder clay appears at the surface residents have encountered at depth

gravel beds that extend as narrow tongues for considerable distances. Wells penetrating these buried gravel belts generally provide an ample supply of water suitable for household and stock use. Most of the moraine-covered areas present less difficulty in locating water-bearing beds at comparatively shallow depths. Gravel knolls and ridges have formed the sites of good wells on many farms. Here as in the till-covered areas considerable variation is found in the quality of the water obtainable. The water is generally hard, but the quantity of dissolved mineral salts shows considerable variation often within comparatively small areas.

The outwash gravels are in general the most porous of the glacial deposits in the area. Little difficulty is experienced in obtaining water of good quality at shallow depths in these gravels.

The ground water supply of the glacial drift is dependant upon the local precipitation. Consequently, the available supply of ground water has shown a continual decrease during the drought period and several wells in the municipality have ceased to be productive. Although the actual ground water conditions as a rule vary with the change in character of the drift, data obtained from many wells show that this does not always hold and that in places there appears to be little difference in the character of the water in the different forms of glacial deposits. A more accurate picture of the variation in water conditions is indicated by the area bounded by the "A" line on the map (Figure 1). Within the area outlined adequate supplies of drinkable water are being obtained from sand and gravel beds and pockets in the drift within 80 feet of the surface. In areas outside of this zone the glacial drift is either sparingly productive or yields water of very poor quality. In many places, particularly in the southwestern and southeastern parts of the municipality where the drift is thin, residents have been obliged

to sink wells into the water-bearing horizons of the underlying bedrock.

Water-bearing Horizons in the Bedrock

Three water-bearing bedrock formations are known to occur beneath the glacial drift throughout the municipality. These formations are referred to locally as the Ravenscrag, the Eastend, and the Marine Shale. The uppermost or Ravenscrag formation consists of a series of yellowish brown shales, grey to bluish grey sandstones, and thin seams of lignite coal. This formation underlies the municipality down to an approximate elevation of 2,000 feet above sea-level. The Ravenscrag is underlain by some 60 feet or more of fine grey sands and silts comprising the Eastend formation. Near the base of this formation, at an approximate elevation of 1,900 feet above sea-level, the silts become more shaly and grade downward imperceptibly into the compact, fine-grained beds of the Marine Shale series. This shale is easily recognizable in drilling by its dark grey to black colour and "soapy" feel when wet and by the small, roughly cubical fragments into which it crumbles upon drying. The shale probably exceeds 800 feet in total thickness beneath this municipality.

Of the three formations the uppermost, the Ravenscrag, is the most productive. The coal seams and associated sand beds which form the aquifers to individual wells in this formation are not all continuous over large areas. In some cases it appears rather that the water-bearing beds occur irregularly distributed through the formation at elevations varying as much as 50 feet or more within a distance of a mile. As a rule, however, residents contemplating sinking a well into the bedrock should note the elevations at which the water is being found in wells adjacent to the proposed site, as within limited areas the water should be encountered at approximately the same elevation. An attempt is made in the following discussion to indicate areas in which the

bedrock water conditions are in general similar. The water-bearing horizons present in the upper part of the Ravenscrag formation are found to be confined either to one township or at most two, and hence are discussed under the sections of the report dealing with individual townships. The most consistent horizon that has been found in the municipality occurs at elevations between 2,160 and 2,103 feet above sea-level throughout township 1, range 17, and the southwestern part of township 1, range 16. Most of the wells produce from an elevation of approximately 2,130 feet. This aquifer is a thin coal seam or a bed of grey sand that ranges in depth from 117 to 189 feet from the surface. Here, as in the municipalities farther west, the supply obtainable is adequate for local stock requirements, but the quality of the water is in many places poor and cannot be used for drinking. Over large areas in southern Saskatchewan thick beds of sand are known to occur at the base of the Ravenscrag formation. Several deep wells in this municipality have tapped this horizon at elevations ranging from 2,060 to 2,020 feet above sea-level. It is probable that this horizon will prove to be productive throughout the greater part of this municipality. Due to the difference in surface elevation the depth to this horizon varies over the area, but in the southern and eastern townships it generally lies from 250 to 310 feet below the surface.

Two wells drilled to depths of 425 and 415 feet in sec. 12, tp. 1, range 16, and sec. 12, tp. 2, range 17, respectively, have encountered a very fine grey sand and shale bed in a lower series of beds known as the Eastend formation. The water in the first well was reported to be hard and "alkaline" and in the other soft and "soda" bearing; the latter type is believed to be the more characteristic of waters from this formation.

Only one well, located in NE.$\frac{1}{4}$, sec. 32, tp. 3, range 16, has been drilled into the Marine Shale series. In the upper 260 feet the well passed through drift, Ravenscrag and Eastend formations.

After penetrating a 30-foot sand bed, believed to be the basal sand beds of the Ravenscrag or the Eastend formation, the well was continued in a compact grey shale to a depth of 900 feet. The well produces soft, "soda-bearing" water that, although used for watering stock is not suitable for drinking. It has not been determined definitely whether the supply is derived largely from the sand bed above the shale or from a sand horizon at the base of the well. Wells sunk to greater depths into the shale in municipalities to the east were dry and this suggests that the water in this well comes from the sand bed above the shale. The shale is generally so impervious to the passage of water that only very small supplies can usually be expected from it, and the water is in nearly all places so heavily charged with mineral salts in solution as to be unfit for drinking, and injurious to stock. Despite the possibility that part at least of the water in the well mentioned above is being derived from the shale it is improbable that adequate supplies of water suitable for farm requirements will be found below an approximate elevation of 1,875 feet above sea-level in any part of this municipality.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 1,Range 16

The glacial drift covering the township is the source of most of the ground water being used in this township. Supplies from the underlying bedrock formations are utilized in areas where the drift has been found to be sparingly productive. The surface of the township is gently rolling and characteristic of the morainic deposits that form the drift throughout all but the extreme southwestern corner of the township. Water-bearing pockets of sands and gravels occur irregularly interspersed through the drift. They are more plentiful in the upper 30 feet than at greater depths. Generally throughout that part of the township lying within the "A" line indicated on the map (Figure 1) little difficulty is experienced in obtaining a supply of hard, slightly mineralized, but drinkable water adequate for local farm requirements at depths not exceeding 30 feet. In NE.$\frac{1}{4}$, section 2, however, it was found necessary to sink a well to a depth of 90 feet,before a water-bearing horizon was penetrated.

To the south and east of the area bounded by the "A" line more difficulty has been experienced in finding productive beds and pockets. In many places here it may be necessary to sink several test holes before a permanent supply is obtained. In the cases where a productive bed has been tapped the water is similar in quality to supplies found in the upper part of the drift in the area bounded by the "A" line. The others obtain a supply sufficient only for a few head of stock. A number of residents along the eastern border have found it necessary to sink wells through the drift into the underlying Ravenscrag or Eastend formations in order to obtain sufficient water for their stock.

The supplies obtained from the bedrock are derived from two horizons in the Ravenscrag and from one horizon in the under-

lying Eastend formation.

The uppermost horizon of the Ravenscrag has been encountered in two wells in the southwest corner of the township, at elevations of 2,130 and 2,107 feet above sea-level. The wells are sunk to depths of 140 and 189 feet, respectively, and the water is coming from a coal seam the lateral extent of which has not been determined. The yields from these wells are sufficient for stock needs. The quality of the water in the 140-foot well is poor and is unfit for household use.

The second water-bearing horizon in the Ravenscrag is struck in a 330-foot well located on NE.$\frac{1}{4}$, section 26, at an elevation of 2,020 feet. The coarse grey sand bed forming the aquifer yields a supply sufficient for stock needs. The water, although hard and containing fairly large amounts of dissolved mineral salts, is being used for household purposes. Here again no information is available to indicate the areal extent of this bedrock horizon. The general character of the lower Ravenscrag suggests, however, that this sand bed may be traceable at this horizon over a considerable area. The 425-foot well located on SE.$\frac{1}{4}$, section 12, is drawing its supply from a fine sand bed at an elevation of 1,895 feet above sea-level. This horizon is believed to be near the base of the Eastend formation. This well, although not used at the present time is reported to have yielded a fairly large supply of water that was hard and "alkaline" in character, and too highly mineralized to be used for drinking. This horizon will probably be found to be similarly productive throughout the greater part of the municipality. Drilling below this elevation into beds of the Marine Shale series, however, cannot be expected to yield an adequate water supply.

Township 1, Range 17

A mantle of glacial drift covers the entire township, varying from 65 feet thick along the southern boundary to 150 feet or more over the northern sections. Moraine with its characteristic

rolling surface forms the drift throughout the southwestern and northeastern parts of the area. A till plain covers the remainder of the township with the exception of the extreme northeast corner, where deposits of outwash gravels overlie the till. Although comparatively little variation is seen in the yield or quality of water derived from the different types of glacial deposits, the "A" line has been drawn to include the northwestern and northeastern parts of the township, to indicate an area in which the supply derived from the drift is essentially sufficient for local farm requirements. Throughout the remaining parts of the township many of the wells sunk in the drift have proved inadequate for watering more than a few head of stock and residents have sunk wells into the underlying Ravenscrag bedrock formation where larger supplies are generally obtainable. No wells have been sunk in the area covered by the outwash gravels. Due to the porous nature of these deposits, however, fairly large supplies of water of good quality are to be expected from wells sunk in them to depths not exceeding 30 feet. The sand and gravel pockets interspersed through the boulder clay in the moraine and till covered areas are more irregular in their occurrence. In general, small gravel knolls and ridges over the moraine area have in several places formed the sites of shallow wells that yield small supplies of hard, slightly "alkaline" water. Throughout the central till plain the porous gravel and sand beds are less plentiful. More careful prospecting is generally necessary before a productive pocket is tapped. In places where these pockets have not been found residents in order to obtain drinking water have either sunk shallow wells beside dugouts or sloughs or have sunk deep wells into the bedrock. The till has been found to be particularly unproductive along the southern part of the eastern border of the township. Only a few pockets of sand and gravel have been encountered and they lie within 30 feet of the surface. Since they are directly dependant on rainfall to replenish their supply the recent drought

period has caused the yield from many of these wells to drop appreciably.

Throughout the southern and eastern parts of this township the Ravenscrag formation is the chief source of ground water supply. The uppermost water-bearing horizon of this formation is in a coal seam encountered at a depth of 100 feet in a well located in section 18. The horizon occurs at an approximate elevation of 2,210 feet above sea-level. The water although drinkable occurs in very small amounts and the well is almost dry. It is advisable in this part of the area to continue wells to a lower horizon than has been tapped at many places in the area at elevations between 2,194 and 2,103 feet above sea-level. It is probable that this horizon, which is a bed of coarse sand or more occasionally a coal seam, will be found to be productive at depths varying from 110 to 170 feet from the surface throughout the greater part of the township. The yield from individual wells is fairly large and quite adequate for at least 20 head of stock. The water is generally of fairly good quality although water from several wells on the extreme southeast corner is so highly charged with mineral salts in solution as to be unfit for domestic use. It is, however, being used for stock with no apparent ill effects.

A 265-foot well located on NW.$\frac{1}{4}$, section 9, and a 150-foot well on SE.$\frac{1}{4}$, section 12, tap what is believed to be the lowest water-bearing horizon in the Ravenscrag at an approximate elevation of 2,045 feet above sea-level. Supplies in both wells are sufficient for stock needs and in section 9, the water may be used for the household. In section 12, however, where a coal seam forms the water-bearing bed the water is not suitable for domestic use.

It is believed that this aquifer extends under the whole township and that it can be tapped at depths less than 300 feet from the surface, depending upon the surface elevation. It is improbable

that a satisfactory water supply will be encountered at depths greater than 350 feet in any part of this township.

Township 1, Range 18

Ground water is derived from two sources in this township. These are: (1) the glacial deposits that mantle the area to depths varying from 12 to 25 feet in the central and southern parts of the township and to depths exceeding 80 feet in the northern sections; and (2) two water-bearing horizons in the underlying Ravenscrag formation.

The glacial deposits consist largely of till which appears at the surface in the southwest corner of the area but is mantled by a layer of more porous moraine over the remainder of the township. A small area of glacial outwash sands and gravels occurs east of the Coteau lakes in sections 17 and 18. Although fairly good water conditions are to be expected at shallow depths in the gravels, no information was obtained of wells having been sunk in this area. The lakes themselves lie in natural depressions in the drift in which considerable amounts of mineral salts have gradually accumulated. The presence of these salts in solution renders the water in the lake unfit for farm requirements. The water conditions in both the till and the more rolling moraine-covered areas are generally poor. Isolated pockets of sands and gravels occur scattered irregularly through the upper 30 feet of the boulder clay. These pockets are water-bearing and wells tapping them yield small supplies of hard water. In many places a considerable amount of mineral salts occur dissolved in the water, but in nearly all places the water is used for household requirements. The lack of rainfall during recent years has materially lessened the yield from the shallow wells.

On farms where water for more than 10 to 15 head of stock is required residents are advised to sink wells into the Ravenscrag formation that underlies the glacial deposits throughout the town-

ship. The uppermost water-bearing horizon known to occur in this formation is encountered in the northeastern quarter of the township at elevations ranging from 2,250 to 2,208 feet above sea-level. A 12-foot well on SW.$\frac{1}{4}$, section 23, obtains a yield of soft water from the aquifer. In section 35 it is tapped by a 160-foot well, and another well located in NE.$\frac{1}{4}$, section 32, is believed to be also producing from the same source at a depth of 127 feet. Water from the latter two wells is hard and in the well in section 32 is highly charged with dissolved mineral salts that render the water unsuitable for domestic use. Throughout the intervening area it seems likely that this horizon can be tapped by wells less than 150 feet in depth.

A lower horizon, believed to be in the basal sand beds of the Ravenscrag formation, has been struck in several wells at elevations ranging from 2,138 to 2,090 feet above sea-level in the southwestern and central parts of the township. The aquifer was tapped at depths of 85 and 52 feet, respectively, in SW.$\frac{1}{4}$, section 5, and SE.$\frac{1}{4}$, section 17. It was, however, necessary to sink a well 223 feet deep before the aquifer was reached on the higher land in NE.$\frac{1}{4}$, section 22. The yield from each of these wells is sufficient for 20 or more head of stock, but the quality of the water is poor and unfit for household use. This aquifer is believed to be quite extensive and to underlie the greater part of the township at depths nowhere exceeding 350 feet from the surface.

Township 2, Range 16

Ground water is being derived in this township from two sources. These are: (1) the glacial deposits of moraine that mantle the area to an average depth of approximately 150 feet; and (2) two water-bearing horizons of the underlying Ravenscrag formation.

Sand and gravel pockets irregularly interspersed through the upper 40 feet of the moraine that covers the entire township form the only water-bearing beds known to exist in the glacial drift. Along the western boundary and in the central part of the township the pockets are apparently quite numerous and of considerable areal extent. Consequently, in this area little difficulty is experienced in obtaining a good supply of drinkable water at shallow depths. The most continuous and widespread of these gravel beds occurs in the central sections of the township beneath a layer of boulder clay up to 25 feet. In that part of the township lying to the east of the area enclosed by the "A" line, shown on Figure 1, and particularly along the eastern boundary of the township, the supply from glacial deposits is insufficient for farm requirements, and the water is often rendered undrinkable by the presence of excess mineral salts in solution. It has been found more advantageous in areas where such conditions exist in the drift to sink wells through the glacial deposits to tap an aquifer in the underlying Ravenscrag formation.

The uppermost water-bearing horizon of the Ravenscrag is struck in two 200-foot wells in NW.$\frac{1}{4}$, section 12, and in SW.$\frac{1}{4}$, section 22, sunk to elevations of 2,140 feet and 2,100 feet above sea-level. This aquifer yields good supplies of a hard water that although suitable for watering stock is generally unfit for household use.

A lower aquifer is encountered along the eastern boundary in wells varying in depth from 255 to 310 feet. The elevation of this fine sand horizon varies from 1,965 to 2,065 feet above sea-level. Good supplies of water, sufficient for the local stock needs, are obtained from wells tapping this horizon. In most places, however, the quality of this water is such as to render it unfit for domestic use. The extent of this aquifer is not known, but it is believed to extend under most of the township and would be

tapped in wells approximately 300 feet in depth, throughout the township. The 230-foot dry hole on SE.$\frac{1}{4}$, section 12, was not sunk deep enough to prove or disprove the presence of the aquifer in this part of the township.

Township 2, Range 17

Glacial drift covers the entire area to depths ranging from 30 to 150 feet or more, and is the source of most of the ground water supply of the township.

The glacial drift over the southwest part of the township consists of boulder clay or till forming a fairly level plain. Over the northeastern half of the township it is in the form of more irregularly surfaced moraines and in a small area in the southeast it consists of outwash materials. The well records reveal very little difference, if any, in water-bearing properties of the above three types of glacial deposits. It is probable, however, that less difficulty would be experienced in obtaining fairly large supplies of drinkable water at shallow depths from the outwash gravels than from the moraine or the till. Most of the existing wells producing from the glacial drift are located along the northeast-southwest diagonal of the township. Of these the greater number derive their water from isolated sand and gravel pockets within 30 feet of the surface. In places, however, it was necessary to sink to depths of 80 feet before water was obtained. The water is reported to be fit for domestic use in all cases, and generally the supply from individual wells is sufficient for 10 to 20 head of stock. In the areas remote from the northeast-southwest township diagonal, with the exception of the area in the extreme southeast corner underlain by outwash gravels, more difficulty is experienced in obtaining an adequate supply of good water, especially as much of the water from small pockets occurring at depth in the boulder clay is highly mineralized and unfit for drinking.

Two wells have been sunk through the glacial drift into the underlying bedrock. One, a 209-foot well located in NW.$\frac{1}{4}$, section 7, obtains a good supply of drinkable water from a sand

horizon in the Ravenscrag formation lying at an elevation of 2,161 feet above sea-level. The other, a 415-foot well in SW.$\frac{1}{4}$. section 12, passes through the Ravenscrag formation and taps a fine sand horizon believed to lie in the Eastend formation at an elevation of 1,935 feet. The supply of water from the well is sufficient for all local stock needs. The water is soft and contains "soda". It may be used satisfactorily for the household and stock, but as soda is harmful to plants its use for irrigation is not advisable. Coal is known to underlie section 13 at depths of less than 50 feet from the surface. Such coal seams in the Ravenscrag are water-bearing in many parts of the municipality. It is, therefore, believed that drilling through the drift in any part of the township will encounter water either in the Ravenscrag or in the Eastend, at horizons above an elevation of 1,900 feet above sea-level. On the higher land it may be necessary, however, to drill to depths as great as 450 feet before production is obtained.

Township 2, Range 18

Glacial drift ranging in thickness from 80 to 160 feet covers the entire township. The northeastern half of the township is largely a till plain, but to the southwest it becomes more hillocky and rolling, with the characteristic topography of a moraine. Within the northeast part of the township bounded by the "A" line indicated on Figure 1, little difficulty has been experienced in obtaining an adequate supply of moderately hard water from isolated sand and gravel beds or pockets at depths not exceeding 40 feet. In all cases but one the water is reported as being suitable for household use. Remote from this area the drift is sparingly productive. The yield is generally small, due to the limited areal extent of the gravel beds that act as the reservoirs in the boulder clay. Water from these wells is in places soft, in others hard and "alkaline", but usually it is suitable for household purposes. Many

residents have found it advisable to dig a shallow well in the drift for domestic supply and to drill a well into the underlying Ravenscrag bedrock to procure a supply for stock.

The highest water-bearing horizon of the Ravenscrag has been tapped in many places in the northern half of the township, where it is encountered at the elevations ranging from 2,280 to 2,226 feet above sea-level. The wells tapping the horizon, which is generally of sand or of coal underlain by sand, vary in depth from 134 to 170 feet in sections 22, 23, 28, and 32, but lies 228 feet below the surface in NW.$\frac{1}{4}$, section 19. This horizon yields sufficient quantities of hard, drinkable water for household needs and for at least 20 head of stock.

The second aquifer in the Ravenscrag has been tapped in two wells; one in SE.$\frac{1}{4}$, section 2, sunk to a depth of 160 feet, and the other in SE.$\frac{1}{4}$, section 6, sunk to a depth of 116 feet, entering this horizon at elevations of 2,165 and 2,209 feet above sea-level, respectively. The yield from each of these wells is sufficient for at least 20 head of stock. The water from the 116-foot well, due to the large amounts of salts it contains in solution, cannot be used in the household.

The lowest aquifer definitely known to exist in the township is struck in a 230-foot well located in NE.$\frac{1}{4}$, section 22, at an elevation of 2,045 feet above sea-level. This well yields ample supplies of water for stock requirements, but the poor quality of the water does not permit of it being used for household purposes. It is believed that this aquifer will be found to be quite extensive throughout the township at elevations ranging from 2,050 to 1,950 feet above sea-level.

Township 3, Range 16

All wells in this township, with one exception, derive their water supply from sand and gravel beds irregularly interspersed through the upper 25 feet of the moraine that covers the entire area to depths of 150 to 200 feet. The lower part of the

glacial drift is composed largely of compact boulder clay in which very few porous beds suitable for the retention of any large supply of water are present. The supplies from the wells in the upper part of the drift have decreased considerably during the drought period. In the western and southern parts of the township, however, the shallow wells at the present time yield sufficient quantities of hard, drinkable water for household needs and for 10 to 30 head of stock. A fairly extensive bed of sands and gravels occurs at shallow depths in the vicinity of Mather lake. The water in the lake itself is so highly mineralized that it is unfit even for stock. Wells sunk in surrounding gravels yield small supplies of water that is not so heavily charged with mineral salts in solution. This water though unsatisfactory for such purposes is being used for the household and stock in this area. Throughout the northeastern and east-central parts of the township the shallow wells sunk in the drift do not yield sufficient quantities of water to satisfy local requirements, and many of the residents are obliged to haul water from surrounding districts.

No wells have been sunk through the drift into the underlying Ravenscrag bedrock formation in this part of the area. It may be necessary to drill to depths of 200 to 260 feet in order to reach a bedrock aquifer, but such if tapped should yield supplies sufficient and suitable for stock.

A 310-foot well located in NE.$\frac{1}{4}$, sec. 26, tp. 2, range 16, immediately to the south, obtains a supply of water suitable for stock use from the Ravenscrag formation. It seems probable that should wells be sunk to similar depths in the southern part of this township they would prove equally successful. Drilling to a depth much below an elevation of 1,900 feet above sea-level will encounter beds of the Marine Shale series, from which little water can be expected. The 905-foot well located in section 32 of this township stopped at an elevation of 1,495 feet. The lower 615 feet of this well was sunk in the Marine Shale series. The well yields

a large supply of soft, "soda"-bearing water that is used for watering stock and for washing. The "soda" tends to give the water a flat taste and it is not used for drinking. The source of this water is not definitely known. The possibility of it having been derived from a sand bed penetrated at a depth of 260 feet below the surface has been discussed on page 14 dealing with the water-bearing horizons in the bedrock of the municipality.

Township 3, Range 17

The ground water supply of this township is being derived entirely from the glacial drift that covers the area to a depth of 150 feet or less. The drift consists essentially of moraine in all but the northwestern part of the township which is covered by boulder clay or till. The water comes from pockets of sand and gravel interspersed through the clay of both these types of deposits. The pockets are usually small and depend for their source upon the local rainfall, consequently, during the past dry years supplies from them have been continuously decreasing.

In the northwest corner and along the eastern boundary of the township wells sunk to depths of less than 25 feet obtain good supplies of water. In the area extending from north to south through the central part of the township, it has been found necessary to sink wells to depths of 40 to 80 feet, and one well located in SE.$\frac{1}{4}$, sec. 35, was drilled to a depth of 148 feet before even a supply of highly mineralized, undrinkable water was obtained. The quality of the water is variable throughout this part of the township. A few wells yield small supplies that are used for drinking, but in most of the wells the water is unsatisfactory for household use.

It is believed that fairly large supplies of water suitable at least for stock requirements might be obtained by sinking wells through the drift into the underlying Ravenscrag formation. It may be necessary, however, to drill to depths of over 300 feet before the more productive sands of this formation are encountered.

Township 3, Range 18

The ground water supply of this township is being derived almost entirely from the glacial drift that mantles the entire area to depths of 100 feet or more. One well, however, taps a water-bearing horizon in the underlying Ravenscrag formation.

Glacial till composed largely of compact boulder clay covers the northeast and southwest parts of the township. This till plain becomes more irregular and rolling toward the centre to form a typical area of moraine extending as a belt approximately 3 miles in width centred along the northwest-southeast diagonal of the township. A small area of glacial outwash deposits of sands and gravels occupies a part of sections 7 and 8. No wells have been sunk into these gravels, but at least small supplies of water are to be expected from them at shallow depths. Elsewhere in the drift-covered areas water occurs in gravel and sand beds which are generally found interspersed through the upper 60 feet of the boulder clay. The areal extent of these beds is usually small and the supplies of water from them are correspondingly small. They depend for their source upon the local rainfall, consequently, during the past dry years supplies have been continuously decreasing. Generally throughout this township individual wells sunk to tap these pockets yield a supply of water sufficient for as many as 30 head of stock. In a few cases, however, the yields are so small as to necessitate procuring additional supplies. Water from the glacial drift is invariably hard and often contains large amounts of dissolved mineral salts, but in only a few wells is the salt content so high as to render the water unfit for human consumption.

A 112-foot well located in NE.$\frac{1}{4}$, section 6, obtains a fairly large supply of water from a sand horizon in the underlying Ravenscrag formation, lying at an elevation of 2,258 feet above sea-level. The water from it is of poor quality, so that the farmer finds it necessary to haul his drinking water. It is quite possible

that this aquifer extends over the greater part of the township, and will be encountered in wells of a similar depth. Deeper aquifers near the base of the Ravenscrag or in the lower Eastend formation are also believed to be present throughout the township and should be tapped by wells sunk to depths not exceeding 400 feet.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF LAKE ALMA, NO.8, SASKATCHEWAN.

West of 2nd meridian — Township / Range	1 / 16	1 / 17	1 / 18	2 / 16	2 / 17	2 / 18	3 / 16	3 / 17	3 / 18	Total No. in Municipality
Total No. of Wells in Township	35	48	42	59	38	30	33	26	19	330
No. of wells in bedrock	8	11	9	7	2	10	1	0	1	49
No. of wells in glacial drift	27	37	33	52	36	20	32	26	18	281
No. of wells in alluvium	0	0	0	0	0	0	0	0	0	0
Permanency of Water Supply										
No. with permanent supply	27	43	25	36	38	30	27	24	19	269
No. with intermittent supply	2	0	0	3	0	0	1	0	0	6
No. dry holes	6	5	17	20	0	0	5	2	0	55
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	5	10	7	6	6	9	2	4	3	52
No. of non-artesian wells	24	33	18	33	32	21	26	20	16	223
Quality of Water										
No. with hard water	27	29	19	35	34	22	24	23	16	229
No. with soft water	2	14	6	4	4	8	4	1	3	46
No. with salty water	0	0	0	0	0	0	0	0	1	1
No. with alkaline water	8	0	7	9	4	2	0	2	2	34
Depths of Wells										
No. from 0 to 50 feet deep	25	37	28	50	30	22	31	20	15	258
No. from 51 to 100 feet deep	2	2	11	2	6	0	0	5	3	31
No. from 101 to 150 feet deep	5	5	1	0	0	3	1	1	1	17
No. from 151 to 200 feet deep	1	3	1	2	0	3	0	0	0	10
No. from 201 to 500 feet deep	2	1	1	5	2	2	0	0	0	13
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	1	0	0	1
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	19	34	16	31	32	22	25	19	13	211
No. not usable for domestic purposes	10	9	9	8	6	8	3	5	6	64
No. usable for stock purposes	28	42	24	39	37	29	27	23	17	266
No. not usable for stock purposes	1	1	1	0	1	1	1	1	2	9
Sufficiency of Water Supply										
No. sufficient for domestic needs	29	43	25	39	38	30	28	24	19	275
No. insufficient for domestic needs	0	0	0	0	0	0	0	0	0	0
No. sufficient for stock needs	20	24	15	26	28	23	20	15	14	185
No. insufficient for stock needs	9	19	10	13	10	7	8	9	5	90

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 Lake Alma, No. 8, 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	NE.	5	1	16	2	189	2,143																		*2
2	NE.	26	1	16	2	330	2,060	700	700	0	18	385	50	155	920	556	1,711	89		249	104	0	1,239	30	*2
3	NE.	22	1	18	2	223	2,220	850	850	0	40	425	80	245	1,005	482	1,862	143		237	390	0	1,026	66	*2
4	NE.	22	2	17	2	26	437																		*1
5	SE.	27	2	17	2	60	2,240																		*1
6	SW.	5	3	18	2	52	12,860																		*1

Water samples indicated thus, *1, are from glacial drift.
Water samples indicated thus, *2, are from bedrock, Ravenscrag formation.
Analyses are reported in parts per million.
Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).
Analyses Nos. 1,4,5, and 6, by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

The glacial deposits, in general, show marked variations in character within short distances, and corresponding variations are to be expected in the quality of the ground water derived from the drift. One well may yield a hard, slightly mineralized water, whereas another sunk to a similar depth 50 yards away may give a water so highly charged with dissolved sulphate salts as to be unsuitable for domestic or stock requirements. It is not to be inferred, therefore, that should water of poor quality be encountered in one well such conditions must necessarily prevail over a large area.

The small seepages of water derived from the compact boulder clay are generally highly mineralized. Analysis No. 6 on the accompanying table is of water from a 52-foot well sunk entirely in boulder clay. The determined total solid content of 12,860 parts per million in this water is exceptionally high. Although the figures indicating the relative amounts of the constituent salts were not available, it is presumable from comparisons with other analyses of waters from the boulder clay that the dissolved salts are largely sulphates of sodium (Na_2SO_4), and magnesium ($MgSO_4$), magnesium carbonate ($MgCO_3$), calcium carbonate ($CaCO_3$), and common salt ($NaCl$). A water with such a high total dissolved solid content is unfit for use even for stock. Small sand or gravel pockets occurring in boulder clay at depths greater than about 40 feet generally yield a water similar in quality to that which occurs in the boulder clay itself. This is to be expected, as water slowly percolating downward from the surface tends to make into solution many of the salts inherent in the clay. Extensive sand and gravel beds or pockets encountered at shallow depths yield a much less highly mineralized type of water. In a general way the amount of dissolved mineral salts in waters from the glacial drift is dependant upon the areal extent and porosity of the producing

aquifer and the thickness of the overlying boulder clay.

Two wells contributing to the supply of the town of Lake Alma illustrate this generalization. One well located in SE.$\frac{1}{4}$, sec. 27, tp. 2, range 17, was sunk 60 feet through boulder clay to a sand bed. Analysis of the water obtained at this horizon shows it to have a total dissolved solid content of 2,240 parts per million. Water with a higher dissolved solid content is being used for drinking in many parts of Saskatchewan with apparently no ill effects. However, the use of such waters should be discouraged if supplies lower in total dissolved mineral salts are available. A second well located in NE.$\frac{1}{4}$, sec. 22, tp. 2, range 17, encountered gravel at a depth of only 26 feet. This water has a very low total dissolved solid content. Calcium carbonate ($CaCO_3$), calcium sulphate ($CaSO_4$), magnesium sulphate ($MgSO_4$), and calcium chloride ($CaCl_2$) were found to be present in solution, but only in small quantities. Such water if uncontaminated by sewage or decaying organic material should be suitable for household use.

Water from the Bedrock

The first, second, and third analyses given on the accompanying table are of waters from aquifers in the Ravenscrag formation. It will be noted that there exists some element of uniformity in the determined dissolved solid content of 2,143, 2,060, and 2,220 parts per million. The two detailed analyses indicate total permanent hardnesses of 700 and 850 parts per million. Such waters are considered to be very hard. These analyses are believed to be typical of the waters derived from the Ravenscrag formation in this municipality. Supplies from this formation are used for stock. These waters contain large amounts of the sulphate of sodium (Glauber's salt) and smaller amounts of the sulphate of magnesium (Epsom salts). The combined amounts of these two salts is in excess of 1,000 parts per million, but since the total consists largely of the less harmful sulphate of sodium the water at places is used for drinking apparently without any serious ill-

effects. The amounts of the chloride of sodium (common salt) that these samples contain is fairly small. Many waters from the Ravenscrag formation contain common salt in larger quantities.

Waters from still greater depths in the Ravenscrag formation, particularly from the basal sand beds, and from the underlying Eastend formation have been found to differ considerably from the hard sulphate waters of the upper part of the Ravenscrag. The latter water is soft and contains fairly large amounts of sodium carbonate (black alkali or "soda"). The presence of "soda" in the water tends to give it a flat taste, but in several places in the municipality water of this type is being used both for household purposes and for stock. The black alkali is harmful to plants and consequently this type of water should not be used for garden irrigation. In several places iron also forms an objectionable constituent in waters from the Ravenscrag. Much of this iron can be removed by allowing the water to stand for a period in troughs or other containers, thus exposing a large water surface to the air. The iron tends to settle out as a brown precipitate. Agitation of the water is also helpful in removing iron.

WELL RECORDS—Rural Municipality of LAKE ALMA NO. 8, 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
1	SW.	3	1	16	2	Bored	120	2,270					Glacial clay			N	No water; 3 other dry wells.
2	NE.	2	"	"	"	Bored	90	2,290	- 70	2,220			Glacial gravel	Red sediment hard, iron		D, S	Insufficient.
3	NE.	4	"	"	"	Dug	12	2,250					Glacial sand	Hard, clear		D, S	Sufficient but plugged with sand.
4	NE.	5	"	"	"	Drilled	189	2,290	- 30	2,260	183	2,107	Ravenscrag coal	Hard, iron, cloudy		S	Sufficient supply. #
5	NE.	6	"	"	"	Drilled	140	2,270	- 40	2,230	140	2,130	Ravenscrag coal	Hard, iron, sulphur, soda		N	Not used; another well 12 feet deep.
6	SE.	9	"	"	"	Dug	12	2,240	- 6	2,234	12	2,228	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient supply; haul water from here.
7	NE.	10	"	"	"	Dug	15	2,290					Glacial drift				Dry hole.
8	SE.	12	"	"	"	Drilled	425	2,320			425	1,895	Eastend sand	Hard, clear, "alkaline"		N	Well plugged. Another 35 feet deep gives just sufficient supply.
9	SE.	14	"	"	"	Dug	14	2,340			14	2,326	Glacial gravel	Hard, clear		N	Insufficient, goes dry.
10	NW.	15	"	"	"	Bored	68	2,270	- 38	2,232	68	2,202	Glacial sand	Hard, clear, iron, "alkaline"		D, S	Sufficient supply.
11	SE.	15	"	"	"	Dug	16	2,300	- 2	2,298			Glacial clay	Hard, clear		D, S	Insufficient supply.
12	NW.	17	"	"	"	Dug	20	2,320					Glacial gravel	Hard, clear, "alkaline"		S	Sufficient supply.
13	NE.	17	"	"	"	Dug	8	2,300	0	2,300	8	2,292	Glacial gravel	Soft, clear		D, S	Good supply; flowing spring.
14	NW.	20	"	"	"	Dug	22	2,250	?	?	22	2,228	Glacial sand	Hard, clear		D, S	Sufficient supply.
15	NE.	20	"	"	"	Dug	10	2,270			10	2,260	Glacial sand	Hard, clear, "alkaline"		S	Insufficient supply.
16	SW.	22	"	"	"	Dug	14	2,300	- 12	2,288			Glacial sand	Hard, cloudy		D, S	Insufficient supply.
17	NE.	26	"	"	"	Drilled	330	2,350	-210	2,140	330	2,020	Ravenscrag sand	Hard, clear, "alkaline"		D, S	Sufficient supply. #
18	NW.	32	"	"	"	Springs		2,340	+ 2	2,342			Glacial gravel	Hard, iron, red sediment		S	Good supply of water; 4 springs.
19	SW.	33	"	"	"	Dug	15	2,250			15	2,235	Glacial sand	Hard, clear		S	Sufficient supply.
20	NE.	33	"	"	"	Dug	28	2,250			28	2,222	Glacial gravel and sand	Hard, clear, "alkaline"		D	Sufficient for house use only.
21	NE.	34	"	"	"	Dug	12	2,330			12	2,318	Glacial quick-sand	Hard, clear		D, S	Sufficient supply.
22	SE.	35	"	"	"	Dug	6	2,330	- 4	2,326	6	2,324	Glacial gravel	Medium soft, clear		D, S	Sufficient supply; water hauled from here.
1	NE.	1	1	17	2	Bored	107	2,225	- 62	2,163	100	2,125	Ravenscrag quicksand	Hard, iron, rusty		N	Not used now; sufficient for stock.
2	NW.	2	"	"	"	Dug	20	2,250			20	2,230	Glacial sand	Hard, clear		D	Sufficient supply; other well 10 feet deep.
3	NW.	3	"	"	"	Bored	117	2,220	- 50	2,170	117	2,103	Ravenscrag quicksand	Hard, clear		N	Sufficient; now filled with quicksand.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of LAKE ALMA NO.8, 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.	7	1	17	2	Dug	4	2,300	- 2	2,298	4	2,296	Glacial sand	Fairly soft, clear		S	Sufficient supply; other well 18 feet for house.
5	SE.	9	"	"	"	Dug	18	2,340	- 15	2,325	18	2,322	Glacial sand and gravel	Slightly hard, clear		D, S	Sufficient supply.
6	NW.	9	"	"	"	Drilled	265	2,310	-200	2,110	265	2,045	Ravenscrag sand	Slightly hard iron, brown		D, S	Sufficient supply.
7	NW.	10	"	"	"	Dug	28	2,200			28	2,172	Glacial gravel and sand	Soft, clear		D, S	Sufficient supply; another 16 foot well has gone dry.
8	SE.	12	"	"	"	Bored	150	2,190			150	2,040	Ravenscrag coal	Hard, iron, cloudy	44	S	Sufficient for stock.
9	SW.	12	"	"	"	Bored	118	2,240	- 80	2,160	118	2,122	Ravenscrag grey ashes	Hard, clear		N	Good supply of water but not used; use 5 seepage wells.
10	SE.	13	"	"	"	Dug	12	2,190	- 8	2,182	4	2,186	Glacial grey-sand, ?	Soft, clear		D, S	Insufficient supply; house supply only.
11	SW.	13	"	"	"	Dug	15	2,240			15	2,225	Glacial sand	Soft, clear		S	Waters 18 head stock.
12	NW.	13	"	"	"	Dug	16	2,240			16	2,224	Glacial gravel	Hard, clear		D	Insufficient supply.
13	NE.	14	"	"	"	Drilled	125	2,260			125	2,135	Ravenscrag? sand	Hard, clear		D, S	Very good supply.
14	SE.	17	"	"	"	Bored	100	2,310			100	2,210	Ravenscrag coal			N	No water now; well has caved in.
15	SW.	18	"	"	"	Drilled	158	2,320	-100	2,220	158	2,162	Ravenscrag coal	Hard, clear, iron		D, S	Very small supply of water.
16	NE.	18	"	"	"	Bored	100	2,310			100	2,210	Ravenscrag coal	Hard, clear, iron		S	Just sufficient for 8 head stock.
17	SE.	19	"	"	"	Dug	9	2,310			9	2,301	Glacial gravel	Soft, clear		D, S	Sufficient supply; 2 other similar wells.
18	NE.	21	"	"	"	Dug	4	2,220	0	2,220	4	2,216	Glacial gravel	Hard, clear		D, S	Good supply of water; this is a flowing spring.
19	SE.	23	"	"	"	Dug	18	2,210	+ 2	2,212	18	2,192	Glacial sand	Soft, clear		D, S	Good supply; this is a flowing spring.
20	SW.	23	"	"	"	Dug	19	2,218			19	2,199	Glacial gravel	Hard, clear, iron		S	Waters 20 head stock.
21	SE.	24	"	"	"	Dug	18	2,200	- 16	2,184	18	2,182	Glacial grey clay	Hard, clear,		D, S	Insufficient supply; another well yields a small supply of water.
22	SE.	27	"	"	"	Drilled	166	2,320	-100	2,220	166	2,154	Ravenscrag sand	Hard, clear, iron		D, S	Sufficient supply.
23	SW.	30	"	"	"	Dug	20	2,340	- 17	2,323	20	2,320	Glacial grey clay	Hard, clear		D, S	Insufficient supply.
24	SW.	30	"	"	"	Dug	14	2,340	- 10	2,330	6	2,334	Glacial gravel	Soft, clear		D, S	Sufficient supply.
25	NW.	32	"	"	"	Dug	10	2,280			10	2,270	Glacial gravel	Soft, clear		D, S	Sufficient supply; another well went dry.
26	NE.	32	"	"	"	Dug	15	2,250	- 10	2,240	10	2,240	Glacial gravel	Soft, clear		D	Sufficient for house use; use springs for stock.
27	SW.	35	"	"	"	Drilled	166	2,360	-100	2,260	166	2,194	Ravenscrag quick-sand	Hard, clear, iron		S	Another 20 foot well used for house; both yield sufficient supplies.
1	SE.	3	1	18	2	Spring		2,130	+ 1	2,131			Glacial sand	Hard, "alkaline" clear		S	Another well 30 feet deep. soft water , used for house.
2	NW.	4	"	"	"	Dug	34	2,230			34	2,196	Glacial sand	Hard, clear		D	Insufficient supply; another well 10 feet deep waters 40 head stock.
3	SW.	5	"	"	"	Bored	85	2,180	- 50	2,130	85	2,095	Ravenscrag sand	Hard, iron, "alkaline" clear		S	Good supply; another 18 foot well gives small supply for house.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of LAKE ALMA NO.8, 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.	7	1	18	2	Dug	12	2,150			8	2,142	Glacial sand	Hard, clear		D, S	Sufficient for 10 head stock.
5	SW.	14	"	"	"	Dug	25	2,160			25	2,135	Glacial sand	Slightly hard, clear		D	Sufficient for house; another 15-foot well waters 15 head stock.
6	SW.	16	"	"	"	Bored	90	2,170	- 60	2,110	90	2,080	Ravenscrag gravel	Hard, clear, iron		S	Other well 20 feet deep; gravel aquifer, for house use.
7	SE.	17	"	"	"	Bored	52	2,190	- 20	2,170	52	2,138	Ravenscrag gravel	Hard, iron, "alkaline"		S	Sufficient supply; another similar well.
8	NE.	21	"	"	"	Bored	58	2,350	- 38	2,312	38	2,312	Glacial gravelly clay	Hard, clear		D, S	Sufficient for house only; haul water 2½ miles.
9	SE.	22	"	"	"	Dug	12	2,270	- 9	2,261	12	2,258	Ravenscrag grey sand	Hard, clear, "alkaline"		D, S	Sufficient supply; also wells in coulée.
10	NE.	22	"	"	"	Drilled	223	2,300	-123	2,177	207	2,093	Ravenscrag sand and gravel	Hard, iron, "alkaline"		S	Sufficient supply; other wells 80 feet and 400 feet deep. #
11	SW.	23	"	"	"	Dug	12	2,220	- 8	2,212	12	2,208	Ravenscrag sand	Soft, clear		D, S	Good supply; spring.
12	NW.	24	"	"	"	Dug	18	2,300			18	2,282	Ravenscrag clay	Soft, clear		D, S	Insufficient supply; other well 18 feet deep similar.
13	SW.	25	"	"	"	Dug	12	2,300	- 10	2,290	10	2,290	Ravenscrag gravel	Soft, clear		D, S	Insufficient supply.
14	NE.	28	"	"	"	Dug	17	2,425	- 12	2,413	10	2,415	Ravenscrag sand and gravel	Hard, clear		D, S	Insufficient supply; coulée dam for stock.
15	NE.	32	"	"	"	Drilled	127	2,380	-107	2,273	127	2,253	Ravenscrag ?	Hard, iron, red		S	Good supply.
16	SW.	34	"	"	"	Dug	20	2,480	- 12	2,468	20	2,460	Glacial sand and gravel	Soft, clear		D, S	Sufficient supply; other well 25 feet is "alkaline" and not used.
17	NE.	35	"	"	"	Drilled	160	2,400	-140	2,260	160	2,240	Ravenscrag sand	Hard, clear, iron		D, S	Good supply; 14 other wells.
18	SW.	36	"	"	"	Dug	50	2,375					Ravenscrag			N	Dry hole.
1	SE.	1	2	16	2	Drilled	285	2,250	-200	2,050	285	1,965	Ravenscrag fine sand	Hard, iron, turns red		S	Good supply; other 16 foot well gives small supply for house.
2	NE.	1	"	"	"	Drilled	265	2,300	-100	2,200	110	2,190	Ravenscrag quick-sand	Hard, clear, iron		D, S	Sufficient supply.
3	W½.	1	"	"	"	Drilled	255	2,275	-150	2,125	255	2,020	Ravenscrag sand				
4	SE.	5	"	"	"	Dug	12	2,290	- 5	2,285	1	2,289	Glacial gravel	Hard, clear, "alkaline"		D, S	Good supply.
5	NE.	5	"	"	"	Dug	12	2,290	- 10	2,280	12	2,278	Glacial sand	Medium hard, clear		D, S	Insufficient supply; because well plugs, 2 dry wells 100 feet and 20 feet in depth.
6	SE.	6	"	"	"	Dug	16	2,380	- 8	2,372	16	2,364	Glacial sand	Hard, iron, red		S	Good supply; others haul water from here.
7	NW.	6	"	"	"	Bored	40	2,310			40	2,270	Glacial sand	Hard, iron		D	Sufficient for house.
8	SE.	7	"	"	"	Dug	24	2,290			24	2,266	Glacial sand	Soft, clear		D, S	Insufficient supply; water is hauled.
9	NW.	8	"	"	"	Dug	13	2,290	- 11	2,279	13	2,277	Glacial gravel	Hard, clear		D, S	Sufficient supply.
10	SE.	8	"	"	"	Dug	16	2,300	- 12	2,288	16	2,284	Glacial ?	Soft, clear		S	Insufficient supply.
11	NE.	9	"	"	"	Dug	12	2,300	- 5	2,295	12	2,288	Glacial sand	Hard, clear	46	D, S	Another similar well.
12	SE.	12	"	"	"	Drilled	230	2,270					Ravenscrag ?				Dry hole.

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WELL RECORDS—Rural Municipality of LAKE ALMA NO. 8, 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	NW.	12	2	16	2	Drilled	200	2,340	-100	2,240	200	2,140	Ravenscrag quicksand	Hard, clear, "alkaline"	48	S	Sufficient supply.
14	SW.	13	"	"	"	Dug	16	2,350			16	2,334	Glacial sand	Hard, clear, iron		D, S	Insufficient supply; haul water in winter for stock.
15	SE.	14	"	"	"	Dug	6	2,300					Glacial sand and clay	Hard, clear		S	Sufficient supply.
16	NW.	14	"	"	"	Dug	15	2,300	- 13	2,287	15	2,285	Glacial sand and clay	Hard, clear		D, S	Sufficient supply.
17	NW.	15	"	"	"	Dug	10	2,300	- 8	2,292	10	2,290	Glacial sand	Medium hard, clear		D, S	
18	NE.	16	"	"	"	Dug	12	2,315	- 10	2,305	12	2,303	Glacial sand	Soft, clear		D, M	Sufficient for town. Farmers haul from here.
19	NE.	16	"	"	"	Dug	12	2,310	- 6	2,304	12	2,298	Glacial sand	Soft, clear		D	Sufficient supply for locomotives.
20	SE.	17	"	"	"	Dug	46	2,310	- 36	2,274	46	2,264	Glacial drift	Hard, "alkaline", blue colour		S	Sufficient supply.
21	NW.	18	"	"	"	Dug	12	2,320	- 6	2,314	12	2,308	Glacial gravel	Hard, clear		D, S	Good supply; 2 Other wells also yield good supplies.
22	NW.	20	"	"	"	Dug	12	2,350	- 9	2,341	12	2,338	Glacial gravel	Hard, clear		D, S	Insufficient supply; only enough for house.
23	NE.	20	"	"	"	Dug	10	2,300	- 7	2,293	10	2,290	Glacial sand	Hard, clear		D, S	Insufficient supply.
24	SE.	21	"	"	"	Dug	16	2,320	- 13	2,307	8	2,312	Glacial sandy clay	Hard, clear, "alkaline"		D, S	30 gallons a day.
25	SE.	21	"	"	"	Test auger	15	2,300					Glacial drift				Practically dry.
26	SW.	21	"	"	"	Dug	42	2,320					Glacial drift				Dry hole.
27	NW.	21	"	"	"	Bored	58	2,300					Glacial drift				Dry hole.
28	SW.	22	"	"	"	Drilled	200	2,300	-100	2,200	200	2,100	Ravenscrag	Hard, clear, "alkaline"		S	Good supply; haul drinking water.
29	NW.	22	"	"	"	Dug	16	2,300	- 12	2,288	16	2,284	Glacial gravel	Hard, clear, "alkaline"		D, S	Insufficient supply; spring gives good supply of water.
30	SE.	25	"	"	"	Dug	20	2,380			20	2,360	Glacial quick-sand	Hard, clear		D, S	Sufficient supply.
31	NE.	26	"	"	"	Drilled	310	2,375	-120	2,255	310	2,065	Ravenscrag coal white sand	Medium hard, soda, clear		S	Sufficient supply; other 30 foot well yields small supply for house use.
32	SE.	27	"	"	"	Dug	12	2,300	- 8	2,292	12	2,288	Glacial gravel	Hard, clear, "alkaline"		D, S	Fair supply; filled in at present.
33	SW.	30	"	"	"	Dug	20	2,420	- 18	2,402	20	2,400	Glacial gravel	Hard, clear, "alkaline"		D, S	2 other wells; same type of water.
34	NW.	31	"	"	"	Dug	10	2,320	- 8	2,312	10	2,310	Glacial sand	Hard, clear	45	D, S	
35	NE.	32	"	"	"	Dug	38	2,350			36	2,314	Glacial sand	Medium hard, clear			Insufficient supply; use lake and some water hauled.
1	SE.	1	2	17	2	Dug	18	2,270					Glacial clay	Hard, clear		D, S	Insufficient supply.
2	NW.	1	"	"	"	Dug	10	2,300	0	2,300	10	2,290	Glacial gravel	Medium hard, clear		D, S	Small supply from another well 28 feet deep. Sufficient supply; 8 barrels a day.
3	NE.	2	"	"	"	Bored	30	2,240	- 20	2,220	30	2,210	Glacial gravel	Hard, clear		D, S	Sufficient supply.
4	SE.	4	"	"	"	Dug	14	2,310	- 10	2,300	14	2,296	Glacial gravel	Medium hard, clear		D, S	Good supply; another similar well.

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WELL RECORDS—Rural Municipality of LAKE ALMA NO. 8, 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
5	NW.	4	2	17	2	Bored	80	2,310	- 38	2,272	80	2,230	Glacial sand	Hard, clear, iron		D, S	Sufficient supply.
6	SW.	5	"	"	"	Bored	45	2,320	- 35	2,285	35	2,285	Glacial clay	Hard, clear, iron, "alkaline"		D, S	Waters 54 head stock .
7	NE.	6	"	"	"	Drilled	46	2,310					Glacial drift	Hard, cloudy		S	Good supply; another well 14 feet deep used for house.
8	NW.	7	"	"	"	Drilled	209	2,370	-110	2,260	209	2,161	Ravenscrag sand	Hard, clear, iron		D, S	Sufficient supply.
9	SE.	8	"	"	"	Dug	10	2,300	- 6	2,294	4	2,296	Glacial sand	Slightly hard, clear		D, S	Good supply.
10	SE.	9	"	"	"	Dug	12	2,350	- 7	2,343	5	2,345	Glacial gravel	Soft, clear		D, S	Sufficient supply; also another well 30 feet deep used for stock.
11	SW.	9	"	"	"	Bored	35	2,310			35	2,275	Glacial sand	Soft, clear		D	Sufficient only for house; good supply in another well for stock.
12	NW.	10	"	"	"	Dug	16	2,370	- 11	2,359	5	2,365	Glacial sand	Hard, clear		D, S	Insufficient supply.
13	SE.	12	"	"	"	Dug	38	2,320	- 9	2,311			Glacial clay	Hard, clear, "alkaline"		D, S	Insufficient supply; hauls water.
14	SW.	12	"	"	"	Drilled	415	2,350	- 60	2,290	415	1,935	Eastend black slate and sand	Soft, soda, clear	44	D, S	Sufficient supply. #
15	NW.	15	"	"	"	Dug	10	2,320	- 7	2,313	10	2,310	Glacial gravel	Medium hard, clear		D, S	Sufficient for 5 head stock.
16	SW.	16	"	"	"	Bored	55	2,350	- 26	2,324	55	2,295	Glacial grey sand	Hard, iron, "alkaline", red		S	Good supply.
17	SE.	22	"	"	"	Dug	18	2,310	- 8	2,302	10	2,300	Glacial sand and gravel	Hard, clear, iron		D, S	Sufficient supply; another 18 foot well yields soft water.
18	NE.	22	"	"	"	Bored	26	2,324	- 12	2,312	6	2,318	Glacial gravel	Medium hard, cloudy		D, S, M	Hardly sufficient for the town. #
19	NE.	22	"	"	"	Bored	70	2,310			70	2,240	Glacial	Hard, clear, "alkaline"			
20	NE.	22	"	"	"	Drilled	28	2,320	- 13	2,307	28	2,292	Glacial sand	Hard, clear		D, S	Sufficient supply.
21	NW.	23	"	"	"	Dug	30	2,310	- 24	2,286	24	2,286	Glacial quick-sand	Hard, clear		D, S	Waters 70 head stock.
22	SW.	25	"	"	"	Dug	18	2,360	- 8	2,352	18	2,342	Glacial gravel and clay	Hard, clear		D, S	Sufficient supply.
23	NW.	25	"	"	"	Dug	65	2,370	- 55	2,315	55	2,315	Glacial boulders	Hard, clear, iron		D, S	Barely sufficient.
24	SE.	27	"	"	"	Bored	60	2,350	- 40	2,310	50	2,300	Glacial quick-sand	Hard, clear, iron		S	Good supply; another well used for house. #
25	SE.	27	"	"	"	Dug	22	2,310			18	2,292	Glacial sand	Medium hard, clear		D, M	Good supply for town; another well 22 feet deep is not used.
26	NE.	27	"	"	"	Bored	60	2,350	- 40	2,310	50	2,300	Glacial quick-sand	Hard, clear, iron		S	Sufficient supply.
27	SW.	28	"	"	"	Dug	20	2,300	- 10	2,290	20	2,280	Glacial sand	Hard, clear		D, S	Sufficient supply; another well beside lake used for stock.
28	SE.	30	"	"	"	Spring		2,340	0	2,340	0	2,340	Glacial sand	Hard, clear		S	Sufficient for stock.
29	NW.	36	"	"	"	Dug	38	2,390	- 26	2,364	38	2,352	Glacial gravel	Hard, clear, iron		D, S	Sufficient supply; yields 4 barrels a day.
1	SE.	2	2	18	2	Drilled	160	2,325	-140	2,185	160	2,165	Ravenscrag sand	Hard, clear, iron		D, S	Sufficient supply.

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WELL RECORDS—Rural Municipality of LAKE ALMA NO. 8, 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	SE.	6	2	18	2	Drilled	116	2,325	- 36	2,289	116	2,209	Ravenscrag sand	Hard, clear, iron		S	Sufficient supply; another well 40 feet deep, waters 46 head stock.
3	NE.	7	"	"	"	Dug	12	2,425	- 5	2,420	3	2,422	Glacial sand and gravel	Soft, clear		D, S	Waters 70 head stock; insufficient supply.
4	SW.	12	"	"	"	Dug	15	2,325	- 7	2,318	7	2,318	Glacial gravel	Soft, clear		D, S	Sufficient supply.
5	NE.	12	"	"	"	Bored	35	2,325			35	2,290	Glacial sand	Hard, clear		D, S	Insufficient supply; another similar well 25 feet deep.
6	SE.	18	"	"	"	Dug	16	2,450	- 7	2,443	7	2,443	Glacial sand	Soft, clear		D, S	Insufficient supply; waters 30 head stock, but has 118 head stock on farm.
7	NW.	19	"	"	"	Drilled	228	2,480			228	2,252	Ravenscrag sand	Hard, iron, turns brown	44	D, S	Sufficient supply.
8	NW.	20	"	"	"	Bored	30	2,360					Glacial clay	Hard, clear		D, S	Only sufficient for 5 head stock; another well in slough.
9	NE.	20	"	"	"	Dug	20	2,360					Glacial clay	Hard, clear		D, S	Sufficient for 5 head stock only.
10	SE.	23	"	"	"	Drilled	134	2,360			134	2,226	Ravenscrag sand	Hard, iron, turns red	44	D, S	Sufficient supply.
11	NE.	22	"	"	"	Drilled	230	2,375	-100	2,275	230	2,145	Ravenscrag fine sand	Hard, "alkaline", black sediment		S	Sufficient supply.
12	NE.	23	"	"	"	?	140	2,370	- 70	2,300	140	2,230	Ravenscrag quicksand	Hard, clear, iron		D, S	Sufficient supply.
13	NW.	24	"	"	"	Dug	24	2,325			20	2,305	Glacial sand	Soft, clear		D, S	Waters 150 head stock; another well 27 feet deep obtains a supply from sand.
14	NE.	24	"	"	"	Dug	15	2,380			8	2,372	Glacial sand	Slightly hard, clear		D, S	Very little water; insufficient supply.
15	NW.	27	"	"	"	Dug	27	2,370			27	2,343	Glacial sand	Hard, clear		D, S	Waters 30 head stock; neighbours haul 1 tank a week from here.
16	NE.	27	"	"	"	Dug	10	2,370			10	2,360	Glacial sand	Hard, clear, "alkaline"		N	Not used, water is too "alkaline".
17	SE.	28	"	"	"	Dug	30	2,375	- 10	2,365	30	2,345	Glacial sand	Hard, clear		D, S	Sufficient supply.
18	SW.	28	"	"	"	Dug	14	2,350	- 9	2,341	14	2,336	Glacial gravel	Soft, clear		S	Waters 35 head stock.
19	NE.	28	"	"	"	Drilled	170	2,450	-100	2,350	170	2,280	Ravenscrag?	Hard, clear, iron		S	Good supply of water.
20	SW.	30	"	"	"	Dug	14	2,455	- 10	2,445	4	2,451	Glacial gravel	Soft, clear		D, S	Insufficient supply; hauls water; another well is dry.
21	NW.	31	"	"	"	Dug	10	2,360			10	2,350	Glacial sand	Hard, clear		D, S	Good supply; neighbours haul water from here.
22	SE.	33	"	"	"	Drilled	180	2,460	- 80	2,380	180	2,280	Ravenscrag?	Hard, clear, iron		S	Sufficient supply.
23	SE.	36	"	"	"	Bored	42	2,365			42	2,323	Glacial sand and gravel	Medium hard, iron, clear		D, S	Sufficient supply; another well 6 feet deep waters 30 head stock.
1	NW.	1	3	16	2	Dug	16	2,400	- 12	2,388	16	2,384	Glacial gravel	Hard		D, S	Waters 22 head stock.
2	SE.	2	"	"	"	Dug	12	2,400	- 8	2,392	12	2,388	Glacial gravel	Hard, clear	43	D, S	Sufficient supply; another well not used.
3	SE.	3	"	"	"	Dug	20	2,350	- 18	2,332	20	2,330	Glacial gravel	Hard, clear, iron		D, S	Water comes quickly; good quality and supply
4	SW.	4	"	"	"	Dug	5	2,300	0	2,300	5	2,295	Glacial gravel	Hard, clear		D, S	Sufficient supply; another seepage well dry.
5	SE.	6	"	"	"	Dug	20	2,300	- 18	2,282	18	2,282	Glacial clay and sand	Hard, clear, iron		D, S	Waters 28 head stock; also spring in pasture.

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

WELL RECORDS—Rural Municipality of LAKE ALMA NO. 8, 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	SW.	9	3	16	2	Dug	12	2,400	- 9	2,391	9	2,391	Glacial sand	Hard, clear	42	D	Used for house; could be used for 10 head stock.
7	NW.	13	"	"	"	Dug	25	2,400	- 23	2,377	25	2,375	Glacial gravel	Hard, clear	42	D, S	Insufficient; enough for house only.
8	NE.	14	"	"	"	Dug	14	2,400	- 12	2,388	12	2,388	Glacial clay	Hard, clear		D	Insufficient supply; haul water for stock.
9	NW.	14	"	"	"	Dug	16	2,400	- 11	2,389	11	2,389	Glacial yellow clay	Hard, clear	40	D	Insufficient supply; haul water for stock.
10	SW.	16	"	"	"	Dug	18	2,400	- 13	2,387	13	2,387	Glacial gravel	Very hard, red sediment	42	D, S	Nearby lake not suitable for drinking. Yields 100 gallons a day; waters 25 head stock.
11	SW.	17	"	"	"	Dug	8	2,400	- 5	2,395	5	2,395	Glacial gravel	Hard, sour taste		D	Sufficient supply; stock watered at Lake Mather which has been condemned.
12	SE.	19	"	"	"	Dug	6	2,400	- 4	2,396	6	2,394	Glacial quick-sand	Medium hard, clear	50	D, S	Sufficient for 6 head stock.
13	SE.	20	"	"	"	Dug	10	2,400	- 8	2,392	10	2,390	Glacial gravel	Hard, clear	45	D, S	Waters 25 head stock; at one time was a flowing spring.
14	SE.	21	"	"	"	Dug	14	2,400					Glacial clay	Hard, clear		D, S	Insufficient supply; dry at present.
15	SW.	21	"	"	"	Bored	16	2,400									Dry hole.
16	SE.	23	"	"	"	Dug	16	2,350	- 15	2,335	15	2,335	Glacial gravel mixed	Very hard		D	House use only; use dam for stock.
17	SE.	28	"	"	"	Dug	20	2,400	- 19	2,381	19	2,381	Glacial sand and clay			D, S	Insufficient supply; also 2 other small wells.
18	SW.	28	"	"	"	Dug	13	2,400	- 10	2,390	10	2,390	Glacial sand	Soft, clear		D, S	6 barrels a day.
19	SE.	31	"	"	"	Dug	16	2,400									Dry hole.
20	NW.	32	"	"	"	Drilled	905	2,400	-700	1,700	?	?	Bedrock ?	Soft, soda		S	Sufficient for stock; also use a spring.
21	NE.	33	"	"	"	Dug	15	2,300	- 10	2,290	10	2,290	Glacial gravel	Hard, clear		D, S	Sufficient supply; waters 23 head stock.
22	SW.	34	"	"	"	Dug	16	2,300	- 10	2,290			Glacial clay	Hard, clear	45	D, S	Sufficient for 40 head stock; another well 40 feet deep contains soda and yields water having a bitter taste.
23	SW.	35	"	"	"	Dug	8	2,300	- 6	2,294	6	2,294	Glacial sand	Hard, cloudy	55	D, S	Insufficient supply; yields 1 barrel a day in summer. Haul water to here.
1	NW.	2	3	17	2	Dug	14	2,370	- 10	2,360	7	2,363	Glacial gravel	Medium hard, clear		D, S	Only waters 16 head stock.
2	NE.	2	"	"	"	Dug	22	2,350	- 12	2,338	16	2,334	Glacial sand	Soft, clear		D, S	Waters 130 head stock; another well 52 feet deep is not used.
3	SE.	3	"	"	"	Bored	28	2,340	- 25	2,315	28	2,312	Glacial gravel	Hard, iron		D, S	Poor supply in summer.
3a	NE.	9	"	"	"	Bored	76	2,360	- 46	2,314			Glacial clay	Hard, iron		D, S	Sufficient supply.
4	NE.	10	"	"	"	Bored	50	2,370			50	2,320	Glacial sand	Hard, iron, rusty	44	D, S	Insufficient supply.
5	NW.	11	"	"	"	Dug	25	2,355	- 20	2,335	25	2,330	Glacial sand	Hard, clear		S	Insufficient for stock; water enters slowly.
6	NW.	13	"	"	"	Dug	12	2,370	- 8	2,362	12	2,358	Glacial sand	Hard, clear		D, S	Insufficient supply; quicksand plugs well.
7	SW.	14	"	"	"	Dug	10	2,364	- 7	2,357	8	2,356	Glacial sand	Medium hard, clear		D, S	Sufficient supply; another well went dry.
8	SW.	16	"	"	"	Bored	68	2,380	- 18	2,362	68	2,312	Glacial sand	Hard, clear		D, S	Good supply; cannot be pumped dry.
9	NW.	16	"	"	"	Dug	56	2,400	- 51	2,349	56	2,344	Glacial sand	Medium hard, clear		D, S	Sufficient supply.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of LAKE ALMA NO.8, 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
10	SW.	17	3	17	2	Dug	20	2,350	- 14	2,336	20	2,330	Glacial fine sand	Hard, clear	40	D, S	Sufficient supply; also use a spring.
11	SE.	20	"	"	"	Dug	16	2,380			4	2,376	Glacial quick-sand	Medium hard, clear		D, S	Waters 20 head stock; 2 farmers haul water from this well.
12	SW.	20	"	"	"	Dug	25	2,400	- 22	2,378	22	2,378	Glacial sand	Hard, clear		D, S	Waters 20 head stock.
13	NW.	25	"	"	"	Dug	10	2,450	- 7	2,443	10	2,440	Glacial sand	Hard, clear		D, S	Sufficient supply.
14	NE.	28	"	"	"	Dug	52	2,440	- 48	2,392	52	2,388	Glacial sand	Hard, clear, "alkaline"		S	Sufficient supply
15	NE.	30	"	"	"	Dug	30	2,470			26	2,444	Glacial sand	Hard, clear		D, S	Waters only 15 head stock.
16	SW.	32	"	"	"	Dug	20	2,450			20	2,430	Glacial sand	Medium hard, clear		D, S	Waters 40 head stock.
17	SE.	33	"	"	"	Bored	45	2,460	- 42	2,418	45	2,415	Glacial sand	Hard, iron, turns rusty		D	Almost dry, 2 other wells are dry; insufficient for house.
18	NE.	33	"	"	"	Dug	28	2,360	- 22	2,338	18	2,342	Glacial drift	Hard, clear, "alkaline"		S	Barely sufficient supply.
19	SW.	34	"	"	"	Bored	48	2,475	- 6	2,469	48	2,427	Glacial gravel	Hard, clear, iron		D, S	Good supply.
20	SE.	35	"	"	"	Drilled	148	2,400	-120	2,280	148	2,252	Glacial gravel	Hard, clear	40	S	Waters 64 head stock.
1	NE.	4	3	18	2	Dug	18	2,340	- 4	2,336	4	2,336	Glacial gravel	Medium hard, clear		D, S	Waters 30 head stock.
2	SW.	5	"	"	"	Bored	52	2,350					Glacial ?	Salty		N	Water not fit for use.
3	NE.	6	"	"	"	Drilled	112	2,370	- 62	2,308	112	2,258	Ravenscrag sand	Hard, clear, iron		S	Haul drinking water; sufficient supply for stock.
4	SE.	8	"	"	"	Dug	7	2,350	- 3	2,347	0	2,350	Glacial sand	Soft, clear		S	Waters 30 head stock.
5	SE.	9	"	"	"	Spring	0	2,340	0	2,340	0	2,340	Glacial ?	Soft, "alkaline"		S	Waters 30 head stock.
6	SE.	17	"	"	"	Dug	24	2,420			24	2,396	Glacial clay	Hard, clear		D	Insufficient supply.
7	SW.	18	"	"	"	Bored	91	2,390	- 80	2,310	91	2,299	Glacial sand	Hard, clear		S	Water should not be used.
8	SE.	19	"	"	"	Bored	51	2,370	- 33	2,337	51	2,319	Glacial quick-sand	Hard, clear, iron		D, S	Sufficient supply; another well 8 feet deep yields soft water.
9	NE.	21	"	"	"	Dug	30	2,420	- 12	2,408	12	2,408	Glacial sand	Medium hard, clear		D, S	Insufficient supply; haul water to here.
10	SW.	27	"	"	"	Dug	16	2,440			16	2,424	Glacial gravel, sand	Medium hard, clear		S	Waters 50 head stock.
11	NE.	33	"	"	"	Dug	20	2,450			2	2,448	Glacial sand	Medium hard, clear		D, S	3 other wells; plenty of water for stock.
12	NE.	34	"	"	"	Dug	20	2,425					Glacial clay	Hard, clear, "alkaline"		D, S	Only waters 4 head stock.
13	SE.	35	"	"	"	Dug	10	2,450	- 5	2,445	2	2,448	Glacial sand	Medium hard, clear		D, S	Sufficient supply.

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