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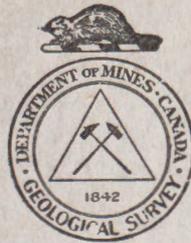
BUREAU OF ECONOMIC GEOLOGY
GEOLOGICAL SURVEY

PRELIMINARY REPORT
GROUND-WATER RESOURCES
OF THE
RURAL MUNICIPALITY
No. 48
SASKATCHEWAN

BY

B.R. MacKay, H. H. Beach & D. P. Goodall

Water Supply Paper No. 38



OTTAWA

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GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF

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 purposes and the smaller supplies of ground water required for domestic and stock-raising purposes by settlers, villages, and Indian reserves. The drought conditions resulted in repeated crop failures, and in a large number of farms in the acute drought areas of Saskatchewan and Alberta being abandoned. In an effort to relieve the serious situation a number of special studies of the water problem were begun by both Federal and Provincial Governments and allied organizations. The Federal Department of Agriculture undertook among other phases of the drought problem an investigation into the existing supplies of surface water, their conservation by means of dams and dug-outs, and how they could be made more generally available for irrigation. The Geological Survey of the Federal Department of Mines began an extensive study of the underground water conditions of southern Saskatchewan, this water being used principally for domestic and stock-raising purposes. For many years past the water problems in this and other provinces of Canada have engaged the attention of the Geological Survey, and considerable information had already been collected. A number of short reports dealing with the ground water conditions of special areas in Manitoba, Saskatchewan and Alberta have been published by both the Federal and Provincial Geological Surveys, but no systematic study of the ground water resources has been made up to the present.

Field Work

The senior author was in charge of this investigation and was instructed to cover as much of the territory as possible in the season. To effect this it was decided to maintain an

office at Regina and to have a large party consisting of twenty-six units, each to consist of three men who would cover their respective areas and visit every farm. In order that the information gathered by these different party units would be as complete and uniform as possible a questionnaire was prepared on which could be tabulated answers to all the essential questions required for a detailed study of the ground water conditions. An effort was made in the field by each party unit to fill in the questionnaire as completely as possible. In many instances, however, it was found that wells had either been abandoned, or the resident had little or no knowledge of the character of the water-bearing horizon and associated beds. When a party unit had completed the survey of a township the set of questionnaires and a report describing the characteristic features pertaining to the underground water conditions were mailed to the field office. Messrs. D.C. Maddox, F.H. Edmunds, H.H. Beach, H.N. Hainstock, R.D. MacDonald, and D.P. Goodall acted as supervisors in inspecting the work of the field units.

During the field season an area of 80,000 square miles, comprising 2,200 townships, was systematically examined, and records of approximately 60,000 wells were obtained, together with water samples for analyses obtained from 720 representative wells. These are systematically classified so that information pertaining to any well may be readily consulted. These records are supplemented by a set of 24 sectional sheets which cover all of southern Saskatchewan north to include township 32. Each sectional sheet comprises 120 townships. On these are indicated by symbol the location, type, and source of water of each of the 60,000 wells.

Publication of Results

The publication of such a great mass of detailed information is out of the question. This forms the permanent record of the Geological Survey. It is highly desirable, however, that a digest of the essential information pertaining to the ground water conditions of each municipality be furnished in convenient form to the municipality offices, to certain Provincial and Federal departments, and to allied organizations, at which centres it will be possible for any resident of the municipality or other party interested in any particular area to consult these reports. Should anyone find that he requires more detailed data than that contained in the report such additional information as the Geological Survey possesses can be procured on application to the Director, Bureau of Economic Geology, Department of Mines, Ottawa. In making such request the applicant should indicate the exact location of the area by giving the quarter section, township, range and meridian.

The reports have been prepared principally for farm residents, municipal bodies, and well drillers who are either contemplating sinking a well for the first time or considering deepening their well to a lower horizon in order to obtain a more abundant supply of water. In describing the water and geological conditions a certain number of technical terms must of necessity be used, and in case the reader should not be familiar with them their meanings have been defined in the glossary.

~~How to Use the Report~~

It is advisable that anyone desiring water information pertaining to a particular section of the municipality read over first the section dealing with the municipality as a whole, as by so doing he will be in a much better position to understand the section of the report dealing with the ground water conditions of

the area in which he is particularly interested. As he reads the text he should keep open before him for constant reference the accompanying map of the municipality on which are two figures, one showing the surface and bedrock geology of the area as they affect the ground water supply, and the other the relief and the location and type of water wells. The land relief is shown by means of lines of equal elevation, termed "contours", which lie generally at vertical intervals of 50 feet. The elevation above sea-level of each fourth line is indicated on the map. The statistical summary that follows the text gives at a glance the main characteristics of the wells in each township of the municipality and of the municipality as a whole as listed under the various sub-headings. This is followed by a section dealing with the analyses and quality of the water derived from the unconsolidated deposits and from bedrock. The table of well records gives the detailed information pertaining to each well. In this are tabulated the altitude of the well, its depth, the height to which the water will rise, and the elevation of the water horizon. The wells are grouped in the table by townships and are numbered from the lower right corner of the township westward and northward, and the location of each well by its quarter section is given. The elevations used were determined by aneroid barometer and were checked frequently by elevations on the published maps or by instrument surveys.

Where the ground surface of an area is comparatively flat an effort has been made to indicate the position of the water-bearing horizon in feet below the surface. In rolling country where there is a considerable difference of elevation within short distances a uniform figure for the depth to the water horizon is not generally possible. It then becomes necessary to indicate the position in terms of the elevation of a water-bearing bed in feet above sea-level.

Should one desire to ascertain at any location at which no well has as yet been sunk, the approximate depth at which a particular water-bearing horizon can be reached it is necessary to know two things--first, the elevation of the land surface, and second, the probable elevation of the water-bearing bed, or aquifer. The elevation of the land surface can be obtained by noting the position of the well site on the map. Figure 2, with respect to the two bounding contour lines of known elevation, and estimating either how far above the lower, or how far below the upper, control elevation line the well site lies. The approximate elevation of the water-bearing horizon at the well site can be obtained by noting on the table of well records the elevation of the horizon in the wells adjacent to the proposed location and from the range of elevations given and the relative positions of the wells shown on the map to select what appears to be its most probable elevation at the new well site. Having determined this elevation the depth that it is necessary to sink in order to tap it is the difference between its elevation and the elevation of the land surface. This method is especially applicable when the water-bearing horizon is in bedrock. In unconsolidated deposits the water horizon either conforms to the rolling land surface or occurs in isolated sand beds at various horizons that do not form a continuous water-bearing bed over a large area. Care should be taken in making any calculations for depth of water-bearing horizons to be sure that the elevations selected for the determinations occur in the same geological horizon, that is they should be either all in glacial drift or in the same bedrock formation.

The table of well records also contains notes on the temperature, quality, and quantity of the water being obtained from the various wells, and from this it is possible to draw reasonable conclusions as to the character and quantity of the water likely to be encountered at the proposed well site.

Glossary of Terms Used

Alluvium. Deposits of earth, silt, sand and gravel, and other transported material laid down by rivers, floods, or other causes upon land that has been submerged beneath the waters of lakes or rivers.

Aquifer. Layers or pockets of water-bearing sand or gravel that occur in unconsolidated deposits or as beds forming part of a bedrock formation.

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 deposits of gravel, sand, silt, and marl that have been laid down by the agency of water and which through a long period of time and the weight of the overlying sediments have become cemented into a solid rock.

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 section in a river valley that is 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 exerted by the water at any given point. It is due mainly to the weight of the column of water occurring at higher levels in the same aquifer or water-bearing bed.

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

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

Potable. Suitable for drinking.

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.

Water-bearing Horizon. A layer in either unconsolidated deposits or in bedrock formations that is water-bearing; same as aquifer.

Zone of Saturation. An area in which the permeable rocks are saturated with water that will move under ordinary hydrostatic pressure.

Names and Descriptions of Geological Formations,
Referred to in These Reports

Wood Mountain Formation. The local name given to a series of gravel and thin sand beds which have a maximum thickness of 50 feet, and which occurs as isolated patches on the higher elevations of Wood mountain. They are the youngest of the consolidated rocks and, where present, rest upon the beds of the Ravenscrag formation.

Cypress Hills Formation. The local name given to a series of conglomerates and sand beds occurring in the southwest corner of Saskatchewan, which rests upon the Ravenscrag or older formations. The thickness of this formation varies from 30 to 125 feet.

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

Whitemud Formation. The local name given to a series of white, grey, and buff coloured clays and sands that varies in thickness from 10 to 75 feet. The base of this formation grades in places into a coarse, limy sand having a maximum thickness of 40 feet.

Eastend Formation. The local 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 eastern escarpment of the Missouri coteau. The thickness of the formation seldom exceeds 40 feet.

Marine Shale Formation. The general name given to the thick deposit of incoherent, dark grey to dark brownish grey, plastic shales, which weather light grey to buff in places. It forms the uppermost bedrock formation over the greater part of eastern and central Saskatchewan. In the western part of the province it consists of a series of dark shales termed the Bearpaw formation. This is underlain by a series of sands, shales, and coal seams, known as the Belly River formation.

WATER-BEARING HORIZONS OF THE MUNICIPALITY

Rural municipality No. 48 is an area of 216 square miles in southwestern Saskatchewan. The municipality consists of six townships described as townships 4 and 5, ranges 16, 17, and 18, west of the 3rd meridian. Frenchman River valley, locally known as Whitemud valley, trends across the area from the centre of the western boundary in an easterly and northeasterly direction to the northeast corner. The valley is over 2 miles wide in many places. The banks are very steep, and their continuity is interrupted at intervals by the entrance of small stream channels from the north. Slumping has taken place along the banks throughout the full length of the valley and forms a border of rough hillocky terrain on both sides of the valley floor which lies at an elevation of about 350 feet below the adjoining uplands. Broad reaches of flat hay meadows, in many places over a mile wide, extend down the valley bottom as far as the bend in the river in the northern part of township 5, range 17. From here down stream to the eastern boundary of the municipality the flats are less continuous. The stream channel and those of convergent streams from the north in cutting through soft bedrock shales have developed an irregular "badland" topography. The channel of Frenchman river itself is insignificant in width in comparison with the valley it occupies. The stream meanders greatly in its course, forming an almost continuous series of oxbows. Although this stream may carry a large flow of water during the spring run-off it usually ceases to flow in August. Sufficient water remains in depressions along the channel, however, to provide ample supplies for stock during the dry seasons.

The surface of the uplands south of the valley rises gently to a maximum elevation of approximately 3,000 feet above sea-level at the highest points of an east-west trending range of low hills and falls away to an elevation of approximately 2,950 in

the southeast corner of the municipality. In the northwestern corner of the municipality the maximum elevation of 3,300 feet above sea-level is reached.

The farming communities of this municipality are confined to township 4, and a mile wide belt along the south of township 5, range 16, the south half of township 4, ranges 17 and 18, south of the river, and the southwest half of township 5, range 18, north of the river. The remainder of the municipality consists of grazing leases held by several large ranches.

As no contoured topographic map of this area exists, considerable difficulty has been experienced in determining the elevation relationship existing between various wells, and in tracing aquifers. The elevations cited have been determined by aneroid barometers which were checked, where possible, against the Geodetic Survey and railroad bench marks and other points of known elevation in the area. Due, however, to the daily barometric changes and the lack of accurately determined bench marks throughout the municipality there is a possibility of appreciable errors in some of the altitude determinations given.

Water-bearing Horizons in the Unconsolidated Deposits

Recent deposits of clay interbedded with sand, silt, and gravel occur along the bottom of Frenchman valley and its tributaries. In the small coulées where the gradient is steep these deposits are not generally more than a few feet thick, but wells sunk in them usually produce fair supplies of hard water that is used for drinking. A much greater thickness of sediments with fewer porous zones covers the bottom of Frenchman valley. These sediments are derived from various sources but principally from the erosion of the glacial drift on the uplands and of the Bearpaw shales exposed along the valley sides. The waters in the valley are highly "alkaline" and suitable only for stock. Recent deposits of sand and gravel interbedded with clay also occur around the edges of some of the sloughs on the rolling uplands south of the

river. These deposits seldom exceed 20 feet in depth. The wells in them produce a constant supply of hard water throughout the summer months, but they cannot always be depended upon for winter supply.

A great continental ice-sheet covered the land surface of southern Saskatchewan many thousands of years ago. As the ice-sheet advanced southward over the municipality, and again as it retreated toward the north as a result of the melting of the ice at its southern margin, it distributed its load of clays, boulders, sands, and gravels unevenly over the old land surface. This material is known as glacial drift. Where the ice front was stationary for a long time there was formed an accumulation of glacial debris, which in places was partly sorted by the action of streams issuing from the front of the melting ice and in other places consists of unsorted boulder clay. This material, referred to as terminal moraine has a very uneven surface and is generally more porous than the boulder clay or till of the ground moraine that occupies areas between the terminal and has a more even surface. The prominent belt of irregular hills extending throughout the southern part of this municipality and to its northwestern corner is a typical terminal moraine. The glacial drift in this belt has in places a thickness of 150 feet or more. Numerous pockets of gravel and sand occur irregularly interspersed through the boulder clay of the northern half of township 4 and the southern half of township 5, range 16. These pockets usually lie within 20 feet of the surface and yield fair supplies of hard water that is used for drinking. Farther west, where the terminal moraine is less prominently developed, these aquifers are scarce and many of the residents of this part of the municipality are obliged to sink seepage wells near the sloughs to obtain drinking water or haul the water from a distance. The few pockets of sand or gravel that have been encountered in the boulder clay are generally at

depths of 20 to 100 feet from the surface. They usually yield fair supplies of hard water that is used for drinking. It is impossible to predict where or at what depth the water-bearing pockets will be encountered, as many dry holes have been sunk in this area. Farmers situated in the southwestern part of the area generally find it necessary to conserve the surface run-off by constructing dams or dugouts or by sinking wells into the underlying bedrock formations. This latter procedure is costly, but the bedrock can be expected generally to yield sufficient water for stock requirements of the average farm.

North of the river in the northwestern part of the municipality the glacial drift is much thinner. Erosion has removed much of the drift in the vicinity of the river and the underlying bedrock is exposed in many places. Over the uplands of the northwest corner, the drift probably does not exceed 50 feet in thickness. A few small water-bearing pockets of gravel and sand occur scattered through the boulder clay, but although the water found in these deposits is of fair quality its supply is usually inadequate to meet farm requirements.

Water-bearing Horizons in the Bedrock

The bedrock formations underlying the glacial drift in this municipality are known as the Ravenscrag and the Bearpaw. Both are exposed in many places along the banks of Frenchman valley. The upper, or Ravenscrag, formation is composed of soft, grey to blue-grey sandstones interbedded with harder sandstone and dark-coloured shales. A small coal seam occurs at an elevation of 3,250 to 3,290 feet above sea-level in the northwest corner of the municipality within the area outlined by the A-boundary on the accompanying map (Figure 1). Wells sunk in this area usually encounter water in the coal seam or in the sand beds immediately below the coal at depths not exceeding 150 feet. The water is under a slight hydrostatic pressure and usually rises in the wells

a few feet above the aquifer. It is hard and is used for drinking.

In the rest of the municipality deep wells have encountered only that part of this formation that lies below the coal horizon. Water-bearing sands, blue-grey to light grey in colour, occur near the base of the Ravenscrag, and are a reliable source of ground water supplies over a large area to the north and west of this municipality. Only a few wells in the southwest part of this district have been sunk to this aquifer. Many of the springs along the north and west banks of Frenchman valley are thought to have their origin in these sands. The exact southern limits of the Ravenscrag formation are not known, but the formation probably underlies the drift throughout the greater part of the area south of the river. Due to the thickness of the drift, it may be necessary to sink wells to depths of 100 to 150 feet before the water-bearing sands of the Ravenscrag are penetrated. A thick bed of very fine grey sand is believed to underlie the coarse sands of the lower part of the Ravenscrag formation, at an approximate elevation of 2,950 feet above sea-level in the southwestern corner of the municipality. This sand, known as the Eastend formation or possibly the upper part of the Bearpaw formation, yields fairly large supplies of water, which although salty has been used for domestic requirements.

The Bearpaw shale underlies the entire municipality below an approximate elevation of 2,920 feet above sea-level. Frenchman river has cut its bed down to this formation throughout the full length of the municipality. The grey shales of this formation outcrop at many localities both along the sides and the bottom of the valley. A few thin beds of fine sand may occur at the top of the formation. The greater part of it is composed, however, of fine-grained, compact, dark grey marine shale. Many holes sunk into the shale were dry, and others yielded only small

quantities of highly "alkaline", and salty water which is unfit for human consumption and not very suitable for stock. Drillers are, therefore, advised to confine their search for water to the Recent deposits along Frenchman valley and to the glacial deposits and the Ravenscrag formations on the uplands, little water suitable even for stock use can be expected below an elevation of 2,900 feet above sea-level in any part of the municipality.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 4, Range 16

Deposits of Recent alluvium in this township are limited to a few feet of top soil in the sloughs and depressions between the hills. These deposits are usually made up of clay mixed with varying amounts of sand and fine gravel. Although quite porous these beds cannot retain water for long unless frequently replenished owing to the relatively high rate of evaporation from the surface. Water from this source is frequently soft and generally used for drinking unless contaminated by organic material. The yield from the shallow wells in slough bottoms, although varying considerably constitute a valuable addition to the water supplies in some localities.

Numerous small pockets of sand and gravel occur in the boulder clay at depths of not more than 20 feet from the surface in the terminal moraine covered area of the north and central parts of the township. These deposits are usually situated on the lower slopes and in the depressions between the hills and are the principal source of ground water supplies for this part of the township. The water is medium hard to soft and most of the supplies are reported to be suitable for household use. South of the moraine in the southern part of the township very few porous zones are to be found in the drift. Here the farmers depend upon uncertain supplies of water obtained from shallow seepage wells dug beside sloughs. These wells usually become dry in late summer and are not replenished

until spring, making it necessary to haul water several miles during part of the year.

A well on NE. $\frac{1}{4}$, section 27, is producing hard water that comes from a sand aquifer at a depth of 110 feet and is used for drinking. The water rises to within 60 feet of the surface. It has not been determined whether this water is being derived from the glacial deposits or the underlying Ravenscrag formation. The areal extent of this aquifer is not known, as no other wells have been sunk to this depth in the township.

Lower Ravenscrag (bedrock) sands should be encountered at depths of 100 to 150 feet from the surface throughout the township, with the possible exception of a narrow belt along the southern border including sections 1 to 6 where it is possible that the Ravenscrag has been removed by erosion and the Bearpaw shales immediately underlie the glacial deposits. Wells sunk to the sand beds of the Ravenscrag should produce ample supplies of water that probably would be suitable for both domestic and stock use.

Water conditions in the underlying Bearpaw formation are discussed in the preceding section of this report dealing with the municipality as a whole.

Township 4, Range 17

Deposits of Recent alluvium not exceeding 40 feet in thickness cover the bottom of the river valley in the northern part of the township. These deposits are made up of yellow clays and silts interbedded with an occasional layer of fine sand. A single well dug on SE. $\frac{1}{4}$, section 32, is producing small but constant supplies from these deposits, but the water is too highly "alkaline" for household use. It is probable that this condition of the water is prevalent throughout the valley floor. As the Recent deposits are of negligible extent south of the river they cannot be regarded as a source of water.

Water conditions in the glacial drift are also poor in this township. Thin scattered pockets of sand or gravel are interspersed through the boulder clay to depths of 30 to 40 feet in the low areas between the hills throughout the east-central part of the township. Wells sunk to these pockets generally yield small supplies of hard water, suitable for domestic use and sufficient for about 10 head of stock. Deeper drilling in the glacial drift has not increased the supply of water and where the porous sand or gravel pockets are small or absent only meagre supplies of highly "alkaline" water can be expected from the heavy boulder clay. Lower Ravenscrag sands carrying good supplies of water are known to underlie the glacial drift throughout the central part of the township. A well bored in NE. $\frac{1}{4}$, section 15, tapped these water-bearing sands at a depth of 170 feet. The water is hard and is used for drinking. It is under hydrostatic pressure and rises in the well about 15 feet above the aquifer. Probably this horizon will be encountered at depths of 150 to 180 feet throughout that part of the township, south of the river, with the exception of the extreme southern sections, where the Bearpaw shale is believed to immediately underlie the drift. This assumption is born out by the fact that a well sunk to a depth of 220 feet in sec. 33, tp. 3, range 17, directly south of this area, was entirely dry.

The Bearpaw shales underlie the mantle of Recent alluvium in the river valley. As the water conditions in the shale are extremely poor, search for water in the valley should be confined to the Recent sands and silts. The Bearpaw underlies the Ravenscrag formation at an approximate elevation of 2,900 feet above sea-level throughout the remainder of the area, with the exception of the extreme southern sections where no Ravenscrag exists. Although no deep drilling has been done into the Bearpaw in the central and southern parts of the township it is probable that the shale will prove to be as poorly productive as in other areas where it has been penetrated.

Township 4, Range 18

Water conditions in the Recent alluvium of this township are similar to those described for township 4, range 17.

The thick layer of glacial drift covering the upland part of the township is made up principally of boulder clay containing very few pockets of porous materials necessary for any large accumulation of ground water. In the south half of section 7 two wells have penetrated water-bearing sands and gravels at depths of 40 to 60 feet. The water in these wells does not rise above the aquifer; it is hard, and is used for drinking and the supply is quite sufficient for farm requirements.

Remote from the southwest corner, farmers of the upland part of the township are less fortunate, and are obliged to dig shallow seepage wells beside sloughs or go to the expense of sinking wells to the lower sands of the Ravenscrag bedrock formation. The Ravenscrag is encountered at depths of 120 to 160 feet throughout a zone averaging 2 to 3 miles in width extending across the township south of the river valley. The supply from this source is generally amply sufficient for local farm requirements, and the water although often slightly "alkaline" is reported to be quite suitable for household use. The water conditions are much poorer in southern sections of the township. This is due to the absence of the Ravenscrag formation beneath the drift. Here the glacial deposits rest either directly upon the Bearpaw shales or upon a bed of fine sands and silts forming the top of the Bearpaw formation. Wells penetrating the fine sand bed that occurs at an approximate elevation of 2,930 feet above sea-level, or at depths of 200 to 300 feet depending on surface elevation, can be expected to yield fairly large supplies of salty water suitable for the watering of stock. Drilling to depths below 2,900 feet is inadvisable in any part of the township as the dark grey, non-water-bearing Bearpaw shale underlies the entire area below this elevation. Since the shale occurs immediately below the

Recent alluvium of the valley bottom, the search for water in this part of the township should be confined to depths not exceeding 30 feet.

Township 5, Range 16

Recent alluvium deposits of fine sands and silt are mostly confined to the river valley that occupies the northern half of this township, and are described in the general section of this report. In addition to these fine-textured sediments coarser sands and gravels occur at the confluence of the numerous small stream channels of relatively steep gradient that flow down from the highlands to the north. These streams are fed by springs from the Ravenscrag formation; therefore, water of good quality is to be expected at shallow depths from the alluvium deposits on this side of the valley.

A number of wells sunk to depths of 10 to 20 feet have encountered sand or gravel pockets in the glacial drift in the southern or upland part of the township. The yield from the drift is dependant upon the areal extent of the gravel or sand pocket encountered. Several of the wells in this district are producing sufficient water for local requirements, whereas others yield a supply barely sufficient for a few head of stock. The water from these wells, however, is said to contain only small amounts of "alkali" and is regarded by those who use it as quite suitable for household use.

No wells have been sunk deeper than 20 feet in the drift or to the underlying bedrock formations in this township. The Lower Ravenscrag formation underlies the drift throughout the area south of the river valley. Although this formation is exposed at several places along the edge of the valley, it may be buried under 100 feet or more of drift in the southern part of the township. Fairly large supplies of water are to be expected from wells sunk to the sand horizons in this formation.

The underlying grey shales of the Bearpaw formation are exposed at many places at the bottoms of the slopes of the river valley throughout the northern half of the township. Since little water suitable for domestic use or farm requirements is to be expected from the shales, the search for water in this township should be confined to the Recent deposits along the valley and to the glacial drift and underlying Ravenscrag formation on the southern uplands.

Township 5, Range 17

Frenchman River valley and its tributaries occupy a large proportion of this township of range land. No wells have been sunk in this area, but numerous flowing springs occur in the northern half of the township and produce an abundance of water for the stock. Most of these springs are situated on the north or west side of the river valley. Some are flowing from Recent alluvium of the smaller stream channels, others come from glacial drift of the highlands to the west, but probably all have their origin in the Lower Ravenscrag sands. This formation underlies a thin mantle of drift along the west side of the township, and is exposed in several places along the edge of the valley, as shown on the accompanying map (Figure 1). Wells sunk in this area should encounter the productive aquifers of the bedrock at depths not exceeding 50 feet.

Township 5, Range 18

Shallow deposits of sand and gravel interbedded with clay occur in the bottoms of the coulées along the southern border, and in the northeast corner, of this municipality. A spring in NW. $\frac{1}{4}$, section 5, at an elevation of about 3,000 feet above sea-level, yields abundant supplies of soft, clear water from these sediments. This flow of ground water is believed to come from the Ravenscrag formation outcropping along the banks of this coulée. The water finds its way to the surface through the Recent deposits. Springs

of similar origin are situated in a coulée in the northeast corner of the township.

Glacial drift, ranging in depth from a few feet along the edges of the coulées to 50 feet or more in the highlands to the northwest, overlies bedrock throughout the greater part of the township. Small, scattered pockets of sand or gravel occur at varying depths in the boulder clay and, where tapped by wells, produce limited supplies of hard water.

The Ravenscrag (bedrock) formation underlies the drift throughout the entire township with exception of a few areas of low elevation in the coulées. Ground water occurs in at least three different sand horizons in this formation. The upper water sand occurs only in the northwestern part of the township in sections 19, 20, 29, 30, and 31, at depths of 60 to 80 feet from the surface. Another aquifer of wider areal extent occurs from 5 to 20 feet below a coal seam. This aquifer is thought to underlie the area enclosed by sections 15, 18, 31, and 34, and is outlined on the accompanying map (Figure 1). South of this area a third sand aquifer lying at the base of the Ravenscrag has been tapped by wells sunk to depths of 60 to 110 feet which produce fair supplies of hard water. This basal sand is considered to extend throughout the remainder of the township with the exception of a narrow belt along the south where dry holes have been sunk to the underlying Bearpaw shales without encountering these sands.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL
MUNICIPALITY OF NO. 48, SASKATCHEWAN

West of 3rd meridian	Township Range	4	4	4	5	5	5	Total No. in Municipality
		16	17	18	16	17	18	
<u>Total No. of Wells in Township</u>		46	21	21	13	0	24	125
No. of wells in bedrock		0	1	2	0	0	9	12
No. of wells in glacial drift		46	16	18	13	0	15	108
No. of wells in alluvium		0	4	1	0	0	0	5
<u>Permanency of Water Supply</u>								
No. with permanent supply		32	16	19	11	0	20	98
No. with intermittent supply		8	5	0	0	0	1	14
No. dry holes		6	0	2	2	0	3	13
<u>Types of Wells</u>								
No. of flowing artesian wells		0	0	0	0	0	0	0
No. of non-flowing artesian wells		1	1	0	1	0	10	16
No. of non-flowing artesian wells		39	20	16	10	0	11	96
<u>Quality of Water</u>								
No. with hard water		34	20	15	9	0	15	93
No. with soft water		6	1	4	2	0	6	19
No. with salty water		0	0	0	0	0	0	0
No. with "alkaline" water		11	6	2	2	0	0	21
<u>Depth of Wells</u>								
No. from 0 to 50 feet deep		45	19	15	13	0	15	107
No. from 51 to 100 feet deep		0	1	2	0	0	4	7
No. from 101 to 150 feet deep		1	0	2	0	0	4	7
No. from 151 to 200 feet deep		0	1	2	0	0	1	4
No. from 201 to 500 feet deep		0	0	0	0	0	0	0
No. from 501 to 1,000 feet deep		0	0	0	0	0	0	0
No. over 1,000 feet deep		0	0	0	0	0	0	0
<u>How the Water is Used</u>								
No. usable for domestic purposes		36	15	19	11	0	17	98
No. not usable for domestic purposes		4	6	0	0	0	4	14
No. usable for stock		40	21	19	11	0	21	112
No. not usable for stock		0	0	0	0	0	0	0
<u>Sufficiency of Water Supply</u>								
No. sufficient for domestic needs		28	14	19	11	0	20	92
No. insufficient for domestic needs		12	7	0	0	0	1	20
No. sufficient for stock needs		11	6	6	4	0	13	40
No. insufficient for stock needs		29	15	13	7	0	8	72

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 and unless the figure is very high it does not imply that the water is too alkaline for irrigation purposes. The analyses are given in parts per million--that is, in parts by weight of the constituents in 1,000,000 parts by volume 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 practically all rocks, but in larger amounts 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 teakettles 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, and waters that contain a large amount of them cannot be used for irrigation.

Sulphates

Sulphates (SO_4) are one of the common constituents of natural water. The sulphate salts most commonly found are sodium sulphate (Glauber's Salt, Na_2SO_4), magnesium sulphate (Epsom

Salts, $MgSO_4$) and calcium sulphate ($CaSO_4$). Waters that contain these sulphate salts are called "sulphated waters". When the water contains large quantities of the sulphate of sodium ("White Alkali") it is injurious to vegetation and cannot be used for irrigation. According to Thresh and Beale, London, the continued use of water that contains 1,200 parts or more per million of magnesium sulphate and 500 parts or more per million of sodium sulphate causes diarrhoea and scour among stock, and one half this quantity makes the water unfit for domestic use.

Chlorides

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

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 out 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 had 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 to the bicarbonates of calcium and magnesium, and permanent hardness 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. The following table from "The Examination of Water and Water Supplies" by Thresh and Beale, London, 1925, can be used for determining the relative hardness of a water.

<u>Total Hardness</u>	<u>Character</u>
Less than 50 parts per million.	Very soft
50 - 100 " " "	Moderately soft
100 - 150 " " "	Slightly hard
150 - 200 " " "	Moderately hard
200 - 300 " " "	Hard
Over 300 " " "	Excessively hard

Many of the Saskatchewan water samples analysed by the Geological Survey 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.

The term "alkaline" has been applied rather loosely to some ground waters. Its original meaning was a chemical one and it implied that the substance in question would neutralize acids. The carbonates of calcium, magnesium, and sodium are the only compounds found in ground water that would make it alkaline chemically. A later application of the term "alkaline" was to soils that contain sufficient "black alkali" or "white alkali" to make them unfit for vegetation. In the Prairie Provinces a water is usually considered to be alkaline when it contains so much dissolved solids that it is not very suitable for human consumption; except that 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".

Analyses of Water Samples from the Municipality of

No. 48, 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.	Alka- linity	CaO	MgO	SC ₄	Na ₂ O	Solids	CaCO ₃	CaSO ₄	MgCO ₃	MgSO ₄		Na ₂ CO ₃	Na ₂ SO ₄
1.	SE.	5	4	16	3	18	1,783									(4)	(1)		(2)		(3)		(5)	xl

Water samples indicated thus, xl, are from glacial drift or other unconsolidated deposits. Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5) are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water. Hardness is the soap hardness expressed as calcium carbonate (CaCO₃). Analysis No. 1 by Provincial Analyst, Regina. For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

No samples of ground water were taken for analysis from this municipality by the Geological Survey. The following discussion is based upon analyses made of water collected in adjoining municipalities in which both the unconsolidated deposits and the underlying bedrock formations show a close similarity.

Water from Recent silts and fine sand of Frenchman valley in adjoining municipalities carry a relatively high percentage of the soluble sulphates of sodium (Na_2SO_4 , Glauber's Salt) and magnesium (MgSO_4 , Epsom Salts), with smaller amounts of sodium chloride (NaCl) and magnesium carbonate (MgCO_3). The combined sodium and magnesium sulphate content often exceeds 2,000 parts per million. The water is mainly used for stock.

Ground water from Recent deposits of the smaller stream channels is in part derived from the Lower Ravenscrag sands. It has had little or no contact with the Bearpaw shales and, consequently, is usually only slightly "alkaline".

The quality of water from wells sunk in the glacial drift often show a wide variation throughout any one municipality, so much so that although one well may produce water suitable for all farm requirements, a neighbouring well, only a few yards away, may contain water with too high a mineral content to be of use even for stock. It must not be inferred, therefore, that if water of poor quality is encountered in one well that similar conditions exist over a large area. The small seepages of ground water from the boulder clay or from small, isolated pockets of sand interspersed through the clay is generally excessively hard and highly "alkaline". The total solid contents present are largely made up of Glauber's Salt and Epsom Salts with smaller quantities of calcium and magnesium carbonate. This water is generally unsuited to household use, but may be used for watering stock.

Wells sunk in boulder clay in this municipality are usually situated beside sloughs or artificially constructed dugouts and derive their water by seepage. The clay acts as a filter and if the surface water in the reservoir does not contain a high concentration of salts in solution due to continuous evaporation, or is not contaminated by organic material, the water in the well will be quite suitable for drinking. The analysis showing the relative amounts of dissolved solids given on the accompanying table of water analyses was supplied by the owner of a well of this type, situated on SE. $\frac{1}{4}$, sec. 5, T₄, R₁₆. The calcium carbonate (CaCO_3) and calcium chloride (CaCl_2) are not detrimental to health, but contribute greatly to the hardness of the water.

Waters from the more extensive sand and gravel deposits in the moraines are usually of better quality than those from the boulder clay. These waters are invariably hard, but the sulphate content is seldom sufficiently high to render the water unsuitable for household use.

Water from the Bedrock

Some variation has been found in the character of waters that come from the Ravenscrag formation. The following generalizations are based on information given by the residents using wells deriving their supplies from this formation. In general, water from the upper part of the Ravenscrag, which is the source of most of the bedrock water used on the uplands, is quite hard, although charged with varying amounts of sulphate salts, particularly sodium sulphate (Glauber's Salt). This water is considered to be suitable for all domestic and stock raising requirements. Water derived from a coal seam aquifer may be more highly mineralized than supplies from sand beds. The combined sulphates are not usually in excess of 1,200 parts per million. Iron often forms an objectionable impurity in water from the Ravenscrag but may be largely removed by aeration and filtration. A simple method that has proved effective in many localities in the

province is to suspend a sheet of galvanized, corrugated iron between the pump and the trough or other container. The iron in the water upon coming in contact with the air is oxidized and settles as a brown precipitate on the bottom of the container.

The basal sand beds of the Ravenscrag formation in general yield water of good quality. Springs issuing from these sands form an important source of supply along Frenchman valley. An analysis made of water from a spring, located near the southern boundary of the municipality to the north, is believed to be representative of water from the lower part of this formation. The analysis indicated a total solid content of 360 parts per million, made up of approximately 80 parts per million each of calcium carbonate, magnesium carbonate, sodium sulphate and magnesium sulphate and 15 parts per million of common salt in solution. The water has a total hardness of 280 parts per million causing it to be termed "hard". The small amount in which the sulphate salts are present, however, makes this water of excellent quality for household use.

Water derived from springs along the valley having their source in the Bearpaw shale is highly mineralized and unfit for human consumption. The combined Glauber's Salt (Na_2SO_4) and Epsom Salts (MgSO_4) content is believed to be frequently in excess of 2,000 parts per million and common salt (NaCl) is seldom less than 200 parts per million. Although no analyses have been made of water obtained from wells deriving their supply in the Bearpaw shales it is probable that the small supplies obtainable will be similar in character to water derived from the springs in this formation along the bottom of Frenchman valley.

WELL RECORDS—RURAL MUNICIPALITY OF NO. 48 SASKATCHEWAN

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	SW.	1	4	16	3	Dug	20	2,963	- 17	2,946	17	2,946	Glacial blue clay	Hard, clear		D, S.	Insufficient for local needs.
2	NW.	2	"	"	"	"	20	2,935	- 16	2,919	16	2,919	" " "	" clear,	47	S	" " " " .
3	NE.	2	"	"	"	"	16	2,955	- 14	2,941	14	2,941	and sand Glacial blue clay	" "	47	D	" " " " .
4	NE.	3	"	"	"	"	10	2,940	- 5	2,935	5	2,935	" " "	"alkaline"	47	D, S.	" " " " ; haul water for stock
5	SE.	4	"	"	"	"	15	3,025	- 14	3,011	14	3,011	" " "	" "	48	D, S.	" " " " " " " "
6	SW.	4	"	"	"	"	16	3,030	- 10	3,020	10	3,020	" yellow "	" "	47	D, S.	" " " " " " " "
7	SE.	5	"	"	"	"	18	3,020	- 15	3,005	15	3,005	" clay "	" "	46	D,	Sufficient " " " #
8	NE.	5	"	"	"	"	10	3,030	- 8	3,022	8	3,022	" yellow "	Hard, clear, "alkaline"	48	D, S.	Insufficient for local needs. Hauls for house.
9	NW.	7	"	"	"	"	15	3,070	- 9	3,061	9	3,061	" " "	Hard, clear		S	" " " " " " "
10	NE.	7	"	"	"	"	21	3,045	- 18	3,027	18	3,027	" sand "	Soft "		D	" " " " .
11	NE.	8	"	"	"	"	16	2,875	- 11	2,864	11	2,864	" blue clay "	Hard, "alkaline"	47	D, S.	Sufficient for local needs.
12	SE.	17	"	"	"	"	12	3,040	- 7	3,033	7	3,033	" sand "	Soft, clear	47	D, S.	" " " " .
13	NW.	18	"	"	"	"	16	3,065	- 0	3,065	0	3,065	" blue clay "	Hard "	46	D, S.	Insufficient for " " , hauls for stock.
14	SW.	19	"	"	"	"	16	3,105	- 14	3,091	14	3,091	" " "	" "	47	D, S.	" " " " .
15	NW.	23	"	"	"	"	6	2,980	- 1	2,979	1	2,979	" gravel "	"alkaline" Hard, clear,	47	D, S.	Sufficient for local needs.
16	SE.	25	"	"	"	"	9	2,980	- 4	2,976	4	2,976	" sand "	Hard, clear	47	D, S.	" " " " .
17	SW.	26	"	"	"	"	4	2,970	- 2	2,968	2	2,968	" " "	" "	48	D, S.	" " " " .
18	NE.	27	"	"	"	Bored	110	3,060	- 55	3,005	102	2,958	" " "	" "	46	D, S.	" " " " .
19	SE.	28	"	"	"	Dug	15	3,010	- 11	2,999	11	2,999	" " "	" "	46	D, S.	" " " " .
20	NW.	31	"	"	"	Bored	30	3,050	- 26	3,024	26	3,024	" " "	"alkaline" Hard, clear	47	D, S.	Insufficient for " " .
21	NE.	31	"	"	"	Dug	14	3,000	- 11	2,989	11	2,989	" gravel "	"alkaline" Soft, clear	47	D, S.	Sufficient for local needs.
22	NE.	33	"	"	"	"	14	2,980	- 8	2,972	8	2,972	" " "	" "	47	D, S.	" " " " .
23	SW.	35	"	"	"	"	16	2,950	- 13	2,937	13	2,937	" sand "	" "		D, S.	" " " " .
1	SW.	1	4	17	3	Dug	18	2,980	- 13	2,967			Glacial clay	Hard, clear, "alkaline"		D, S.	Insufficient for local needs.
2	SW.	2	"	"	"	"	14	3,020	0	3,020			" "	?		D, S.	" " " " .
3	NE.	2	"	"	"	"	11	3,010	0	3,010			Stream sands	Hard, clear		D, S.	Sufficient " " " .

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

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

WELL RECORDS—RURAL MUNICIPALITY OF NO. 48 SASKATCHEWAN

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
5	NE.	5	4	17	3	Bored	70	3,160	- 68	3,092			Glacial clay	Hard, iron, "alkaline"	S	Insufficient for local needs.	
6	NE.	7	"	"	"	Dug	12	3,210	0	3,210			" "	Soft, clear	D, S	" " " "	
7	NW.	9	"	"	"	"	12	3,180	0	3,180			and sand Glacial gravel	Hard "	D, S	" " " "	
8	NE.	12	"	"	"	Bored	40	3,095	- 32	3,063	32	3,063	" sand	" "	44	D, S	" " " "
9	NW.	13	"	"	"	Dug	28	3,100	- 18	3,082			Recent sand	" "	S	Sufficient " " " "	
10	NW.	14	"	"	"	"	20	3,100	0	3,100			" "	Hard, clear	D, S	" " " "	
11	NE.	14	"	"	"	"	20	3,090	0	3,090			Glacial clay	" "	S	Insufficient " " " "	
12	NE.	15	"	"	"	Bored	185	3,115	-155	2,960	170	2,945	Ravenclag sand	"alkaline" Hard, clear	S	Sufficient " " " "	
13	SW.	16	"	"	"	Dug	20	3,140	0	3,140			Glacial clay	" "	D, S	Insufficient " " " "	
14	SW.	17	"	"	"	"	18	3,190	0	3,190			" "	" "	S	" " " "	
15	SE.	18	"	"	"	"	20	3,210	0	3,210			" "	" "	D, S	" " " "	
16	NE.	18	"	"	"	"	10	3,160	0	3,160			" "	" "	D, S	Sufficient " " " "	
17	SE.	32	"	"	"	"	30	2,870	- 27	2,843			Stream gravels	" "	S	" " " "	
1	SW.	4	4	18	3	Dug	18	3,230	- 4	3,226	4	3,226	Glacial clay	"alkaline" Hard, clear	D	" " " "	
2	NW.	5	"	"	"	"	16	3,220	- 0	3,220	0	3,220	" "	" "	D	" " " "	
3	NE.	5	"	"	"	"	14	3,235	- 11	3,224	11	3,224	" clay and gravel	" "	D	" " " "	
4	NE.	6	"	"	"	"	20	3,220	- 9	3,211	9	3,211	Glacial clay	" "	D	" " " "	
5	SE.	7	"	"	"	Bored	75	3,255	- 60	3,195	60	3,195	" yellow clay	" "	D, S	" " " "	
6	SW.	7	"	"	"	Dug	40	3,215	- 36	3,179	36	3,179	" sand	" "	D, S	" " " "	
7	SE.	10	"	"	"	Bored	140	3,255	-100	3,155	100	3,155	" gravel	" "	D, S	" " " "	
8	SW.	10	"	"	"	"	12	3,265	- 4	3,261	4	3,261	" "	"alkaline" Hard, clear	D	Insufficient " " " "	
9	SW.	11	"	"	"	Drilled	80	3,275					clay Glacial blue clay			Dry hole; another dry hole 200 feet deep.	
10	SE.	13	"	"	"	Dug	18	3,230	- 14	3,216	14	3,216	" clay	Hard, clear	D, S	Insufficient for local needs.	
11	SW.	13	"	"	"	"	10	3,225	- 1	3,224	1	3,224	" blue clay	" "	D	" " " "	
12	SE.	15	"	"	"	"	16	3,230	0	3,230	0	3,230	" sandy clay	Soft, "	D	Sufficient " " " "	
13	SW.	15	"	"	"	"	40	3,240	- 10	3,230	10	3,230	" clay	" "	D, S	Insufficient " " " "	
14	SE.	16	"	"	"	"	12	3,235	0	3,235	0	3,235	" "	Hard "	D, S	" " " "	

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

WELL RECORDS—RURAL MUNICIPALITY OF

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
15	SW.	16	4	18	3	Dug	12	3,200	- 10	3,190	10	3,190	Glacial clay	Hard, clear, "alkaline"	46	D, S	Insufficient for local needs.
16	NE.	17	"	"	"	Drilled	120	3,245	+ 70	3,175	110	3,135	Ravenscrag sand	Hard, clear		D, S	" " " "
17	SW.	19	"	"	"	"	164	3,250	-134	3,116	154	3,096	Ravenscrag sand	Soft, clear		D, S	Sufficient " " "
18	NW.	20	"	"	"	Dug	16	3,205	- 10	3,195	10	3,195	Glacial sandy clay	" "		D, S	Insufficient " " "
1	SW.	1	5	16	3	Dug	22	2,950	- 6	2,944	5	2,945	Glacial gravel	Soft, clear		D, S	Sufficient for local needs.
2	NW.	3	"	"	"	"	16	2,900	- 8	2,972	7	2,973	" fine sand	Hard		D, S	Insufficient for " " "
3	SE.	4	"	"	"	"	13	2,970	- 10	2,960			" clay	" clear		D, S	" " " "
4	NW.	5	"	"	"	"	12	2,900	- 9	2,971			" "	" "		D, S	" " " "
5	NE.	5	"	"	"	"	14	3,010	- 8	3,002			" gravel	Soft, clear		D, S	Sufficient " 15 head stock.
6	SW.	6	"	"	"	"	12	3,020	- 6	3,014	10	3,010	" sand	Hard "		D, S	" " 12 " "
7	SE.	6	"	"	"	"	14	3,005	- 11	2,994	10	2,995	" "	" "		D, S	" " local needs.
8	SW.	9	"	"	"	"	14	3,000	- 4	2,996			" clayey	" "		D	Insufficient " " " "
1	SW.	3	5	18	3	Bored	140	3,300					gravel Ravenscrag sand-stone				Dry hole.
2	NE.	4	"	"	"	"	114	3,300	-105	3,195	112	3,188	Ravenscrag sand	Hard, clear		D, S	Insufficient for local needs, also 160 foot dry hole.
3	NW.	5	"	"	"	Spring		3,000	0	3,000	0	3,000	Glacial	Soft "		S	Sufficient " " " "
4	NW.	6	"	"	"	Dug	30	3,260	- 15	3,245	15	3,245	Ravenscrag sandy gravel	" "		D, S	" " " "
5	SW.	8	"	"	"	"	60	3,010	- 54	2,956	60	2,950	Ravenscrag sand-stone	Hard "		D, S	" " " "
6	SW.	9	"	"	"	Bored	105	3,245	- 65	3,180			Ravenscrag black sand	" "		D, S	" " 50 head stock.
7	SE.	10	"	"	"	Dug	36	3,400	- 12	3,388			Glacial	iron Hard		D, S	" " local needs.
8	SW.	10	"	"	"	"	16	3,290	- 12	3,278			" clay	" "			Caved in.
9	NW.	10	"	"	"	Bored	90	3,300	- 80	3,220			Ravenscrag coal	" clear		N	
10	NW.	15	"	"	"	Dug	20	3,300	- 13	3,287	18	3,282	Glacial sand	" "		D, S	Insufficient for local needs.
11	SE.	17	"	"	"	Bored	120	3,305	- 60	3,245			Ravenscrag	" "		D, S	Sufficient " " " "
12	NW.	17	"	"	"	Dug	15	3,330	- 2	3,328	13	3,317	Glacial sandy gravel	iron Hard, clear		D	" " household needs.
13	SW.	18	"	"	"	"	9	3,235	- 2	3,233			Glacial blue clay	Soft "		D, S	" " local needs.
14	NE.	18	"	"	"	"	18	3,330	- 14	3,316			" clay	Hard "		D, S	Insufficient " " "
15	SE.	19	"	"	"	Bored	30	3,330	- 18	3,312			" "	" "		D, S	Sufficient " " " "
16	SW.	20	"	"	"	"	35	3,330	- 23	3,307			" "	" "		S	" " " "
17	SW.	21	"	"	"	"	80	2,970	- 50	2,920			Ravenscrag ?	" "		S	" " " "
18	NW.	21	"	"	"	Dug	12	3,230	- 8	3,222	12	3,218	Glacial sand	iron soft, clear		S	" " " "
19	NW.	30	"	"	"	"	66	3,360	- 50	3,310			Ravenscrag sand	" "		D, S	" " " " Spring occur on NE ¼ sec. 35 and NW ¼ sec. 36.

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