CANADA

DEPARTMENT OF MINES

HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF HAZELWOOD NO. 94 SASKATCHEWAN

By

B. R. MacKay, H. N. Hainstock and P. D. Bugg

WATER SUPPLY PAPER No. 46

OTTAWA

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INTRODUCTION

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

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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 given 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 age.

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.

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

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

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

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

<u>Water Table.</u> 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.

<u>Wells.</u> 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 <u>Flowing Artesian Wells.</u>

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

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

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 rests 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 Hazelwood is an area of 324 square miles in southeastern Saskatchewan. The centre of the municipality lies 33 miles due south of the town of Broadview. It consists of nine townships described as townships 10, 11, and 12, ranges 4, 5, and 6, west of the 2nd meridian. The southeastern corner of the municipality lies within the Moose Mountain forest reserve. With the exception of an area in townships 11, ranges 5 and 6, and township 12, range 6, that is covered with till, the municipality is mantled by terminal morainic deposits that were deposited when the ice-sheet was stationary, or slowly retreating. As a result the surface of this whole area is very irregular with a series of rough, abrupt, morainic hills and numerous small lakes and undrained depressions. The thickness of the glacial drift varies with the elevation, but it is at least 300 to 400 feet thick, as indicated by the well on NE.$\frac{1}{4}$, sec. 18, tp. 10, range 4, which is drilled to a depth of 700 feet. In this hole a coal seam of the Ravenscrag formation is penetrated between a depth of 300 and 400 feet. This hole is located 2 miles east of the highest hill in this municipality which attains an elevation of 2,650 feet above sea-level. The area that lies in township 11, ranges 5 and 6, and township 12, range 6, is flat and mantled by boulder clay or till, in which only a few farms are situated.

Water-bearing Horizons in the Unconsolidated Deposits

The southeastern corner of this municipality lies within the Moose Mountain forest reserve which is not inhabited nor penetrated by roads, and the following discussion does not include this area. The upper 10 to 40 feet of the drift, with the exception of a few feet of top soil, is composed of yellow clay in which irregular-shaped bodies of sand and gravel are located. In some localities a thin bed of sand underlies the yellow clay and overlies a pebbly blue clay. Where the yellow clay is thin, it is often underlain by a bed of pebbly blue clay which in turn is underlain by a discontinuous bed of sand or gravel at a depth of 20 to 40 feet. Because of the limited extent of these sand or gravel pockets or lenses many holes are sunk without obtaining water. These sand and gravel deposits comprise the first water-bearing horizon. The supply of water that is obtained from it is dependant upon seasonal precipitation. Domestic supplies are derived mainly from this horizon.

A second water-bearing horizon is formed by gravel or sand that underlies a pervious layer of pebbly blue clay, and overlies an impervious bed of fine-textured blue clay. The depth to this horizon varies from 40 to 160 feet, the wells increasing in depth as the elevation of the land rises toward Moose mountains. This water-bearing horizon has not been located in the southern half of this municipality as few wells have been sunk. The flowing artesian wells in the northwestern corner of township 12, range 5, and the northeastern corner of township 12, range 6, derive their water from this water-bearing horizon, which forms the main source of supply for the municipality. The water is hard and highly mineralized, and in many instances cannot be used for domestic purposes. Individual wells generally yield a sufficient quantity of water to supply 50 to 200 head of stock.

A few wells in the southern half of the municipality have penetrated a third water-bearing horizon at a depth of 190 to 330 feet, the deeper wells being found at higher elevations. This aquifer is a sand and gravel bed which is overlain by a fine-textured bed of blue clay. The quantity of water yielded by the wells tapping this aquifer and the hydrostatic pressure of the water in them increases as the surface elevation becomes less.

That is, the shallower wells tapping the aquifer will supply 200 to 400 head of stock with water which rises to a point 50 feet below the surface, whereas the deeper wells which tap it will only supply 100 to 150 head of stock with water that rises to a point 90 feet below the surface. The water is very hard and "alkaline" and in most cases cannot be used for domestic purposes.

Water-bearing Horizons in the Bedrock

Only one dry hole, located on NE.¼, sec. 18, tp. 10, range 5, has penetrated bedrock. It encountered a small seam of coal of the Ravenscrag formation at a depth of between 300 and 400 feet. The last 200 to 300 feet of the hole probably penetrates the Marine shale formation, as little or no water was encountered below 400 feet. It would not be advisable to drill to any great depth in this municipality as the only source of water supply is found in the glacial drift.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 10, Range 4

This township lies entirely within the Moose Mountain forest reserve, which comprises an area of some 150 square miles in Moose mountains. This whole area is characterized by many abrupt, boulder strewn hills, numerous small lakes, and undrained depressions. The glacial deposits in this area are in the form of a terminal moraine and were laid down by the great continental ice-sheet when it was stationary or nearly so. The hummocky topography and the abundance of boulders make this area unfit for agricultural purposes and on account of the dense growth of poplar and other varieties of trees, it has been set aside as a forest reserve. The elevation of the highest summit in the township is 2,600 feet and that of the largest lake 2,452 feet. No information regarding the ground water conditions of this township was obtained.

Township 10, Range 5

The southeastern part of this township lies within the Moose Mountain forest reserve. The township is covered by a terminal moraine, and is sparsely settled, the area being too rough for cultivation. A water-bearing horizon, formed by the pockets of sand and gravel that occur within the upper 10 to 25 feet of the drift, and by small areas of glacial sands and gravels along the ravines, is the source of water for most of the existing wells in the township. This water-bearing horizon is not continuous and in drought years the wells that tap it become completely dry. A few of the residents obtain a fair amount of hard, highly mineralized water from seepage wells sunk near the shores of the small lakes. These lakes are generally stagnant and have a high mineral salt content, especially after a long drought period, when a considerable amount of the mineral salt content is concentrated through evaporation of the lake water.

On NE.$\frac{1}{4}$, section 18, five holes were drilled from 180 feet to 700 feet in depth, but no water was located in any of them. A few feet of yellow clay was penetrated, then blue clay for about 300 feet, then a thin seam of coal was passed through, indicating that the Ravenscrag formation was encountered at an approximate elevation of 2,100 feet in this township. From the information at hand it would seem to be impracticable to drill for water in this township. The best method for conservation of water would be to construct dams in the ravines and retain the run-off waters.

Township 10, Range 6

This township is very hilly. Southeasterly from the northwestern corner the elevation rises from 2,100 to 2,450 feet, in a distance of $1\frac{1}{2}$ miles. The highest elevation, of 2,650 feet, is attained in sections 12 and 13. A few farmers are cultivating the land in the northwestern part of the township, but the south-western part is unsettled. Throughout the area under cultivation numerous holes have been dug in an effort to locate water. Small supplies of water are obtained from isolated pockets of sand and gravel within the yellow clay, but in many instances the supply is insufficient for stock requirements and is too "alkaline" for domestic use. On SE.$\frac{1}{4}$, section 14, an abundant supply of hard, slightly "alkaline" water is being obtained from a spring. This spring supplies at least ten farmers with water during the dry seasons.

Township 11, Range 4

Sections 1 to 12 of this municipality lie within the Moose Mountain forest reserve. All of the township is characterized by many abrupt hills, between which numerous small, stagnant lakes occur. The upper 12 to 25 feet of the glacial drift is composed of yellow clay in which are found pockets of sand and gravel. They form a water-bearing horizon that yields a small supply of hard, usable water. There are no continuous sand beds within the upper 25 feet of the drift and often many holes are sunk before a pocket of sand or gravel is located. The water derived from this horizon is generally used only for domestic purposes as the supply is limited. The wells are greatly affected by drought periods. One well, on SE.$\frac{1}{4}$, section 21, is an exception, as it has a sufficient quantity of soft, usable water to supply 200 head of stock. A second water-bearing horizon is formed by a bed of sand that lies at a depth of 40 to 60 feet. It underlies a bed of blue clay. This water-bearing horizon extends throughout the township and the wells tapping it will supply from 60 to 80 head of stock. The water is very hard, and so highly mineralized that it should not be used for domestic purposes. In some instances the total dissolved salt content is even too high for stock. Only one well, located on SE.$\frac{1}{4}$, section 16, is drilled deeper than 100 feet. This well passes through yellow clay for 25 feet and then blue clay for 306 feet, where it penetrates a sand bed at an elevation of 2,154 feet above sea level. It encountered a small amount of usable water that is under slight hydrostatic pressure, but the water is so difficult to pump that the well is rarely used. In summary, there is a shortage of water in this township. Practically all the waters have a high mineral salt content, and the water from the lakes have been known to kill animals. Due to the many hills and ravines, small dams and dugouts could be constructed that would conserve the run-off water for stock in times of drought.

Township 11, Range 5

An area of boulder clay is found in the west-central part of this township. The morainic areas to the north and south slope down to a flat area in the central part of the township that is swampy in wet seasons. Many lakes are found in sections 13, 14, and 24, and also in the northern part of the township. The first water-bearing horizon is located in the uppermost 20 feet of the glacial drift. It is composed of pockets of sands and gravels, in the yellow clay, small areas of glacial sands and gravels, and thin beds of sand in the upper few feet of blue clay. Shallow wells in sections 2 and 4 yield an abundant supply of soft, clear water, whereas the other wells that penetrate this water-bearing horizon yield only a small amount of hard, "alkaline" water. Springs located on NE.$\frac{1}{4}$, section 33, NE.$\frac{1}{4}$, section 34, and NW.$\frac{1}{4}$, section 25, give an abundant supply of hard, usable water, sufficient for 200 head of stock throughout the year.

Four wells located in different parts of the township tap water-bearing horizons formed by thin beds of sand at depths of 75 to 280 feet. These sand beds are not continuous throughout the area, and the water obtained is of small quantity and poor quality. The 280-foot well on SW.$\frac{1}{4}$, section 32, penetrated a sand bed at an elevation of 2,235 feet above sea-level. The hydrostatic pressure caused the water to rise to within 60 feet of the surface, but the water comes in so slowly that this level is soon lowered when the well is pumped, so that only a few head of stock can be watered at any one time. The information available suggests that it is not advisable to drill for water in this township. The best method for the conservation of water would be to construct dams or dugouts.

Township 11, Range 6

Sections 1 to 12 and 35 and 36 are covered by terminal morainic deposits, and are part of Moose mountains. These areas are exceedingly undulating, with many small lakes, 5 to 8 feet deep, that are probably fed by springs as they are not as stagnant as many that depend upon run-off waters for their source of supply. The flat, central region is mantled by glacial till and is almost barren of vegetation. Throughout the township the upper 4 to 15 feet of the glacial drift is composed of yellow clay, in which are found pockets of sand or gravel. Between the yellow clay and the blue clay that extends downward to an unknown depth, is a bed of gravel that is fairly continuous throughout the township. Holes that penetrate these deposits of sand and gravel generally locate water, the quantity of which depends on the amount of annual precipitation. In a few wells the water is so "alkaline" as to be unfit for stock. In such cases it is necessary to haul water from lakes or wells that have a good supply of usable water. Most of the inhabitants have located their houses near lakes and most of the water supply for stock is obtained from these lakes. No attempt has been made to locate water at depth in this township, and it is improbable that water-bearing horizons could be located within reasonable depths. The best method for the conservation of water in the central part of the township would be to construct large dugouts for the stock, with a well beside it for domestic use. Care should be taken to see that the water that seeps from the dugout into the well is properly filtered. Information regarding the method of construction of these dugouts will be supplied upon application to the Provincial Government.

Township 12, Range 4

This township lies on the northern slopes of Moose mountain. It is mantled with glacial drift that is in the form of a terminal moraine. The upper 20 to 40 feet is composed of yellow clay. This is underlain by 70 to 160 feet of pebbly blue clay beneath which is a gravel bed. This gravel bed is underlain by a bed of fine-textured, blue clay of unknown thickness. Pockets of sand and gravel in the yellow clay and isolated beds of sand in the uppermost 10 feet of the blue clay compose the first water-bearing horizon. Many holes have generally to be sunk before water is located in this horizon. The supply of water obtained is very small and is greatly affected by drought periods. The water is medium hard and in most instances is only used for domestic purposes. A second water-bearing horizon is formed by the bed of gravel that underlies the pebbly blue clay. The water derived from this level is exceedingly hard with a high salt content that makes it unpalatable for humans but usable for stock. The water rises to within 20 to 60 feet of the surface in all the wells except one on NE.$\frac{1}{4}$, section 36, in which the hydrostatic pressure is sufficient to cause the water to rise to the surface. This water-bearing horizon extends throughout the township and is the main source of water for this area. One well located on NW.$\frac{1}{4}$, section 15, taps a third water-bearing horizon at a depth of 200 feet, or at an elevation of 2,100 feet above sea-level. The aquifer in this well is formed by rocks and gravel and yields an abundance of very "alkaline" water, containing a large amount of iron salts. It is not fit for humans, but is satisfactory for stock use. The water maintains a level 90 feet below the surface and it cannot be lowered to any appreciable extent by pumping. This water-bearing horizon may be continuous, but the well on SE.$\frac{1}{4}$, section 11, which is 314 feet deep, located only a small amount of water at this level. This may indicate that the aquifer is only a pocket of sand or gravel in the bed of blue clay. It would not be advisable to drill to any great depth in this township to try to locate water as it is highly probable that the lower bed of blue clay extends down to bedrock which is also non-water-bearing.

Township 12, Range 5

Sections 1 to 24 of this township comprise what is locally known as Little Moose Mountain on account of the similarity of its topographical features to that of Moose mountain. There are numerous small lakes that become stagnant after periods of drought, and these are the main source of supply for stock in this area, as it is very difficult to locate a sufficient supply of ground water by drilling. The upper 20 to 40 feet of the glacial drift is composed of yellow clay in which are embedded a few pockets of sand or gravel. Many holes are sunk before any water is located and generally the amount is barely sufficient for domestic purposes. During periods of drought the wells go dry, necessitating the hauling of water for both humans and animals. In sections 1 to 24 many holes have been drilled from 60 to 150 feet in depth, and with the exception of a well located on NW.$\frac{1}{4}$, section 14, 135 feet deep, that has a sufficient amount of water to supply from 40 to 60 head of stock, the holes were all dry. The aquifer for this one well is a pocket of sandy gravel, and the water obtained from it is hard, but usable for both humans and animals.

In sections 25 to 36 there is a much greater supply of water derived from a sand bed that underlies a bed of pebbly blue clay at a depth of 40 to 70 feet. This horizon yields an abundant supply of hard, "alkaline" water that is used for domestic purposes as well as for stock. The hydrostatic pressure is sufficient to cause the water to rise to within 10 to 15 feet of the surface in some wells and to flow above the surface in wells located in sections 29, 30, and 31. This area of flowing artesian wells is of small extent and the water head is probably due to the intake area of the aquifer being at a higher elevation in the Little Moose Mountain area to the south. In this township water is difficult to obtain in sections 1 to 25, whereas in sections 25 to 36 an abundant supply is obtained. It is improbable that wells drilled to depth in this area would locate any supply of water due to the irregular distribution of the gravel deposits in the glacial drift. Pockets of sand or gravel may be located after extensive drilling, but no definite depth or locality can be indicated in which they might be found. The best method to assure a permanent supply is to conserve the surface water by the construction of dams or dugouts.

Township 12, Range 6

Three water-bearing horizons are found within the first 250 feet of the glacial drift of this township. The first lies within the upper 40 feet, and is formed by pockets of sand or gravel in the yellow clay, and by a bed of sand that lies between the yellow clay and a bed of pebbly blue clay. The water derived from this horizon is of an excellent quality, but varies in quantity in the individual wells. A few wells yield an abundance of medium hard, usable water, sufficient for 100 to 150 head of stock, whereas others yield only a few gallons of water a day. They are affected to a great extent by drought conditions and in many instances go completely dry. A second water-bearing horizon is formed by a bed of gravel 1 to 6 feet thick, which underlies the pebbly blue clay at a depth of 50 to 70 feet. It is underlain by 100 to 190 feet of impervious blue clay. A hard, highly mineralized water is obtained from this horizon and the supply is sufficient to water 50 to 60 head of stock. It is used for domestic purposes when other water is not obtainable, but it is very unpalatable until one becomes accustomed to it. Water can probably be obtained from this horizon throughout the township as it has been tapped by wells located in different parts of the township. A third water-bearing horizon is located at a depth of 190 to 250 feet, depending on the surface elevation. This aquifer is formed by a bed of sand overlying a bed of gravel, and underlying a fine-textured blue clay. This horizon yields an abundant supply of very hard, "alkaline" water. It contains a considerable amount of iron that settles out as a red precipitate when the water is exposed to the air. The hydrostatic pressure is high in all the wells, the water in the well on SE.$\frac{1}{4}$, section 27, rising 20 to 30 feet above the surface. This is an excellent flowing artesian well and in dry years it is the main source of supply for many of the farmers when their own shallow wells go dry.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF HAZELWOOD, NO. 94, SASKATCHEWAN

Township	10	10	10	11	11	11	12	12	12	Total No. of municipality
West of 2nd mer. Range	4	5	6	4	5	6	4	5	6	
Total No. of Wells in Township	0	10	28	42	37	55	108	162	126	568
No. of wells in bedrock	0	1	0	0	0	0	0	0	1	2
No. of wells in glacial drift	0	9	28	42	37	55	108	162	125	566
No. of wells in alluvium	0	0	0	0	0	0	0	0	0	0
Permancy of Water Supply										
No. with permanent supply	0	1	12	31	21	11	57	69	42	244
No. with intermittent supply	0	2	5	4	7	4	9	10	2	43
No. dry holes	0	7	11	7	9	40	42	83	82	281
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	4	2	6
No. of non-flowing artesian wells	0	0	2	9	3	1	27	18	11	71
No. of non-artesian wells	0	3	15	26	25	14	39	57	31	210
Quality of Water										
No. with hard water	0	3	17	32	22	14	65	74	43	270
No. with soft water	0	0	0	3	6	1	1	5	1	17
No. with salty water	0	0	0	0	0	0	0	0	1	1
No. with "alkaline" water	0	1	9	5	2	4	26	9	17	75
Depths of Wells										
No. from 0 to 50 feet deep	0	8	28	34	33	51	62	76	95	387
No. from 51 to 100 feet deep	0	0	0	7	1	4	32	75	20	139
No. from 101 to 150 feet deep	0	0	0	0	1	0	11	10	7	29
No. from 151 to 200 feet deep	0	1	0	0	1	0	2	1	1	6
No. from 201 to 500 feet deep	0	0	0	1	1	0	1	0	2	5
No. from 501 to 1,000 feet deep	0	1	0	0	0	0	0	0	1	2
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	0	3	16	29	23	12	52	70	35	240
No. not usable for domestic purposes	0	0	1	6	5	3	14	9	9	47
No. usable for stock	0	3	17	35	28	15	66	79	44	287
No. not usable for stock	0	0	0	0	0	0	0	0	0	0
Sufficiency of Water Supply										
No. sufficient for domestic needs	0	2	17	35	28	15	66	79	44	286
No. insufficient for domestic needs	0	1	0	0	0	0	0	0	0	1
No. sufficient for stock needs	0	3	8	25	17	8	33	40	24	158
No. insufficient for stock needs	0	0	9	10	11	7	33	39	20	129

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 boilders 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 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. 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 Hazelwood, No. 94, 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.	6	11	6	2	16	1,008										1,008	(3)	(1)		(2)			(4)	xl
2.	NW.	28	12	5	2	46	3,140	2,000	2,000	Nil	40	285	710	356	1,945	129	2,964	285	1,337		1,061		215	66	xl
3.	NE.	32	12	5	2	62	2,934										2,934	(3)	(1)		(2)			(4)	xl
4.	SE.	27	12	6	2	239	2,475										2,475		937	428			866	62	xl
5.	NE.	31	12	6	2	193	2,000	950	900	50	25	100	100	216	1,169	395	1,747	100	107	644			855	41	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 ($CaCO_3$).

Analyses Nos. 1 and 3, by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

The ground water in the unconsolidated deposits of this municipality has a very high mineral salt content. This mineral salt content is largely dissolved out of the pervious yellow, and pebbly blue clays which either overlie or underlie the water-bearing horizons. The ground water from the first water-bearing horizon has the smallest total dissolved solid content of the samples of the municipality analysed, as is shown by a sample taken from a 16-foot well on NE.$\frac{1}{4}$, sec. 6, tp. 11, range 6. This sample has a total dissolved solid content of 1,008 parts per million. The ground water from the second water-bearing horizon has the highest dissolved solid content, as is indicated by the samples taken from the wells on NW.$\frac{1}{4}$, section 28, and NE.$\frac{1}{4}$, section 32, tp. 12, range 5. These wells are 46 and 62 feet deep and the water from them contained a total dissolved solid content of 3,140 and 2,934 parts per million, respectively, which is approximately 2,000 parts per million more than that obtained from the shallower wells. The samples taken from wells at a depth of about 200 feet have a total dissolved solid content of approximately 2,000 parts per million. The lower mineral salt content is probably due to the fact that the deeper aquifer underlies an impervious blue clay, whereas the pebbly blue clay nearer the surface is permeable and more mineral salts are dissolved out of it than from the impervious clay.

The mineral salt that is found in the greatest quantity in all the samples analysed, except one, is calcium sulphate. This salt imparts hardness to the water and will leave a scale in boilers, but it has no harmful effect on humans or plants. The next salt in order of abundance is magnesium sulphate or Epsom Salts. It is found in all the samples except that taken from the deeper well. This salt gives the water a bitter taste if it occurs in very large amounts, and it has a very laxative effect. In the samples analysed the water would have a laxative effect until one became accustomed to it.

The other salts which are found in smaller quantities are calcium carbonate, sodium sulphate (glauber's salts), and sodium chloride or common salt. The presence of the last two salts named in more than normal amounts makes water unfit for drinking and other domestic purposes. There is not an excessive amount of these two salts in the samples analysed except in the water from the 200-foot well which contains over 850 parts per million of sodium sulphate. The amount of sodium chloride or common salt found in the samples analysed is negligible.

Most of the water in this municipality can be used for stock, but in many instances it may not be found undesirable for domestic purposes, especially that obtained from the deeper wells. It would be advisable to have the water analysed by the Provincial Analyst at Regina, Saskatchewan, before it is used for domestic purposes.

Water from the Bedrock

No water is being derived from the bedrock in this municipality. Water that is obtained from the Marine shale formation usually has a high content of mineral salts in solution and is unsuitable for drinking. In some cases it is too highly mineralized for stock use.

NOTE:

Because of difficulties involved in reproduction, the tables of well records referred to are not included with this report. Information regarding individual wells may be obtained by writing to the Director, Geological Survey of Canada, Ottawa.