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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF ST. ANDREWS NO. 287 SASKATCHEWAN

By

B. R. MacKay, H. N. Hainstock and G. Graham

WATER SUPPLY PAPER No. 202

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E.R. MacKAY, H.W. HAINSTOCK, and GEO. GRAHAM

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GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF ST. ANDREWS, NO. 287, SASKATCHEWAN

INTRODUCTION

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

Publication of Results

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

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

How to Use the Report

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

is given on some or all of the contour lines on the figure.

If one intends to sink a well and wishes to find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are 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.

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

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

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

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

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

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

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

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

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

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

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

Cypress Hills Formation. The name given to a series of conglomerates and sand beds which occur in the southwest corner of Saskatchewan, and 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 St. Andrews, No. 287, is an area of 324 square miles in western Saskatchewan. The area is composed of nine full townships, described as tps. 28, 29, and 30, ranges 13, 14, and 15, W. 3rd mer. The centre of the municipality lies approximately 96 miles southwest of Saskatoon. The municipality is well served by railways and provincial highways. The Saskatoon-Calgary branch of the Canadian National railways runs from the northeastern corner to near the centre of the western boundary. On it are located Rosetown and Zealandia, the former being the main trading centre of the area. Three branch lines of the Canadian Pacific railway cross the municipality. Two of these run in an east-west direction and one in a general north-south direction. Two of the branch lines intersect near Rosetown. Sovereign, near the eastern border of the municipality, is the largest village on the Canadian Pacific railway. Provincial Highway No. 4, running north and south 5 miles east of the western border of the area, intersects with Highway No. 7, from the west, near Rosetown. Highway No. 15 runs due west from Sovereign for 11 miles and then north to Rosetown, where it terminates.

The greater part of the municipality is a fairly level plain, but in the west-central part the ground surface is rolling and somewhat hilly. In the northwestern corner Eaglehill creek has eroded a fairly deep valley, which in some parts is a mile wide. The minimum elevation of 1,850 feet above sea-level occurs in Eaglehill valley, and the maximum, in excess of 2,100 feet, is attained in the Bad hills.

The area known as the Bad hills in the western half of township 29, range 15, and two other small areas, one located in the southeastern corner of township 29, range 15, and the other in the southwestern part of township 29, range 14, are covered by moraine.

The remainder of the township is mantled by boulder clay or glacial till. The boulder clay is overlain by glacial lake clays, which in some areas attain a thickness of at least 40 feet. The boulder clay, however, is exposed at the surface along Eaglehill creek, and bordering the areas that are mantled by moraine. The top soil over most of the township is clay or silty clay loam. In the hilly section it is a lighter loam and in some areas contains boulders. In the southeastern corner the top soil is quite sandy. Several large, low-lying depressions occur throughout the glacial lake clay-covered region; most of them are "alkali" flats, but a few are under cultivation.

It was found impossible to outline any general or continuous water-bearing horizons in either the unconsolidated deposits or the underlying bedrock in this municipality.

Water-bearing Horizons in the Unconsolidated Deposits

The glacial lake clays have not proved a source of water supply. The clays attain a thickness of at least 40 feet in some areas. They generally contain a considerable amount of mineral salts, and in a few areas they form "alkali" flats. It is inadvisable to sink wells into clay, as any water that is obtained will no doubt be too highly mineralized for farm use. Water, however, is obtained from the glacial till that underlies the lake clays. The water conditions in the moraine- and glacial till-covered areas appear to be similar. A few wells sunk near sloughs or in depressions obtain small supplies of water. In years of normal rainfall the supply from such wells is usually sufficient for domestic needs and a few head of stock, but during winters and drought periods the supply decreases and the wells may become totally dry. By deepening the wells it is usually possible to obtain sufficient water for domestic needs throughout the year. Wells that are sunk beside dugouts or dams should also yield a sufficient supply for domestic needs. The water derived from these

seepage wells is usually moderately soft, and if not contaminated by surface waters containing animal refuse it should be satisfactory for all farm needs.

Below the top soil in the moraine- and boulder clay-covered areas weathered or oxidized boulder clay extends down to a depth of 20 to 30 feet. A few scattered pockets of water-bearing sand and gravel occur in this zone. In the glacial lake clay-covered areas the upper part of the underlying boulder clay is not oxidized and does not contain pockets of sand and gravel. A few wells tap the pockets of sand and gravel in the moraine-and till-covered areas. Along Eaglehill creek wells obtain fairly abundant supplies of water, but elsewhere the supply from shallow wells is sufficient for only domestic needs and a few head of stock. The water is often quite highly mineralized, but is usually suitable for drinking. The supply from these shallow wells is readily affected by drought conditions. Prior to digging shallow wells it is advisable to locate the water-bearing deposits by means of a small test auger.

Deposits of water-bearing sand and gravel occur at various elevations in the unweathered or impervious blue clay, and although it is impossible to outline a general water-bearing horizon the deposits appear to be fairly numerous and may be continuous over small areas. It is these deposits that form the aquifers for the wells that are dug in the glacial lake clay-covered areas. The wells vary in depth from 40 to 240 feet, but most of them are from 60 to 100 feet deep. In secs. 24 and 26, tp. 29, range 14, dry holes were dug, but no others were recorded throughout the remainder of the municipality. Where wells are drilled into the bedrock, however, it must be assumed that the drift was non-water bearing, or that aquifers in the drift were passed through in hopes of obtaining water of better quality. If the accompanying well records are studied in conjunction with Figure 2 of the map, it should be possible to locate areas in which the possibilities of obtaining water from the lower part of the drift are fairly

good. The supply from a number of wells that tap deposits in the unweathered drift is inadequate for farm needs. The water from almost all of them is very highly mineralized and hard, and only that from a few wells can be used for domestic purposes.

In those areas where the water supply is inadequate, or the water unsatisfactory for domestic purposes, dugouts should be excavated to collect and retain the surface water. The dugouts should be at least 12 feet deep in order to ensure an adequate supply of water for ordinary stock requirements. Shallow wells may be sunk near the dugouts and the supply should be found quite sufficient for domestic needs. The quality of the water, unless the dugouts are in an "alkali" flat, should be superior to that obtained from the lower part of the drift. Care must be taken, however, to see that the water from such wells does not become polluted. It should be tested frequently for bacteria content. Where topography permits, the construction of small dams may be found more economical than excavating dugouts.

Water-bearing Horizons in the Bedrock

The Belly River formation underlies the glacial drift throughout this municipality, and a large number of wells obtain water from aquifers that occur in this formation. No definite contact of the drift and bedrock was established, and no outcrops are known to occur. In the southeastern corner of the municipality the contact of the bedrock and the glacial drift is thought to be at an elevation of 1,700 to 1,750 feet above sea-level. It probably occurs above this elevation in the western part of the area, as in the municipality of Pleasant Valley, No. 288, it is recorded at an elevation of 2,050 feet above sea-level. The land surface rises towards the west, and this may indicate a rise in the bedrock in the same direction. In the municipality of Marriott, No. 317, bedrock is thought to lie at an approximate elevation of 1,800 feet above sea-level.

No general or continuous water-bearing horizons could be traced in the bedrock, and the aquifers tapped appear to be discontinuous even over very small areas. Wells sunk into the bedrock are more numerous in the southeastern part of the municipality than in the remaining part, although from this it should not be inferred that the bedrock is less productive in the northwestern part of the municipality. Most of the wells tapping aquifers in the bedrock yield hard water. The shallow wells yield highly mineralized water that is often unsatisfactory for domestic use. The deepest wells, scattered throughout various parts of the municipality, encounter aquifers that yield soft water which is quite satisfactory for domestic purposes. The supply of water from almost all the wells sunk into the bedrock is more than adequate for farm needs. In a few wells trouble is experienced in keeping the fine sand that forms the aquifers from plugging the well and reducing the supply of water. A hole was drilled to a depth of 1,000 feet in Rosetown without encountering water, but it is the only bedrock well recorded in this municipality that did not obtain water. From the information on this well, it appears that if water is not obtained from the bedrock at depths of less than 600 feet, it is improbable that aquifers will be encountered until a depth of at least 1,000 feet has been reached. An abundant supply of usable water can usually be obtained from the bedrock at depths of 300 to 500 feet, or at elevations of 1,650 to 1,400 feet above sea-level. In one well located in sec. 28, tp. 29, range 14, however, it was necessary to drill to an elevation of 1,365 feet above sea-level before an aquifer was encountered.

When a deep well is contemplated the well records and accompanying well location map should be carefully studied before a well site is selected. The water-bearing possibilities of the bedrock are more fully discussed in the section dealing with the individual townships.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 28, Range 13

Glacial lake clays cover the entire township and the ground surface is comparatively level. In the southeastern corner the top soil is reported to be quite sandy, but elsewhere it is a fairly heavy, clay loam. The glacial lake clays contain little or no water, but small deposits of water-bearing sand or gravel may occur in the underlying boulder clay. The thickness of the lake clays has not been definitely determined, but they are not thought to be less than 30 feet thick.

Wells located in the NW. ¼, section 1, NE. ¼, section 4, and SE. ¼, section 36, are thought to obtain water from the water-bearing deposits that occur in the glacial till, and two other wells, located in the NE. ¼, section 1, and the SE. ¼, section 3, may be obtaining water from similar sources, but the remaining wells in the township are assumed to draw at least part of their supply from the underlying bedrock. With one exception these wells are from 100 to 180 feet deep. The supply from the well located in section 4 is reduced by sand plugging the casings, but the other wells yield a sufficient supply for stock requirements. The water from all the wells is very hard and the mineral salts in solution are so concentrated that it cannot be used for domestic purposes.

Throughout the municipality a number of wells obtain water from aquifers in the Belly River formation at depths ranging from 180 to 475 feet, or at elevations of 1,450 to 1,730 feet above sea-level. Some of the shallower wells in this group may obtain part of their supply from water-bearing deposits that occur near the contact of the glacial drift and the underlying bedrock, but the deeper wells are without doubt obtaining all their supply from aquifers in the bedrock. Within narrow limits some continuity in the occurrence of the bedrock aquifers may exist, but they are not continuous throughout

the township. However, a perusal of the well records in conjunction with Figure 2 of the accompanying map should make it possible for a well driller to forecast with reasonable accuracy the depth at which water may be expected. In this group of wells the supply is always more than sufficient for local needs, but two wells located in the SW. ¼, section 6, and the NE. ¼, section 30, yield inadequate supplies as they have become plugged with sand. The water from the wells included in this group is hard, and the mineral salt content varies considerably. The water from some of the wells is used for both domestic and stock needs, but that from others is suitable only for stock. No doubt much of the water that is now used for domestic purposes would not be used if water of better quality were obtainable within reasonable hauling distance.

Three wells, located in the NW. ¼, section 16, the NE. ¼, section 17, and the SW. ¼, section 26, obtain soft water from aquifers in the Belly River formation at depths of 450, 600, and 440 feet, or at elevations of 1,505, 1,355, and 1,519 feet above sea-level. From the information at hand it cannot be said that the aquifers are continuous, and each well is assumed to tap a deposit of sand of local areal extent. Although there are wells sunk to elevations of 1,450 feet above sea-level in this township that obtain hard water, it is thought that in most parts of the township a well drilled to an elevation below 1,500 feet should obtain soft water. The supply from the three wells is abundant and the water is under considerable hydrostatic pressure. The lowest pressure occurs in the well in section 16, where the water rises 150 feet above the aquifer.

In this township it has not been found necessary to collect and retain surface water for stock use by means of dugouts, since most of the wells yield an oversufficient supply. The soil is suitable for their excavation and if a sufficient quantity of water should be impounded in this manner, shallow wells dug beside the reservoirs would probably yield sufficient water for domestic purposes. The slightly

mineralized surface water is more beneficial for stock than the highly mineralized water now obtained from most of the wells. The dugout should be fenced off and care taken that the well water does not become contaminated by animal refuse.

Township 28, Range 14

The surface of this township is comparatively level, but low-lying, marshy areas occur in the northwestern corner and in a narrow area extending from section 5 to section 24. The area is mantled by boulder clay, but with the exception of a small area in parts of sections 19, 20, and 29, the boulder clay is concealed by glacial lake clays. The lake deposits attain a thickness of at least 50 feet in some sections of the township. They contain little or no water and the water supply in this township is derived from the underlying boulder clay and bedrock.

Only one well is recorded as obtaining water from the drift at a depth of less than 60 feet. It is located in the NW. ¼, section 16, and is 25 feet deep. This well is probably dug in a depression or near a slough and its supply is almost directly dependant on annual precipitation. Care should be taken to see that wells are not dug in "alkali" flats, as any water derived from these depressions is too highly mineralized for domestic use. In most instances, however, the water from wells dug beside sloughs, and beside impounded waters, is suitable for domestic use. These seepage wells, however, are readily affected by drought conditions and may become totally dry during such periods.

The remaining wells in the township that obtain water from the glacial drift derive their supply from water-bearing deposits that occur at depths of 60 to 170 feet. The aquifers do not form a continuous horizon. The water is usually "alkaline" and highly mineralized, and that from two wells only is being used for domestic purposes. The supply from approximately one-half the wells is inadequate for local

needs. A large supply of usable water is not to be expected from the glacial drift in this township.

A number of wells throughout the township derive water from the underlying bedrock at depths of 225 to 495 feet, or at elevations of 1,715 to 1,455 feet above sea-level. The water from the wells included in this group is recorded as hard. Little or no relationship is evident in the occurrence of the water-bearing sands that form the aquifers for these wells. With the exception of the wells located in sections 22 and 24, however, it has been necessary to drill to elevations of at least 1,550 feet above sea-level before an aquifer was tapped. The supply of water from these bedrock wells, with one exception, is more than sufficient for local requirements. The well in section 22 does not yield an adequate supply of water, but this well is partly clogged by sand and requires cleaning. The water from the two shallowest wells is too highly mineralized to be used for domestic purposes, but that from the other wells is used for drinking as well as for stock.

A few wells obtain soft water from bedrock aquifers at depths ranging from 380 to 600 feet, or at elevations of 1,570 to 1,350 feet above sea-level. There does not appear to be any continuity of the aquifers. It is probable, however, that if a well is drilled to elevations below 1,450 feet above sea-level, soft water would be encountered. The yield from this group of wells is abundant and the water obtained is quite satisfactory for domestic purposes and stock.

Where dugouts can be economically excavated they are recommended for the collection and retention of surface water for stock use. Shallow wells sunk beside the dugouts will yield adequate supplies of water for domestic needs. The slightly mineralized surface water is more beneficial to stock than the highly mineralized water from drift wells.

Township 28, Range 15

The surface of this township is fairly level, but in small areas in the northwestern part it becomes slightly rolling. Flat, marshy areas are common throughout the central part of the township. Small areas in section 31, and in sections 34 and 35, are covered by moraine. Boulder clay or glacial till underlies the remainder of the township, but it is exposed only in the northeastern and northwestern sections, being overlain by glacial lake clays throughout the remainder of the area. The glacial lake deposits probably exceed a thickness of 35 feet in some parts of the area.

The glacial lake clays contain little or no water, but the deposits of moraine and till do contain water-bearing deposits. Small quantities of water may be obtained from pockets of sand and gravel that are thought to occur in the weathered zone of the moraine and exposed boulder clay. These deposits, however, do not appear to be very numerous in this township, and they should be located with a small hand auger prior to digging a shallow well. Should they be encountered they will probably yield sufficient water for domestic needs and a few head of stock.

Pockets of sand and gravel appear to be of more frequent occurrence in the unweathered zone of the drift, and in that part immediately underlying the lake clays. A number of wells throughout the township encounter these deposits at depths of 40 to 240 feet. It is possible, however, that the 240-foot well in section 34 may be obtaining part of its supply from the bedrock. There is no evidence of relationship in the occurrence of these water-bearing deposits in the unweathered part of the drift, and no general water-bearing horizons of large areal extent are thought to be present in the upper 150 feet of the glacial deposits. The supply from the wells and the quality of the water vary considerably. Approximately one-half the wells yield sufficient water for local needs, but the water from most of them is so highly mineralized that it should not be used for domestic purposes.

Two wells, one located in the SE. ¼, section 12, and the other in the SE. ¼, section 34, obtain water from aquifers at depths of 220 and 240 feet, or at elevations of 1,745 and 1,770 feet above sea-level. Both wells are thought to be tapping water-bearing sands in the Belly River formation. Since it was necessary to drill to depths of more than 500 feet to obtain water in the intervening area it is improbable that a general water-bearing horizon exists at an approximate depth of 220 feet below the surface. The supply from the wells is abundant and the water is under considerable hydrostatic pressure, but it is so highly mineralized that it is used only for stock.

Three wells, located in sections 13, 23, and 25, obtain water from aquifers in the bedrock at depths of 400, 550, and 505 feet, or at elevations of 1,535, 1,400, and 1,455 feet above sea-level, respectively. Even though the three wells occur within a radius of one mile it is hardly possible that they derive their water from a common aquifer. Water should be obtained throughout most of this township from aquifers in the bedrock, if wells are sunk to elevations below 1,450 feet above sea-level. The supply from the three wells is abundant, and the water is under sufficient hydrostatic pressure to rise at least 300 feet above the aquifer. Although it is recorded as hard and "alkaline", it is used for domestic purposes as well as stock.

In some parts of this township it would be advisable and economical to excavate dugouts for the collection and retention of surface water for stock use. The dugout should be at least 12 feet in depth in order to retain sufficient water to last throughout the year. Shallow wells sunk near the impounded waters often yield a supply of water that is sufficient for domestic purposes, and the quality of the water may be considerably superior to that obtained from dug or drilled wells. Where the topography is suitable, small dams may be constructed to retain surface water.

Township 29, Range 13

Water supplies in this township are obtained from wells sunk in the glacial drift and underlying bedrock, and from dugouts. The surface of the township is fairly level, the difference in elevation being less than 50 feet. A depression or "alkali" flat occurs in parts of sections 28, 29, 32, and 33. The village of Sovereign, in section 26, is at an elevation of approximately 1,920 feet above sea-level. The surface of the township is covered with glacial lake clays that overlie boulder clay or glacial till. The thickness of the lake deposits is not known, and they contain little or no water.

A few small depressions or sloughs that contain water in the spring could be used for stock. Shallow wells sunk near the edge of the depressions may yield small supplies of water for part of the year, but since they are almost directly dependent on seepage they are noticeably affected by drought conditions. The only shallow dug wells in this township are those that have been sunk beside dugouts. These wells, when the dugout is of sufficient size and depth to contain water throughout the year, usually yield a sufficient supply of water for household needs and a few head of stock. The water is generally of superior quality to that obtained from deeper wells in the drift.

No wells are recorded as obtaining water from sand lenses or beds in the lake clays, but two wells in section 30 are drawing a supply from water-bearing sands that occur in the underlying boulder clay at depths of 115 and 150 feet, or at elevations of 1,835 and 1,800 feet above sea-level. Water-bearing deposits in the glacial till in this township appear to be very sparsely distributed and it appears probable that in most areas the bedrock will have to be penetrated before a water supply will be obtained. The 115-foot well yields a sufficient supply of water for stock use, but it is so highly

mineralized that it cannot be used for domestic purposes. The water from the 150-foot well also is unsuitable for domestic use. Another well, located in section 33, is drilled to a depth of 272 feet and taps a sand aquifer at an elevation of 1,693 feet above sea-level. Part of the water supply of this well may be obtained from the bedrock. Although the water rises 192 feet above the aquifer the supply is said to be insufficient for stock needs. This is probably due to the fact that the well requires cleaning. The water has a bitter taste and is too highly mineralized for domestic purposes.

Most of the wells in this township obtain water from aquifers in the Belly River formation. The wells are drilled to depths ranging from 275 to 505 feet, and tap aquifers at elevations of 1,675 to 1,450 feet above sea-level. There appears to be a fairly continuous water-bearing horizon at an approximate elevation of 1,600 feet above sea-level. Some wells, however, had to be drilled 100 feet deeper before encountering water, and in these locations the aquifer occurring at an elevation of 1,600 feet may have thinned out, or may have been passed through. In any event it should be possible to obtain water from the bedrock in all parts of the municipality if the wells are drilled to depths of 300 to 500 feet.

The supply from all the wells drawing water from bedrock aquifers is adequate for local requirements. The water from the wells located in the NW. ¼, section 16, the SW. ¼, section 29, and the SW. ¼, section 36, is recorded as soft, whereas that from the remaining wells is said to be hard. The hard water from three wells is so highly mineralized that it is used only for stock, but that from the other wells is used for drinking as well as stock needs.

A few dugouts have been excavated in this township and their use is recommended in those sections where an adequate supply of water cannot be obtained from wells. These artificial reservoirs should be at least 12 feet deep and of sufficient areal extent to collect and retain a sufficient supply of surface water for stock needs throughout

the year. Shallow wells sunk near the edge of the dugouts will often yield a supply of water sufficient for domestic needs. The water will, no doubt, be of better quality than that obtained from wells sunk in the drift and the upper part of the bedrock.

Township 29, Range 14

The surface of most of this township is fairly level, but an area consisting of parts of sections 7, 8, 9, 15, 16, 17, and 18, and a small area in section 32, is somewhat hilly or rolling, and stones are commonly found on the surface. Parts of sections 8, 9, and 16, and all of 17, are covered by moraine. The remainder of the area is covered by boulder clay or glacial till, but with the exception of an area surrounding the moraine-covered sections and a small area in the northwestern corner, the boulder clay is overlain by glacial lake clays. In some sections the lake clays attain a thickness of 50 feet.

The glacial lake clays do not contain water-bearing deposits. A few shallow wells, however, have been dug, but they are located near sloughs and obtain their supply by direct seepage from the surface water. In years of average rainfall the supply from these wells is adequate for domestic needs and a few head of stock, but during winters and drought periods the supply may become intermittent or the wells go completely dry. The water, unless contaminated by polluted surface waters, is usable for all farm needs.

Pockets of sand and gravel occur within the weathered or oxidized zone of the boulder clay and moraine where they are exposed at the surface. Wells tapping these deposits are usually less than 35 feet deep. These wells are not so readily affected by drought conditions, but the supply of water obtained is no more than sufficient for local needs. The water often contains a considerable amount of mineral salts in solution, but it is suitable for drinking and for stock.

Throughout the township water is obtained from the water-bearing deposits in the unweathered zone of the boulder clay at depths of from 65 to 150 feet. Although wells tapping these deposits are found in all parts of the township, the deposits are not of large areal extent as dry holes were sunk in sections 24 and 26, and in many other parts of the township it was necessary to drill into the bedrock before water was encountered. Approximately one-half the wells tapping aquifers in the unweathered drift yield sufficient water for stock needs, but the others yield inadequate supplies for local needs. The water is highly mineralized and that from some of the wells is unfit for either domestic or stock purposes. Most of the water would not be used for drinking if water of better quality were available.

A few wells scattered throughout the township obtain water from what is thought to be an aquifer in the upper part of the bedrock at depths of 250 to 290 feet, or at elevations of 1,665 to 1,760 feet above sea-level. The aquifers tapped by this group of wells are not continuous throughout the township, as it was necessary to drill considerably deeper in some areas before water was obtained. However, in the western half of the township it appears probable that wells drilled to an approximate elevation of 1,700 feet should encounter water-bearing horizons. The yield from the wells is more than adequate for farm requirements, but the water is highly mineralized and that from at least two wells is used only for stock.

Four other wells in the township, located in the SE. and SW. ¼'s, section 2, the SW. ¼, section 24, and the SW. ¼, section 26, sunk to depths of 530, 460, 375, and 460 feet, respectively, encounter water-bearing sands in the Belly River formation at elevations of 1,415, 1,435, 1,585, and 1,515 feet above sea-level, respectively. It has been impossible to correlate the aquifers of these wells and there does not appear to be a general aquifer present throughout the township, although there should be no difficulty in encountering an aquifer in the bedrock at elevations below 1,450 feet above sea-level.

The supply from these wells, with the exception of that in section 26, is more than sufficient for farm needs. The deficient supply in the well in section 26 is due in a large part to sand plugging the casing of the well, and so reducing the flow of water. The water from two wells is recorded as soft, and the water in the well located in section 24 contains so much mineral salt in solution that its use is limited to stock.

A few dugouts have been excavated in this township, and one was reported to contain 12 feet of water and should provide sufficient water for stock throughout the year. Other dugouts could be advantageously and economically excavated in this area, and where the water supply from wells is deficient they are especially recommended. Shallow wells sunk beside existing dugouts will often supply enough water for domestic purposes. The quality of such water should be superior to most of that obtained from drift sources in this township.

Township 29, Range 15

Water supplies in this township are obtained from dams, dugouts, and from wells sunk into the glacial drift and into the underlying bedrock. The water from the dams and dugouts is used exclusively for stock. The water from wells is used for stock and occasionally for drinking. A considerable amount of water is hauled for domestic purposes.

The southwestern part of the township and a small area in the southeastern corner are mantled by moraine and the ground surface is quite hilly. Boulder clay is exposed at the surface in a large area in the southeastern part of the township and along the northern edge of the Bad Hills, but elsewhere it is concealed by glacial lake clays. The glacial lake clays are not thought to be more than 35 feet thick. The land surface of the lake clay and glacial till-covered areas is comparatively level. A narrow, marshy depression extends from

section 4 towards the northeastern corner, and the top soil in this low-lying area contains a considerable amount of "alkali salts".

Wells have been sunk in the three types of glacial deposits shown on the map, but it is thought that those sunk in the lake clays obtain water from deposits of sand and gravel that occur in the underlying boulder clay. The deposits of moraine and glacial till appear to have the same water-bearing properties. In general they consist of a few feet of top soil; a weathered or oxidized zone of clay that contains a few scattered deposits of water-bearing sand or gravel; and an unweathered zone of boulder clay that extends to the bedrock and which contains scattered deposits of sand and gravel at varying depths.

The water-bearing deposits in the weathered zone of the glacial drift supply only a few wells with water. Other shallow wells sunk near impounded waters are deriving their supply almost entirely by direct seepage. A prospective well site should be tested for water-bearing deposits by means of a small auger before any expense is incurred by digging. It is almost unnecessary to even test the areas covered by glacial lake clays for shallow water-bearing deposits, as the lake clays and even the upper part of the underlying drift do not usually contain water. The supply from the shallow wells varies considerably, especially those depending on direct seepage. Two of the wells supply sufficient water for stock needs, but it is too highly mineralized for domestic purposes. The others yield an inadequate supply, but the water is used for drinking as well as stock.

The deposits of water-bearing sand and gravel in the lower part or unweathered part of the glacial drift supply most of the wells in this township. Wells in the glacial lake-covered area are tapping these deposits. The wells range in depth from 40 to 240 feet, and it has been almost impossible to trace any relationship between the occurrence of the different aquifers over large areas, and they are no doubt formed by individual water-bearing deposits of small areal

extent. Only a few wells that tap deposits in the unweathered part of the drift yield an inadequate supply for farm requirements. Most of the wells yield water that is so highly mineralized that its use is limited to stock. No doubt the water would not be used for domestic purposes if water of better quality were obtainable within reasonable hauling distance.

Two wells, located in the SW. ¼, section 14, and the SW. ¼, section 36, obtain water from aquifers in the Belly River formation at depths of 340 and 365 feet. The aquifers, however, are not thought to be correlated, and they are located at elevations of 1,675 and 1,585 feet above sea-level, respectively. Although the data on bedrock aquifers are not numerous, it is assumed that wells drilled to an elevation of 1,550 feet above sea-level should tap aquifers in the bedrock. The supply from the two wells is more than adequate for farm needs, but the water is so highly charged with mineral salts in solution that it has been found suitable only for stock. Wells drilled to greater depths would no doubt obtain water of better quality.

In the western part of the township the topography is favourable for the construction of small dams, and two residents have employed this means of impounding the surface water for stock use. If dugouts are excavated, they should be at least 12 feet deep in order to retain sufficient surface water to last throughout the year. Wells sunk near water impounded by dams or dugouts will often yield sufficient water for domestic purposes and it will no doubt be of better quality than that obtained from the drift, or from the upper part of the bedrock.

Township 30, Range 13

The surface of this township is fairly level, but two small depressions occur in parts of sections 5 and 6, and in part of section 33. The glacial lake clays mantle the entire township, but they are not thought to be more than 50 feet thick. Boulder clay or glacial till underlies the lake clays.

Water supplies are obtained from dams, dugouts, and from wells sunk into the glacial drift and into the underlying bedrock.

With only one recorded exception, no wells obtain water at shallow depths from water-bearing deposits in the glacial lake clays. A few wells derive water by seepage from dugouts or sloughs, but their yield is directly dependant on the amount of water impounded in the reservoir. The water in the well lowers as the water in the slough or dugouts decreases. The water from these seepage wells is of fairly good quality and is generally superior to that obtained from the deeper drift wells.

The glacial till or boulder clay that underlies the lake clay throughout the municipality contains scattered pockets of water-bearing sand and gravel. These pockets have been tapped by a number of wells in this township, at depths ranging from 50 to 180 feet. Over small areas the pockets appear fairly numerous, but in no part of the township do they appear to form a general horizon covering more than 3 square miles. It is possible that most of the wells tap individual deposits. The discontinuity of the water-bearing sands and gravels is shown by the fact that dry holes were sunk in section 33, and also by the fact that numerous wells scattered throughout the township had to be drilled into the bedrock before water-bearing sands were tapped. Only a few of the drift wells yield inadequate supplies of water for local needs, but almost all of the wells yield water that is so highly charged with mineral salts in solution that it is entirely unsatisfactory for drinking. The water that is being used for drinking is highly mineralized, and would probably not be used if water of better quality were obtainable within reasonable hauling distance.

Six wells in this township obtain water from the Belly River formation at depths of 300 to 330 feet, and the water-bearing sands are tapped at elevations ranging from 1,610 to 1,640 feet above sea-level. These wells are located in the NE. $\frac{1}{4}$, section 2; NE. $\frac{1}{4}$, section 3; NE. $\frac{1}{4}$, section 9; SE. $\frac{1}{4}$, section 10; NE. $\frac{1}{4}$, section 15; and the NW. $\frac{1}{4}$,

section 20. Other wells drilled in this area should encounter the same or similar aquifers, but the horizons may not be of larger areal extent than the sections mentioned above. The supply from these wells is abundant and the hydrostatic pressure raises the water to within 100 feet of the surface. The water is hard, and that from one well is so highly mineralized that its use is limited to stock.

Two wells, located in the SE. ¼, section 2, and the SW. ¼, section 9, obtain water from the Belly River formation at depths of 500 and 450 feet, or at elevations of 1,430 and 1,500 feet above sea-level. From the information on hand it appears that the same aquifer may be common to the two wells and water may be obtained from this elevation at other localities in the township. The supply from both wells is abundant and the hydrostatic pressure is sufficient to raise the water 410 and 350 feet above the aquifers. The water is soft and it can be used for domestic purposes as well as for stock.

Township 30, Range 14

The ground surface of the greater part of this township is fairly level, but small hills occur in sections 4, 5, and 6, and Eaglehill creek has eroded its valley in the northwestern corner of the township. The area is mantled by glacial till or boulder clay, but it is overlain by glacial lake clays and is exposed only in parts of sections 4, 5, and 6, and in the valley of Eaglehill creek. The lake clays are at least 50 feet thick in some parts of the area.

A few wells in the northern part of the township obtain water within 30 feet of the surface. At least two of these wells depend directly on surface water for their supply, but one well in section 31 has tapped a deposit of water-bearing gravel at a depth of 12 feet. The supply from this well does not appear to be readily affected by periods of drought, but the supply from the others is appreciably depleted during winters and drought periods. The water from the shallow wells is generally suitable for drinking, although care should be taken that no surface refuse is allowed to pollute it. When a shallow well is contemplated the upper part of the drift should

be prospected by means of a small auger, so that water-bearing deposits may be located before a well is dug. The glacial lake clays will probably yield little or no water, but the underlying till or boulder clay should contain scattered deposits of water-bearing sand and gravel. Throughout the township such deposits have been tapped by a number of wells at depths ranging from 70 to 180 feet. Although no dry holes were recorded there does not appear to be a general or continuous water-bearing horizon present throughout the township, as the wells vary greatly in depth, and in a few areas they had to be drilled into the bedrock before water was obtained. Over small, local areas, however, some correlation can be noted in the aquifers. Such is the case in the N. ½, section 16, S. ½, section 21, and part of section 22, where the wells are sunk to depths of 72 to 100 feet. It may be possible that the two wells located in sections 4 and 9 derive their water from the same aquifer or from another local aquifer, the latter assumption probably being correct. Generally speaking, the wells in the deeper drift in the southern part of the township yield an adequate supply of water for local requirements, but a few of the wells in the northern half are deficient in supply. At best, one-half of the wells throughout the area yield water that is too highly mineralized for domestic purposes. The remaining wells are being used, but if water of better quality were obtainable, their use would undoubtedly be discontinued. The water from a well in section 8 was reported by the provincial analyst as satisfactory for drinking.

The aquifers in the Belly River formation in this township are not continuous and wells tapping bedrock aquifers range in depth from 270 to 450 feet, and the aquifers occur at elevations of 1,490 to 1,700 feet above sea-level. It cannot be said that some of the wells do not tap the same aquifer, but it appears that they tap separate water-bearing horizons. The aquifers are widely distributed and water should be obtained from the bedrock if wells are sunk to elevations of 1,500 feet above sea-level. It would probably be

necessary to sink a well at least another 100 feet to obtain softer water. The supply from the wells deriving water from the bedrock in this township is more than adequate for local needs. The water is under considerable hydrostatic pressure and rises at least 70 feet above the aquifer. The water, although fairly highly mineralized, is used, with one exception, for drinking as well as for stock.

Some of the residents find it necessary to haul drinking water. Most of it is obtained from the well in Rosetown. Residents in the eastern half of the township haul water from wells closer to that vicinity. A few dugouts have been excavated in this township and their use has been found satisfactory. The dugouts should be at least 12 feet deep in order to retain an adequate supply of surface water for stock throughout the year. Shallow wells sunk beside the dugouts often yield a supply of water that is sufficient for domestic needs. The water from these wells, when it is not polluted by surface waters, is generally superior to that obtained from the drift wells.

Township 30, Range 15

The ground surface of this township is fairly level. Eaglehill creek flows in an easterly direction along the northern part of the area, and its valley is from one-half to one mile wide, and over 50 feet deep. Two small depressions occur in sections 11 and 12. The elevation along the valley floor of Eaglehill creek is less than 1,850 feet above sea-level, but throughout the remainder of the township it varies from 1,900 to 1,950 feet. Rosetown is at an elevation of 1,928 feet above sea-level.

Boulder clay or glacial till mantles the township, but it is overlain by glacial lake clays and is only exposed in the valley of Eaglehill creek. The lake clays are estimated to be 50 feet thick in parts of the township.

Little or no water is obtained from the glacial lake clays, but the underlying boulder clay contains scattered deposits of water-bearing sand and gravel. In the area along Eaglehill creek, where

the boulder clay is exposed, wells tap deposits of water-bearing sand and gravel within 20 feet of the surface. Two of these wells are springs that have been dug out and cribbed and the water flows above the surface. The water-bearing sands and gravels are not thought to be widely distributed, and small test augers should be used to locate them prior to digging a well. The supply from the flowing wells is more than adequate for local needs and the water is used for drinking as well as stock.

Over the remainder of the township the water that is obtained is of very poor quality. Most of the wells obtain water from deposits of water-bearing sand and gravel in the boulder clay that underlies the lake clays. The deposits are encountered at depths of 60 to 138 feet. Over very small areas it is possible to trace out some relationship in the occurrence of the aquifers, but no general water-bearing horizons appear to be present in this part of the drift. The deposits, however, appear to be fairly numerous in most parts of the township, as no dry holes were recorded in this range of depth. The supply from all but two wells is fairly abundant, but the water from most of the wells is so highly mineralized that it cannot be used for drinking or domestic purposes, as it acts as a strong laxative.

Wells located in the SW. $\frac{1}{4}$, section 14, the NW. $\frac{1}{4}$, section 32, and the NE. $\frac{1}{4}$, section 33, are obtaining water at depths of 160, 180, and 128 feet, respectively. They tap aquifers at elevations of 1,765, 1,770, and 1,747 feet above sea-level, respectively. A hole drilled in section 12 also encountered an aquifer at a depth of 185 feet, or at an elevation of 1,743 feet above sea-level. It is not known if the same aquifer is common to the producing wells, as no information is available on the intervening area. The aquifers may lie at the base of the drift, or occur within the upper part of the bedrock, but the quality of the water leads to the belief that it

is derived entirely from the glacial drift. The supply from two of the wells is inadequate, but that from the well in section 33 is sufficient for farm needs. The water contains such a concentration of mineral salts in solution that its use is confined to stock.

A 480-foot well in section 29 encountered a black sand aquifer in the Belly River formation at an elevation of 1,480 feet above sea-level. The areal extent of this aquifer is unknown, but it is probable that it should be encountered by other wells sunk in this vicinity. The water rose to an elevation of 1,840 feet above sea-level 380 feet above the aquifer, but the fine sand of the aquifer is plugging the well casing and the supply available for use is reduced to such a degree that it is not sufficient for local needs. The water is hard and although mineralized can be used for drinking as well as for stock.

In section 12, at Rosetown, a well obtains water at a depth of 500 feet. The sand aquifer was penetrated from a depth of 488 feet to 500 feet and is located at an elevation of 1,440 feet above sea-level. It seems very unusual but a second well drilled within this immediate vicinity failed to tap the aquifer, and drilling was finally discontinued at a depth of 1,000 feet, or at an elevation of 928 feet above sea-level. This well may have passed through the aquifer tapped by the 500-foot well, or the aquifer may have thinned out or disappeared. It is unusual for an aquifer that yields such an abundant supply of water, reported as 300 gallons a minute, to be of such small areal extent. The supply from the producing well is sufficient for present needs. The water is soft and is quite satisfactory for domestic purposes. It may not be usable for irrigation.

Since there is no shortage of water for stock in this township, dugouts have not been used to collect and store surface water. These artificial reservoirs could be advantageously employed

throughout the area. Dams could also be constructed on Eaglehill creek. The slightly mineralized water from these reservoirs is more beneficial for stock than the water from the drift, and the expense of excavating a dugout is less than that of drilling into the bedrock. Shallow wells dug beside the impounded waters yield water that is usable for domestic purposes.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF ST. ANDREWS, NO. 287, SASKATCHEWAN

West of 3rd meridian — Township / Range	28 / 13	28 / 14	28 / 15	29 / 13	29 / 14	29 / 15	30 / 13	30 / 14	30 / 15	Total No. in Municipality
Total No. of Wells in Township	28	23	28	24	50	31	37	37	28	286
No. of wells in bedrock	23	11	5	19	14	2	8	7	3	92
No. of wells in glacial drift	5	12	23	5	36	29	29	30	25	194
No. of wells in alluvium	0	0	0	0	0	0	0	0	0	0
Permanency of Water Supply										
No. with permanent supply	28	23	28	22	36	29	33	35	26	260
No. with intermittent supply	0	0	0	2	1	2	2	2	1	10
No. dry holes	0	0	0	0	13	0	2	0	1	16
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	2	2
No. of non-flowing artesian wells	25	16	21	21	25	21	25	22	21	197
No. of non-artesian wells	3	7	7	3	12	10	10	15	4	71
Quality of Water										
No. with hard water	25	18	27	20	34	31	33	36	25	249
No. with soft water	3	5	1	4	3	0	2	1	2	21
No. with salty water	0	0	0	1	0	0	0	0	0	1
No. with "alkaline" water	12	8	19	9	8	12	12	23	20	123
Depths of Wells										
No. from 0 to 50 feet deep	0	1	12	3	8	8	4	3	3	42
No. from 51 to 100 feet deep	2	7	9	0	14	8	16	18	15	89
No. from 101 to 150 feet deep	3	3	2	2	13	7	7	6	5	48
No. from 151 to 200 feet deep	1	1	1	0	3	5	2	3	2	18
No. from 201 to 500 feet deep	21	9	2	18	11	3	8	7	2	81
No. from 501 to 1,000 feet deep	1	2	2	1	1	0	0	0	1	8
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	15	14	18	16	21	7	15	19	7	142
No. not usable for domestic purposes	3	9	10	8	16	24	20	18	20	128
No. usable for stock	28	23	27	24	35	30	35	37	27	266
No. not usable for stock	0	0	1	0	2	1	0	0	0	4
Sufficiency of Water Supply										
No. sufficient for domestic needs	28	23	28	22	35	29	35	36	27	261
No. insufficient for domestic needs	0	0	0	2	2	2	2	1	0	9
No. sufficient for stock needs	25	18	24	20	25	24	28	31	22	217
No. insufficient for stock needs	3	5	4	4	12	7	7	6	5	53

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 St. Andrews, No. 287, 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	SO_4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	
1	SW.	27	30	14	3	350	2,165												(2)		(4)	(3)	(1)	(5)	* 2
2	W.½	12	30	15	3	500												60				435	1,053	224	* 2
3	NE.	16	30	15	3	70	3,063												(1)		(2)	(3)		(4)	* 1

Water samples indicated thus, * 1, are from glacial drift.
Water samples indicated thus, * 2, are from bedrock, Belly River formation.
Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5) are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water.
Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).
Analyses Nos. 1 and 3, by Provincial Analyst, Regina; Analysis No. 2, by Canadian Pacific Railways, Winnipeg.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

No samples of water from the unconsolidated deposits in the municipality of St. Andrews were collected by the field party, but one sample from a 70-foot well in township 30, range 15, was analysed by the provincial analyst and the results are recorded in the accompanying table. The following discussion will, therefore, of necessity be based on the results of samples analysed from surrounding municipalities, and to some extent on the quality of the water as determined in the field.

The water from wells that are dug near undrained depressions or sloughs, providing the depressions are not "alkali flats", is as a rule moderately soft. This is also true of wells sunk near dugouts and near water impounded by dams. The water should be found satisfactory for both domestic and stock use, providing of course that it has not become contaminated by surface waters containing animal refuse. It is advisable to have such waters frequently tested for bacteria content.

Only a few wells tap deposits of sand and gravel at shallow depths in this municipality, and the water from them varies from comparatively soft to very hard. It also varies considerably in the amount of mineral salts contained in solution. It is generally used for domestic purposes with no apparent ill effects. A few wells in the northwestern part of the area are fed directly by springs. The water from these has been found entirely satisfactory for domestic purposes and for stock.

The water obtained from wells sunk into the lower part of the drift generally contains considerably more mineral salts in solution than the water from the shallow wells. The sample analysed by the provincial analyst is from the deeper part of the drift. The analysis is no doubt rather typical of the waters from this source. It is doubtful if the water could be used for drinking although it should be

satisfactory for stock. The water from a number of the wells deriving water from this part of the drift is too highly mineralized for domestic purposes, although the waters from wells located in the NE. ¼, sec. 30, and the NE. ¼, sec. 33, tp. 29, range 15, were analysed in 1925, and were pronounced suitable for drinking. The water is not being used for drinking at the present time. The results of the analyses were not available. The water from a well in the N. ½, sec. 8, tp. 30, range 14, was analysed by the University of Saskatchewan and pronounced fit for drinking. In this township, however, good drinking water is hard to obtain from the drift.

Water from the Bedrock

No samples of water from the Belly River formation were collected by the field party, but one sample was analysed by the provincial analyst and another by the Canadian Pacific Railway Company at Winnipeg. Sample 2 should be fairly representative of the soft water that is obtained from the bedrock. It does not contain a particularly high total dissolved solid content. The sodium salts are predominant. Due to the presence of Na_2CO_3 (sodium carbonate), the water may have a soda taste, but it is entirely satisfactory for domestic purposes and stock. The relatively large amount of sodium carbonate may, however, render it unfit for irrigation. Sample 1 is also from the Belly River formation, but it is quite hard due to the salts of calcium and magnesium. Such waters should be found quite suitable for drinking. The water from the well located in sec. 26, tp. 29, range 13, probably will be very similar to the sample analysed.

A number of wells in this municipality are thought to be drawing their water from the upper part of the Belly River formation, and the water from some of these wells is extremely hard and highly mineralized. A few of the waters are unsatisfactory for domestic use and are used only for stock.

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.