CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 242

# GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF SENLAC NO. 411 SASKATCHEWAN

Records Collected by C. O. Hage
Compilation by G. S. Hume and C. O. Hage



OTTAWA

1947

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MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

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## INTRODUCTION

Information on the ground-water resources of east-central Alberta and western Saskatchewan was collected, mostly in 1935, during the progress of geological investigations for oil and gas. The region studied extends from Edmonton in the west to Battleford in the east, and from township 32 on the south to township 59 in western Alberta, township 63 in eastern Alberta, and in part as far north as township 56 in western Saskatchewan.

This region is crossed by North Saskatchewan and Battle Rivers, and includes other more or less permanent streams. Most of the lakes within the area, however, are alkaline, and water is obtained in wells from two sources, namely, from water-bearing sands in surface or glacial deposits, and from sands in the underlying bedrock.

A division has been made in the well records, in so far as possible, between glacial and bedrock water-bearing sands. In investigations for oil and gas, however, the bedrock wells were used to trace the lateral extent of geological formations, with the result that the records deal more particularly with this type of well. No detailed studies were made of the glacial materials in relation to the water-supply, nor were the glacial deposits mapped adequately for this purpose. In almost all of the region investigated in Alberta, and in all but the northeast part of the region studied in Saskatchewan, water can be obtained from bedrock. In a few places, however, the water from the shallower bedrock sands is unsatisfactory, and deeper drilling may be necessary.

The water records were obtained mostly from the well owners, some of whom had acquired the land after the water supply had been found, and hence had no personal knowledge of the water-bearing beds that had been encountered in their wells. Also the elevations of the wells were taken by aneroid barometer and are, consequently, only approximate. In spite of these defects, however, it is hoped that the publication of these water records may prove of value to farmers, town authorities, and drillers in their efforts to obtain water supplies adequate for their needs.

In collecting this information several field parties were employed. These were under the direction of Professors R. L. Rutherford and P. S. Warren of the University of Alberta, C. H. Crickmay of Vancouver, and C. O. Hage, until recently a member of the Geological Survey. The oil and gas investigations of which these water records are a part were undertaken under the general supervision of G. S. Hume.

### Publication of Results

The essential information pertaining to ground-water conditions is being issued in reports that in Saskatchewan cover each municipality, and in Alberta cover each square block of sixteen townships beginning at the 4th meridian and lying between the correction lines. The secretary treasurer of each municipality in Saskatchewan and Alberta will be supplied with the information covering that municipality. Copies of the reports will also be available for study at offices of the Provincial and Federal Government Departments. Further assistance in the interpretation of the reports may be obtained by applying to the Chief Geologist, Geological Survey, Ottawa. Technical terms used in the reports are defined in the glossary.

## How to Use the Report

Anyone desiring information concering ground water in any particular locality will find the available data listed in the well records. These should be consulted to see if a supply of water is likely to be found in shallow wells sunk in the glacial drift, or whether a better supply may be obtained at greater depth in the underlying bedrock formations. The wells in glacial drift commonly show no regional level, as the sands or gravels in which the water occurs are irregularly distributed and of limited extent. As the surface of the ground is uneven, the best means of comparing water wells is by the elevations of their water-bearing beds. For any particular well this elevation is obtained by subtracting the figure for the depth of the well to the water-bearing bed from that for the surface elevation at the well. For convenience both the elevation of the wells and the elevation of the water-bearing bed or beds in each well are given in the well record tables. Where water is obtained from bedrock, the name of the formation in which the water-bearing sand occurs is also listed in these tables, and this information should be used in conjunction with that provided on bedrock formations, pages 4 to 5, which describes these formations and gives their thickness and sequence. Where the level of the water-bearing sand is known, its depth at any point can easily be calculated by substracting its elevation, as given in the well record tables, from the elevation of the surface at that point.

With each report is a map consisting of two figures. Figure 1 shows the bedrock formations that will be encountered beneath the unconsolidated surface deposits. Figure 2 shows the position of all wells for which records are available, the class of well at each location, and the contour line or lines of equal surface elevation. The elevation at any location can thus be roughly judged from the nearest contour line, and the records of the wells show at what levels water is likely to be encountered. The depth of the well can then be calculated, and some information on the character and quantity of water can be obtained from a study of the records of surrounding wells.

## GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground waters that have a peculiar and disagreeable taste. In the Prairie Provinces, water that is commonly described as alkaline usually contains a large amount of sodium sulphate and magnesium sulphate, the principal constituents of Glauber's salt and Epsom salts respectively. Most of the so called alkaline waters are more correctly termed sulphate waters, many of which may be used for stock without ill effect. Water that tastes strongly of common salt is described as salty.

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 porous bed, lens, or pocket in unconsolidated deposits or in bedrock that carries water.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 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.

(2) Wells in which the water is under pressure but does not rise to the surface.

(3) Wells in which the water does not rise above the water table.

BEDROCK FORMATIONS OF WEST-CENTRAL SASKATCHEWAN AND EAST-CENTRAL ALBERTA

The formations that outcrop in west-central Saskatchewan are an extension of similar formations that occur in east-central Alberta. They are of Upper Cretaceious age, and consist entirely of relatively soft shales and sands, with some bands of hard sandstone and layers of ironstone nodules. The succession, character, and estimated thickness of the formations are shown in the following table:

| Formation | Character | Thickness Feet |
|---|---|---|
| Edmonton | Grey to white, bentonitic sands and sandstones with grey and greenish shales; coal seams prominent in some areas, as at Castor, Alberta. | 1,000 to 1,150 |
| Bearpaw | Dark shales, green sands with smooth black chert pebbles; partly non-marine, with white bentonitic sands, carbonaceous shales or thin coal seams similar to those in Pale Beds; shales at certain horizons contain lobster claw nodules and marine fossils; at other horizons are abundant selenite crystals. | 300 to 600 thins rapidly to the north-west |
| Pale and Variegated Beds | Light grey sands with bentonite; soft, dark grey and light grey shales with selenite and ironstone; carbonaceous shales and coal seams; abundant selenite crystals in certain layers. | 950 to 1,000 in Czar-Tit Hills area; may be thinner elsewhere |
| Birch Lake | Grey sand and sandstone in upper part; middle part of shales and sandy shales, thinly laminated; lower part with grey and yellow weathering sands; oyster bed commonly at base. | 100 in west, but less to east and south |
| Grizzly Bear | Mostly dark grey shale of marine origin, with a few minor sand horizons; selenite crystals and nodules up to 6 or 8 inches in diameter | Maximum, 100 |
| Ribstone Creek | Grey sands and sandstones at the top and bottom, with intermediate sands and shales; thin coal seam in the vicinity of Wainwright; mostly non-marine, but middle shale in some areas is marine. | Maximum, 325 at Viking; thins eastward |
| Lea Park | Dark grey shales and sandy shales with nodules of ironstone; a sand 70 feet thick 110 feet below the top of the formation in the Ribstone area, Alberta. | 950 to 1,100 |

Edmonton Formation

The name Edmonton formation was first applied to the beds containing coal in the Edmonton area, and later to the same beds in adjoining areas. The formation has a total thickness of 1,000 to 1,150 feet, but is bevelled off eastward and the east edge of the formation follows a northwest line from Coronation through Tofield to a point on North Saskatchewan River about midway between Edmonton and Fort Saskatchewan. No Edmonton beds occur northeast of this line, but the formation becomes progressively thicker to the southwest due to the fact that the beds incline in that direction and the surface bevels across them.

The Edmonton formation consists of poorly bedded grey and greenish clay shales, coal seams, and sands and sandstones that contain clay and a white material known as bentonite. This material when wet is very sticky and swells greatly in volume, and when dry tends to give a white appearance to the beds containing it. Such beds are relatively impervious to water, and at the surface produce the "burns" of barren ground where vegetation is scanty or absent.

Water is relatively abundant in the Edmonton formation, which contains much sand, commonly in the form of isolated lenses distributed irregularly through the formation. Consequently, there is little uniformity in the depth of wells even within a small area. Water also occurs commonly with coal seams and, unlike the sand lenses, these beds are much more regular and persistent. In contrast with the water from the bentonitic sands, which is generally "soft", water from the coal seams, as the water from the shallow surface deposits, may be "hard". The basal beds of the Edmonton formation usually contain fresh water, but this may become brackish locally where the underlying Bearpaw beds contain highly alkaline or salty water.

## Bearpaw Formation

In southern Alberta, where the Bearpaw formation is thickest, the beds composing it are mainly shales that have been deposited in sea water. In the area north of township 32 the formation thins to the northwest and becomes a shoreline deposit composed of shales containing bentonite, impure sands, and thin coal seams. In some areas, as at Ryley and near Monitor, and in the Neutral Hills, the Bearpaw contains pebble beds. At Ryley these are consolidated into a conglomerate, but mostly the pebbles are loosely distributed in shale or sandy beds.

In the area immediately north of township 32 the Bearpaw occupies a widespread belt beneath the glacial drift, but farther northwest the belt narrows, and at Ryley and northwestward it is only a few miles wide. This belt crosses North Saskatchewan River about midway between Edmonton and Fort Saskatchewan. Bearpaw beds form the main bedrock deposits of the Neutral Hills. Farther south, where they have an exposed thickness of at least 400 feet, they contain green sands, and beds of marine shale interfinger with the bentonitic shales and sands of the underlying formation. To the north, on the banks of North Saskatchewan River, the division between the Bearpaw and the overlying and underlying formations is indefinite, and the thickness of beds of Bearpaw age is relatively small.

The water in the Ryley area is from the Bearpaw formation, and is salty. In other areas to the south the marine Bearpaw formation carries green sand beds that yield fresh water, but commonly a much better supply is found by drilling through the Bearpaw into the underlying Pale Beds.

In Saskatchewan, Bearpaw beds occur southeast of Maclin and south of Luseland and Kerrobert. Only the basal beds are present, and these contain green sands that are commonly water-bearing.

## Pale and Variegated Beds

Underlying the Bearpaw formation is a succession of bentonitic sands, shales, and sandy shales containing a few coal seams. The upper part of this succession, due to the bentonitic content, is commonly light coloured and has been described as the Pale Beds, whereas the lower part is darker, and is known as Variegated Beds. In part, dark shales are present in both Pale and Variegated Beds; others are greenish, grey, brown, and dark chocolate, carbonaceous types. The sands may also be yellow, but where bentonite is present it imparts a light colour to the beds. Both Pale and Variegated Beds are characterized by the presence of thin seams of ironstone, commonly dark reddish, but in part purplish, Selenite (gypsum) crystals are, in places, abundant in the shales.

The best sections of Pale Beds exposed in the region are in the Tit Hills, southwest of Czar. These hills carry a thin capping of Bearpaw shales, beneath which, and around Bruce Lake, more than 200 feet of Pale Beds are exposed. The total thickness of Pale and Variegated Beds in the Tit Hills area is about 970 feet. Variegated Beds outcrop near Hawkins on the Canadian National Railway west of Wainwright, but no area exposes the complete succession, which is considered to comprise about 200 feet of beds.

Records of wells drilled into the Pale and Variegated Beds do not, in general, indicate lateral persistence of sands for long distances, nor any uniform average depth to water-bearing sands in a local area. This points to the conclusion that the sands are mainly local lenses, but as such lenses are numerous, few wells fail to obtain water. In the Cadogan area many flowing wells have been obtained from sands about midway in the succession. In western Saskatchewan Paleland Variegated Beds occur over a wide area from Maclin and Kerrobert northeast through Wilkie to the Eagle Hills, south of Battleford. Numerous outcrops occur in the area south of Unity at Muddy Lake, but south and east around Biggar these beds are almost wholly concealed by glacial drift.

The water from the sands of the Pale and Variegated Beds is generally soft. The supply, apparently, is dependent in part on the size of the sand body that contains the water and in part on the ease with which water may be replenished in the sand. Small sand lenses surrounded by shales may be filled with water that has infiltrated into them, but when tapped by a well the supply may be very slowly replenished. In many instances such wells yield only a small supply, although this is commonly persistent and regular.

## Birch Lake Formation

The Birch Lake formation underlies the Variegated Beds, but in many areas the division is not sharp. The type area of the formation is along the north shore of Birch Lake south of Innisfree, where a section 65 feet thick, composed mostly of sand, is exposed. The total thickness of the formation in this area is about 100 feet, and although this is dominantly sand a central part is composed of alternating thin sand and shale beds. At the base of the formation, in a number of places, is an oyster bed, and this is exposed in a road cut in a section 73 feet thick on the east side of Buffalo Coulée in sec. 3, tp. 47, rge. 7, W. 4th mer. In both upper and lower parts of the formation the sand is commonly massive and outcrops tend to consolidate into hard, nodular masses from a foot to a few feet in diameter. Apparently these are formed through the deposition of salts from the water that finds an outlet at the outcrops. In fact, in some areas the sand may be traced along the side of a hill by the presence of small springs or nodular masses of sandstone.

The Birch Lake formation occurs under the drift and in outcrops in a large area south of North Saskatchewan River and northeast of a line from Willingdon to Innisfree and Minburn. East of this area the southwest boundary is more irregular, but outcrops are persistent on the banks of Battle River from a few miles north of Hardisty to and beyond the mouth of Grizzly Bear Coulée in tp. 47, rge. 5. It is believed, too, that a large area near Edgerton and Chauvin is underlain by the Birch Lake formation and that it extends southeastward into Saskatchewan around Manitou Lake and southeast to Vera.

It is thought that the Birch Lake formation thins eastward from its type section at Birch Lake, and that it loses its identity in western Saskatchewan. Deep wells drilled at Czar, Castor, and elsewhere no longer show the Birch Lake as a clearly recognizable sand formation, so that its southern limit beneath younger formations is unknown. Wherever it occurs as a sand, however, it is water-bearing, although in some areas the sand is apparently too fine to yield any considerable volume of water. In other areas, however, it persistently yields good wells. There is no apparent uniformity in the character of the water, which is either hard or soft in different wells in the same general area. Direct contact with surface waters that contain calcium sulphates may in time change a "soft" water well to a "hard" water well, and many wells are not sufficiently cased to prevent the percolation of water from surface sands into the well, and hence into the deeper, soft water producing sands. In part this accounts for the change in character of the water in a well, a feature that has been noticed by many well owners.

## Grizzly Bear Formation

The type locality for the Grizzly Bear formation, which underlies the Birch Lake beds, is near the mouth of Grizzly Bear Coulée, a tributary of Battle River with outlet in tp. 47, rge. 5. The formation is mainly composed of dark shales that were deposited in sea water. At the mouth of Grizzly Bear Coulée two shale sections, each about 100 feet thick, are separated by a zone of thin sand beds. It is now recognized that the upper section is the Grizzly Bear shale, and that the lower one, very similar in character and also deposited in sea water, occurs in the next lower formation, the Ribstone Creek. The Grizzly Bear shale contains a thin nodular zone about 50 feet above the base, that is, at about the centre of the formation. This zone is sandy, and is believed to yield water in various wells. Other thin sands, in places water-bearing, are also present. The impervious nature of the Grizzly Bear shales makes the overlying Birch Lake sand a strong acquifer, as water collects in the sand above the shale. The contact of the Birch Lake and Grizzly Bear formations can be traced in some places by the occurrence of springs issuing from the base of the Birch Lake sand even where this is not exposed.

Grizzly Bear shales occur in a road cut on the south side of Battle River near the highway bridge at Fabyan. The shales in this area are about 100 feet thick. It is thought they extend as far west as the Viking gas field, where they have been recognized in samples from deep wells. It is probable, however, that the shales thin westward and thicken eastward so that their general form is a wedge between both higher and lower sand beds. The position of the thin edge of the wedge to the west is unknown, but evidently the Grizzly Bear marine shale underlies a large area in east-central Alberta extending into Saskatchewan mainly in the area south of Battle River.

## Ribstone Creek Formation

The type area of the Ribstone Creek formation is on Ribstone Creek near its junction with Battle River in tp. 45, rge. 1, W. 4th mer. At this place the lower sand beds of the formation are well exposed. The upper part of the lower sand member of this formation outcrops on the north side of Battle River, in the northeast part of sec. 26, tp. 47, rge. 5, near the mouth of Grizzly Bear Coulée. Above it, higher on the bank and at a short distance from the river, there is a 12 foot zone of carbonaceous and coaly beds in two layers, each about 2 feet thick, separated by 8 feet of shale. Above this are 90 feet of dark shales that are thought to have been deposited in sea water, that is, they are marine shales. These marine shales in turn are overlain by a sandy zone about 20 feet thick containing oysters in the basal part. This sandy zone is the upper sand member of the Ribstone Creek formation.

It thickens to the east and west from the Grizzly Bear area but is probably at no place much more than 50 feet thick.

The lower sand member of the Ribstone Creek formation also varies in thickness from a minimum of about 25 feet. On the banks of Vermilion Creek, north of Mannville, the basal sand is at least 60, and may be 75, feet thick. It is overlain by shaly sand and sandy shale beds, which replace the shale beds in the central part of the formation as exposed at the mouth of Grizzly Bear Coulée. In the Wainwright area, where the formation has been drilled in deep wells, the basal sand is 60 feet thick, with the central part composed of shale containing sand streaks. The upper sand member is about 20 feet thick in this area. The total thickness of the formation in the Wainwright area is 100 to 200 feet, but this increases to the west and in the Viking area exceeds 300 feet.

The Ribstone Creek formation is widely exposed in a northwest-trending belt in east-central Alberta. The southwest boundary of this northwest-trending belt passes through the mouth of Grizzly Bear Coulée in tp. 47, rge. 5, and beyond to the Two Hills area in tp. 54, rge. 12, whereas the northeast boundary crosses North Saskatchewan River southwest of Elk Point and extends northwest to include an area slightly north of St. Paul des Metis and Vilna to tp. 60, rge. 14. Within this belt water wells are common in the Ribstone Creek sands, which are almost without exception water-bearing in some part of the formation. The limits of the belt to the northeast determine the limits of water from this source, but to the southwest of the belt, as here outlined, water may be obtained in this formation by drilling through the younger beds that overlie it. The Ribstone Creek sands are a prolific source of water in many places and hence the distribution of this formation is of considerable economic importance. Where the formation consists of upper and lower sands with a central shale zone only the sands are water-bearing, although thin sand members may occur in the shale. Where the formation is largely sand the distribution of water may be in any part of the formation, although the upper and lower sands are perhaps the better aquifers. To the east of Alberta, along Battle River and Big Coulée in Saskatchewan, the Ribstone Creek sands are marine. Marine conditions apparently become more prevalent to the southeast and it is believed that in this direction the sands are gradually replaced by marine shales. Thus at some distance southeast of Battleford the Ribstone Creek formation loses its identity and its equivalents are shales in a marine succession.

## Lea Park Formation

The Lea Park formation is largely a marine shale, and only in the upper 180 feet is there any water. In the Dina area south of Lloydminster the upper beds of the Lea Park consist of silty shales about 110 feet thick underlain by silty sands 70 feet thick. Below these sands are marine shales only, and these yield no fresh water either in east-central Alberta or west-central Saskatchewan. The sand in the upper Lea Park formation is thus the lowest freshwater aquifer within a very large area. The extent of this sand in the Lea Park, particularly to the northeast, is not known, but as the strata in east-central Alberta have a southwest inclination, progressively lower beds occur at the surface to the northeast. Thus at a short distance beyond the northeast boundary of the Ribstone Creek formation, as previously outlined, the sand in the upper Lea Park reaches the surface, and represents the last bedrock aquifer in that direction. Farther northeast water must be obtained from glacial or surface deposits only. In Alberta this area without fresh water in the bedrock includes the country north of North Saskatchewan River in the vicinity of Frog Lake and a large area extending to and beyond Beaver River. In this area, however, more fresh water streams are present than farther south, and bush lands help to retain the surface waters. The area northeast of North Saskatchewan River in Saskatchewan is almost wholly within the Lea Park formation, where water can be found only in surface deposits.

## WATER ANALYSES

### Introduction

Analyses were made of water samples collected from a large number of wells in west-central Saskatchewan. Their purpose was to determine the chemical characteristics of the waters from different geological horizons, and thereby assist in making correlations of the strata in which the waters occur. Although this was the main objective of the analyses, it was also realized that a knowledge of the mineral content of the water is of interest and value to the consumer. The analyses were all made in the laboratory of the Water Supply and Borings Section of the Geological Survey, Ottawa.

### Discussion of Chemical Determinations

The dissolved mineral constituents vary with the material encountered by the water in its migration to the reservoir bed. The mineral salts present are referred to as the total dissolved solids, and they represent the residue when the water is completely evaporated. This is expressed quantitatively as "parts per million", which refers to the proportion by weight in 1,000,000 parts of water. A salt when dissolved in water separates into two chemical units called "radicals", and these are expressed as such in the chemical analyses. In the one group is included the metallic elements of calcium (Ca), magnesium (Mg), and sodium (Na), and in the other group are the sulphate (SO4), chloride (Cl), and carbonate ($CO_3$) radicals.

The analyses indicate only the amounts of the previously mentioned radicals, thus neglecting any silica, alumina, potash, or iron that may be present. It will be noticed that in most instances the total solids are accounted for by the sum total of the radicals as shown by the analyses. Actually, the residue when the water is completely evaporated still retains some combined water of crystallization, so that the figures for the "total solids" are higher than the sum total of the radicals as determined. These radicals are also "calculated in assumed combinations" to indicate the theoretical amounts of different salts present in the water. The same method was followed in each analysis, so that the table presents a consistent record of the different compounds present.

### Mineral Constituents Present

Calcium. Calcium (Ca) in the water comes from mineral particles present in the surface deposits, the chief source being limestone, gypsum, and dolomite. Fossil shells provide a source of calcium, as does also the decomposition of igneous rocks. The common compounds of calcium are calcium carbonate ($CaCO_3$) and calcium sulphate ($CaSO_4$).

Magnesium. Magnesium (Mg) is a common constituent of many igneous rocks and, therefore, very prevalent in ground water. Dolomite, a carbonate of calcium and magnesium, is also a source of the mineral. The sulphate of magnesia ($MgSO_4$) combines with water to form "Epsom salts" and renders the water unwholesome if present in large amounts.

Sodium. Sodium (Na) is derived from a number of the important rock-forming minerals, so that sodium sulphate and carbonate are very common in ground waters. Sodium sulphate ($Na_2SO_4$) combines with water to form "Glauber's salt" and excessive amounts make the water unsuitable for drinking purposes. Sodium carbonate ($Na_2CO_3$) or "black alkali" waters are mostly soft, the degree of softness depending upon the ratio of sodium carbonate to the calcium and magnesium salts. Waters containing sodium carbonate in excess of 200 parts per million are unsuitable for irrigation purposes[1]. Sodium sulphate is less

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1 "The extreme limit of salts for irrigation is taken to be 70 parts per 100,000, but plants will not tolerate more than 10 to 20 parts per 100,000 of black alkali (alkaline carbonates and bicarbonates)" Frank Dixey in "A Practical Handbook of Water Supply", Thos. Murby & Co., 1931, p. 254.

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harmful.

Sulphates. The sulphate ($SO_4$) salts referred to in these analyses are calcium sulphate ($CaSO_4$), magnesium sulphate ($MgSO_4$), and sodium sulphate ($Na_2SO_4$).

Chloride. Chlorine (Cl) is with a few exceptions, expressed as sodium chloride (NaCl), that is, common table salt. It is found in all of the analyses, most of the waters containing less than 200 parts per million, but some as much as 2,000 or 3 ,000 parts. These waters have a brackish taste.

Alkalinity. The alkalinity determined in these water analyses is based on the assumption that the only salts present in the samples that will neutralize acids are carbonates, and that, consequently, the degree of alkalinity is proportional to the amount of the carbonate radical ($CO_3$) present.

Hardness. The hardness of water is the total hardness, and has been determined by the amount of a standard soap solution required to form a lather that will stand up (persist) for 2 minutes. Hardness is of two kinds, temporary and permanent. Temporary hardness is caused by calcium and magnesium bicarbonates, which are soluble in water but are precipitated as insoluble normal carbonates by boiling, as shown by the scale that forms in teakettles. Permanent hardness is caused by the presence of calcium and magnesium sulphates, and is not removed by boiling. The two forms of hardness are not distinguished in the water analyses. Waters grade from very soft to very hard, and can be classified according to the following system[2]:

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2 The "Examination of Waters and Water Supplies", Thresh & Beale, page 21, Fourth Ed. 1933 .

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A water under 50 degrees (that is, parts per million) of hardness may be said to be very soft.
A water with 50 to 100 degrees of hardness may be said to be moderately soft.
A water with 100 to 150 degrees of hardness may be said to be moderately hard.
A water with more than 200 and less than 300 degress of hardness may be said to be hard.
A water with more than 300 degrees of hardness may be said to be very hard.

Hard waters are usually high in calcium carbonate. Almost all of the waters from the glacial drift are of this type, especially those not associated with sand and gravel deposits that come close to the surface.

In soft water the calcium carbonate has been replaced by sodium carbonate, due to natural reagents present in the sand and clays. Bentonite and glauconite are two such reagents known to be present. Montmorillinite, one of the clay-forming minerals, has the same property of softening water, owing to the absorbed sodium that is available for chemical reaction[1].

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1 Piper, A. M. "Ground Water in Southwestern Pennsylvania", Penn. Geol. Surv., 4th series.

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If surface water reaches the lower sands by percolating through the higher beds it may be highly charged with calcium salts before reaching the bedrock formations containing bentonite or glauconite. The completeness of the exchange of calcium carbonate for sodium carbonate will, therefore, depend upon the length of time that the water is in contact with the softening reagent, and also upon the amount of this material present. The rate of movement of underground water will, consequently, be a factor in determining the extent of the reaction.

The amount of iron present in the water was not determined, owing to the possibilities of contamination from the iron casings in the wells. Iron is present in most waters, but the amount may be small. Upon exposure to air a red precipitate forms, the water becomes acid, and, hence, has a corrosive action. When iron is present in large amounts the water has an inky taste.

## WATER ANALYSES IN RELATION TO GEOLOGY

### Glacial Drift

The quality of the water from glacial drift depends largely on the nature of the deposit from which it comes and on the depth of the aquifer below the surface. Glacial deposits may be divided roughly into three types.

(1). Sand and gravel beds that form the surface deposit, such as outwash material and glacial lake sands.

(2). Buried outwash and interglacial deposits between two tills of boulder clay.

(3). Pockets or lenses of sand and gravel irregularly distributed through the till.

Water from surface sand deposits is normally low in dissolved salts, the total being generally less than 1,000 parts per million. Where large amounts of limestone occur in the glacial sand and gravel beds a characteristic constituent of the glacial water is calcium carbonate, the amount present varying from 300 to 700 parts per million.

Water from buried outwash deposits contains more dissolved salts than the surface sands, as the water in order to reach them has to percolate through overlying till. Rain water contains carbonic acid, which acts as a solvent and dissolves a great deal of calcium, magnesium, and sodium from the rock-forming minerals. Sulphate salts are commonly present, though their proportions vary greatly in the different waters. The shales that are incorporated in the drift are high in calcium sulphate, so that the amount of shale present will modify the quality of the water. The oxidized upper part of the drift contains less sulphate than the deeper, less oxidized boulder clay. The character of the water in the buried outwash deposits will, therefore, depend largely on the composition and amount of till that overlies it.

Water from irregularly distributed sand and gravel beds will vary in its content of dissolved salts depending upon the character of the material surrounding the reservoir beds. As the water in this type of deposit does not flow to any marked extent, it is apt to be more highly impregnated with soluble salts than where the underground movement is more rapid. Soft water in the drift is mostly confined to shallow wells in sands low in calcium carbonate. Waters from glacial lake clays are sometimes high in soluble salts. The sample from a well in glacial lake clay on N.W. ¼ sec. 27, tp. 42, rge. 17, has 11,040 parts per million of soluble salts, largely magnesium sulphate and sodium sulphate. The sample from SE. ¼ sec. 13, tp. 42, rge. 16, which is believed to come from glacial lake silts, has a very different composition. The total solids in it are only 440 parts per million, of which 250 are calcium carbonate. The great difference in these waters is due to the high soluble salt content that is associated with the lake clays but absent in the silts. Average drift water contains between 1,000 and 3,000 parts per million of dissolved mineral salts.

## Bearpaw Formation

The Bearpaw formation consists of dark marine shales and beds of green sand. Water from these sands has a total solid count ranging from 300 to 1,600 parts per million and a hardness of more than 300 degrees. Calcium carbonate is very marked in all samples, due, perhaps, to the proximity of the water sands to the glacial drift. Sodium sulphate is the chief salt present, followed by calcium carbonate, magnesium sulphate, magnesium carbonate, and sodium chloride in decreasing amounts. These waters are distinguished from the overlying drift waters by being relatively low in total dissolved solids, and in containing no calcium sulphate and only moderate amounts of sodium sulphate, magnesium sulphate, and magnesium carbonate.

## Pale Beds

Pale Beds underlie the Bearpaw formation. Total solids in waters from these beds vary from 700 to 1,300 parts per million. The water is, in most instances, soft, as it contains sodium carbonate in excess of calcium and magnesium carbonates, but when mixed with surface water high in calcium carbonate, it will become hard. The high concentration of sodium salts, especially sodium carbonate, in contrast with the calcium and magnesium salts distinguishes this water from that in Bearpaw sands. The Pale Beds include much bentonite, and it is this mineral that acts as a water softener within the formation. The following analyses are typical of waters from the Pale Beds:

| Salts | SE. sec. 16, tp.38, rge. 21 | NE. sec. 3, tp.39, rge. 25, | SW. sec. 7, tp.37, rge.24, | SE. sec. 21 tp. 38, rge.23 |
|---|---|---|---|---|
| $CaCO_3$ | 73 | 18 | 53 | 35 |
| $CaSO_4$ | - | - | - | - |
| $MgCO_3$ | 52 | 14 | 45 | 38 |
| $MgSO_4$ | - | - | - | - |
| $Na_2CO_3$ | 297 | 679 | 464 | 562 |
| $Na_2SO_4$ | 297 | 158 | 266 | 437 |

| | | | | |
|---|---|---|---|---|
| NaCl | 31 | 45 | 46 | 130 |
| Total solids | 760 | 1,020 | 940 | 1,260 |
| Hardness | 100 | 20 | 30 | 75 |

## Variegated Beds

In Senlac Rural Municipality, Saskatchewan, are a number of wells that have water very similar in character to that found in the Bearpaw formation. These wells tap an horizon that corresponds with the Variegated Beds in Alberta, although they have not been separated from the Pale Beds. They are less bentonitic than the Pale Beds and darker in colour. The water is hard and has a low dissolved solid content. The three analyses given below show a great deal of similarity and suggest a common horizon.

| Salts | NW. sec. 21, tp.41,rge.26 | NW. sec. 3, tp.41,rge.28 | SE. sec. 28, tp.40,rge.2[illegible] |
|---|---|---|---|
| $CaCO_3$ | 250 | 3[illegible]5 | 125 |
| $CaSO_4$ | – | – | – |
| $MgCO_3$ | 1109 | 80 | 155 |
| $MgSO_4$ | 149 | 104 | 69 |
| $Na_2CO_3$ | – | – | – |
| $Na_2SO_4$ | 98 | 132 | 386 |
| NaCl | 12 | 12 | 18 |
| Total solids | 640 | 640 | 780 |
| Hardness | 600 | 600 | 500 |

## Ribstone Creek Formation

Chemical analyses of water from the Ribstone Creek formation vary more than in the Pale Beds, the reason being that at several different horizons the sediments show considerable lateral variation. The formation includes both marine and non-marine beds, thin coal seams being present in the basal part of the formation around Paynton, whereas south of Lashburn, on Battle River, marine fossils were found in strata considered to be at approximately the same horizon. The water analyses show similarities within limited areas, but long distance correlations cannot be made safely except for the saline waters that occur in the flowing wells at Vera, Muddy Lake, and at the south end of Tramping Lake. Analyses of these waters are given in the following table:

| Salts | SE.sec.25, tp.41,rge. 24 | SE.sec.22, tp.41,rge. 24, | NE.sec.36, tp.41,rge. 24, | SW.sec.7 tp.41,rge 24, | SE.sec.30, tp.38, rge. 22, | SW.sec10, tp.35, rge.20, |
|---|---|---|---|---|---|---|
| $CaCO_3$ | 73 | 73 | 73 | 198 | 108 | 90 |
| $CaSO_4$ | – | – | – | – | – | – |
| $MgCO_3$ | 38 | 38 | 38 | 52 | 69 | 52 |
| $MgSO_4$ | – | – | – | – | – | – |

| | | | | | | |
|---|---|---|---|---|---|---|
| $Na_2CO_3$ | 129 | 119 | 129 | 11 | 106 | 125 |
| $Na_2SO_4$ | 55 | 55 | 61 | 61 | 49 | 43 |
| NaCl | 2,929 | 3,036 | 2,690 | 2,863 | 3,531 | 3,861 |
| Total solids | 3,840 | 3, 460 | 3,120 | 3,200 | 3,860 | 4,460 |
| Hardness | 135 | 90 | 110 | 100 | 130 | 130 |

The similarity in these anlayses suggests a common source bed. The distance between the Tramping Lake well and the Vera wells is about 40 miles. This water, which is thought to come from the basal sand of the Ribstone Creek formation, is not typical of water from the same stratigraphical horizon in the vicinity of Battle River, one reason being, possibly, that at Battle River the stream has cut through the Ribstone Creek formation exposing the sand members along its banks. This may cause a more rapid movement of the underground water in this area than farther south, and it is known that the rate of flow is a controlling factor that governs the change of calcium carbonate to sodium carbonate when the softening reagents of bentonite or glauconite are present in the sand.

Some of the soft waters from the Ribstone Creek formation cannot be distinguished from those of the Pale Beds, whereas others are quite different. The following analyses illustratetsome of the different types of water from this formation:

| Salts | Se.sec. 11, tp. 46, rge. 28 | Ind.Agent Little Pine I.R. | SW.sec. 24, tp. 46, rge. 21 | NE.sec. 36, tp. 43, rge. 18 | Se.sec. 26. tp. 43, rge. 18 | NE.sec. 36. tp. 41, rge. 24 | NW.sec. 22. tp. 42. rge. 23 |
|---|---|---|---|---|---|---|---|
| $CaCO_3$ | 90 | 90 | 410 | 73 | 35 | 73 | 125 |
| $CaSO_4$ | - | - | - | - | - | - | - |
| $MgCO_3$ | 97 | 59 | 168 | 38 | 31 | 38 | 97 |
| $MgSO_4$ | - | - | 64 | - | - | - | - |
| $Na_2CO_3$ | 217 | 392 | - | 283 | 592 | 129 | 196 |
| $Na_2SO_4$ | 1,644 | 777 | 2,518 | 225 | 522 | 61 | 1,541 |
| NaCl | 249 | 63 | 76 | 12 | 83 | 2,690 | 71 |
| Total solids | 2,220 | 1,340 | 3,000 | 620 | 1,280 | 3,120 | 1,900 |
| Hardness | 280 | 160 | 750 | 110 | 35 | 110 | 600 |

The above chemical analyses show such a wide range in the dissolved salts present in the different waters in the Ribstone Creek formation that they cannot be used for correlation purposes over a large area.

## Conclusions

(1) In most instances water from glacial drift is quite different from water from bedrock.

(2) Some of the bedrock horizons carry waters that show definite chemical characteristics.

(3) Most waters from glacial till carry total solids amounting to between 1,000 andn3,000 parts per million.

(4) Bedrock waters are commonly low in dissolved salts. Exceptions to this are to be found in water from the Ribstone Creek formation.

(5) Water from the Bearpaw formation is hard. An average of ten wells gave a total solid content of 1,100 parts per million.

(6) Water from the Variegated Beds resembles that from the Bearpaw formation.

(7) Waters from the Pale Beds is mostly soft. An average of ten wells gave a total solid of 1,000 parts per million.

(8) All soft waters contain sodium carbonate ($Na_2CO_3$), which is present in water from the Pale Beds and Ribstone Creek formations but absent from the Bearpaw formation and Variegated Beds.

# RURAL MUNICIPALITY OF SENLAC, No. 411, SASKATCHEWAN

## Physical Features

The southeast part of this municipality, east of Eyehill Creek, exhibits that knob and kettle topography characteristic of a moraine. Elsewhere, except in the southwest corner, the area is covered with light sandy soil, which in township 42 gives place to sand dunes and many alkali lakes. The sand is probably part of a lake deposit formed in front of a moraine and subsequently blown into dunes.

## Geology

The south and southwest parts of this municipality are underlain by Pale or Variegated Beds, whereas to the north, where surface elevations are not as high, lower formations presumably occur immediately beneath the sand and drift. Bentonitic shale, with a small amount of ironstone, occurs in what is considered to be an outcrop in a road-cut on sec. 21, tp. 41, rge. 25, north of Rutland, at an elevation of 2,130 feet. In Rutland, however, the school well, 208 feet deep, obtains water in what is thought to be glacial sand at an elevation of 1,951 feet. No water is obtained from the Pale or Variegated Beds in this immediate vicinity, although several drilled wells in the southwest part of the municipality reach these formations.

## Water Supply

Except within the sand area the glacial drift in this municipality provides at least two zones of water-bearing sands and gravels. These are found principally in township 41, the higher one at an elevation of about 2,160 to 2,170 feet and the other at about 2,060 to 2,090 feet. Other widely scattered sand and gravel beds through the drift also yield water. In the southwest part of the municipality and in the Canadian Pacific Railway well at Senlac, water is obtained from wells drilled into the Pale or Variegated Beds. In the northern part of the municipality water can be obtained from shallow wells in sand where it rests on relatively impervious clay. The water in the surface sand and in the drift is all derived from rain. No doubt part of the water in the Pale Beds has the same source, but it is not known to what extent water can percolate downwards through the Pale Beds, and in the deeper horizons the migration may be from the outcrop down the dip of the beds.

Township 40, Range 25. This is morainal country, with small hills and depressions containing small sloughs and lakes. All well water is from sand and gravel beds in the glacial drift, and there are no widespread continuous aquifers. Where the edges of these aquifers are bevelled by the surface, water probably drains out in springs, or, if the aquifer is tapped by a shallow well, water may flow, as in the well on SW. section 26. A well 276 feet deep on SE. section 27 obtained no water. It is not known if this well reached the base of the drift, but it is suspected it may have passed through it into Pale Beds. Presumably, water would have been encountered at an additional depth of about 60 feet, as a spring issues from sands of the Pale Beds at an elevation of 1,933 feet on NE. sec. 18, tp. 40, rge. 24, and although this particular sand may not be continuous it lies within a zone of Pale Beds that undoubtedly is water-bearing. Other sands within this 60-foot interval might also have yielded water, as outcrops of Pale Beds north of Fire Lake, on SE. sec. 30, tp. 40, rge. 24, occur at an elevation of 2,010 feet, so that the bedrock surface probably approaches this elevation in the vicinity of the well on sec. 26, tp. 40, rge. 25. There is every reason to believe that the Pale Beds underlying this township will yield water, but where the surface elevation is high the wells will be comparatively deep.

Township 40, Range 26. This township has the same type of topography as in the range to the east. All wells, except one drilled to a depth of 303 feet by the Canadian Pacific Railway at Senlac, obtain water from sand and gravel beds scattered irregularly through the drift. There is some indication of a fairly persistent aquifer at elevations of 2,210 to 2,230 feet in the western part of the township, but the probabilities are that it is not very dependable. The same kind of aquifer, showing some continuity, yields water at elevations between 2,125 and 2,145 feet. Coal is reported to be associated with the aquifer of one well, at an elevation of 2,136 feet. This is probably in the drift. Other sands are also present, but are undoubtedly of very local extent, and their presence or absence at any specific location is not predictable.

Township 40, Range 27. Three wells, on NE. sections 10 and 14, and SE. section 15, have been drilled to the Pale Beds underlying the drift, and obtain water from the same zone of sands but probably not the same bed within this formation. The water in the three wells is soft, but rises to very different elevations showing no direct connection. It may be significant that the water in the Canadian Pacific well at Senlac comes from about the same elevation, for from this it could be inferred that this is a fairly dependable and good source of water for the entire area. The other wells in this township are all from sand or gravel beds in the drift. One zone, between elevations of 2,060 and 2,090 feet, supplies several wells, and it is probable that the base of this is close to the base of the drift. Two wells, one in NE. section 24 and the other in SW. section 25, obtain their water from an aquifer at an elevation of 2,143 feet, probably indicating a northwest-trending bed of local significance.

Township 40, Range 28. Several wells in this township have been drilled into the Pale or Variegated Beds underlying the drift. The aquifers occur between elevations of 1,882 and 2,002 feet, and show a surprising lack of uniformity. Some of the wells were drilled by jetting rigs, and this method may account for some of the discrepancies in that the water-bearing bed may not have been detected at the depth at which it was encountered. It would hardly seem that there could be such variation as is shown by the records, although more than one zone of water-bearing strata may be present. For example, the three wells on section 28 are reported to have obtained their water at elevations of 1,904, 1,993 and 2,002 feet respectively. It is obvious that the last two at least are from the same horizon. In this instance an analysis of the water from each well would probably indicate the relationships, unless water from two or more aquifers are mixed in the same well. On SE. section 16 a well 200 feet deep obtained water at an elevation of 1,960 feet. No other well encountered water at a similar horizon, so that it is possible this well is some 40 feet below the other water-bearing strata. It is thought that the well on NW. section 15, which is reported to obtain water at a depth of 190 feet or an elevation of 2,015 feet, may be in glacial sand, and, if so, this sand must represent the approximate base of the glacial drift. Several wells obtain water in the drift between elevations of 2,060 and 2,100 feet, and still others at higher horizons. These aquifers are sands irregularly scattered through the drift, and their more common occurrence at certain elevations means only a greater abundance of such beds at those levels.

Township 41, Range 25. The northeast part of this township is covered with sand, and some other parts have rather light soil. The southern part is occupied by a moraine similar to that in the township to the south. On SE. section 12 a well 195 feet deep is reported to have obtained water in gravel at an elevation of 1,915 feet, whereas the school well at Rutland struck gravel at a depth of 178 feet, and at 208 feet, or an elevation of 1,951 feet, obtained water in what would seem to be glacial sand. This is surprising in view of the fact that north of Rutland, on section 21 of this township, bentonitic shale with a little ironstone shows in a road-cut at an elevation of 2,130 feet and is supposed to be an outcrop of Pale or Variegated Beds. So far as can be deduced from the records, no well in the township penetrated and obtained water from these beds. Most of the wells obtain water from a zone in the drift between elevation of 2,020 and 2,080 feet. In this zone sand and gravel beds seem to be more abundant than in the other parts of the drift, and a well drilled into one of these will obtain a supply of water.

Township 41, Range 26. The available information indicates that all wells in this township obtain their water from sand and gravel beds in the glacial drift. One series of beds lies between elevations of 2,160 and 2,170 feet, whereas another zone occurs at elevations varying from about 2,100 to 2,110 feet. Other aquifers have been encountered at irregular intervals, particularly at higher elevations, and the inference is that the drift contains groups of sand or gravel beds that vary in position with the locality, and that these are the source of water supply within the township.

Township 41, Range 27. In this, as in the last township, there are two distinct zones of water-bearing beds in the drift, and several wells have found water in irregularly distributed sand beds outside these zones. The upper zone, as in the range immediately east, has an elevation of about 2,160 feet, but owing, perhaps, to the fact that the elevation of the surface is generally lower in this township than to the east, most of the wells get water from the lower zone at elevations of 2,060 to 2,090 feet. A few wells, also, have obtained water at slightly above 2,100 feet, and some considerably higher. Thus, although the horizons are, apparently, not continuous aquifers but rather groups of water-bearing beds, they show a degree of persistence that is of value in predicting probable depth to water at any specific location.

Township 41, Range 28. In this township, as in those of the two ranges immediately east, a prominent water-bearing zone lies between elevations of approximately 2,160 and 2,170 feet. The nature of this deposit is not known, but its persistence over such a wide area is rather remarkable. Other sands are scattered irregularly through the drift, and are encountered by chance. One well drilled to a depth of 300 feet, on NW. section 3, penetrated the drift and obtained water at an elevation of 1,979 feet, presumably in the Pale Beds.

Township 42, Ranges 25 to 28 Inclusive. This area is covered by sand and sand dunes, and includes very little farming land. Water can be obtained from the sand in shallow wells. The sand rests on relatively impervious drift, and rain water accumulates at the base of the sand.

# ANALYSES OF WATER SAMPLES FROM RURAL MUNICIPALITY OF SENLAC, No. 411, SASKATCHEWAN.

| | | | | | | | Constituents as Analysed | | | | | | | Constituents as Calculated in assumed Combinations | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | $\frac{1}{4}$ Sec. | Tp. | Rge. | Depth in feet | Elev. of Aquifer | Total dissolved solids | Ca | Mg | Na | $SO_4$ | Cl. | Alk. | Total Hardness | $CaCO_3$ | $CaSO_4$ | $MgCO_3$ | $MgSO_4$ | $Na_2CO_3$ | $Na_2SO_4$ | NaCl. | Source of |
| 112 | SW 23 | 40 | 25 | 140 | 2105 | 1220 | 222 | 72 | 52 | 394 | 22 | 525 | 1100 | 525 | 41 | | 356 | | 118 | 36 | Glacial drift |
| 110 | SE 28 | 40 | 28 | 280 | 1904 | 820 | 79 | 17 | 216 | 325 | 20 | 475 | 340 | 198 | | 59 | | 219 | 333 | 33 | Pale Beds |
| 111 | NE 10 | 40 | 27 | 310 | 1911 | 1020 | 36 | 28 | 276 | 208 | 23 | 555 | 170 | 90 | | 97 | | 371 | 308 | 38 | " " |
| 109 | SE 28 | 40 | 28 | 280 | 1904 | 780 | 50 | 59 | 132 | 316 | 11 | 310 | 500 | 125 | | 155 | 69 | | 386 | 18 | Variegated Beds |
| 59 | NW 21 | 41 | 26 | 40 | 2076 | 640 | 100 | 61 | 37 | 185 | 7 | 380 | 600 | 250 | | 109 | 149 | | 98 | 12 | " " |
| 60 | NW 5 | 41 | 28 | 300 | 1979 | 640 | 122 | 44 | 48 | 172 | 7 | 400 | 600 | 305 | | 80 | 104 | | 132 | 12 | " " |

# RECORDS OF WELLS IN RURAL MUNICIPALITY OF SENLAC, No. 411, SASKATCHEWAN.

| Well No. | LOCATION ¼ Sec. | Tp. | Rge. | Mer. | Type of Well | Depth of Well Ft. | Altitude of Well | WATER LEVEL Above (+) or Below (-) Surface | Elev. Above Sea Level | PRINCIPAL WATER-BEARING BED Depth ft. | Elev. | Geol Horizon | Character of Water | Use to which Water is put[x] | Yield & Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | N.W. 1 | 40 | 25 | 3 | Bored | 97 | 2229 | -87 | 2142 | 97 | 2132 | Glacial gravel | Hard | D.S. | Sufficient |
| 2 | S.W. 2 | 40 | 25 | 3 | " | 80 | 2226 | | | 80 | 2146 | " | " | " " | " |
| 3 | N.W. 3 | 40 | 25 | 3 | Dug | 18 | 2136 | -16 | 2120 | 18 | 2118 | " sand | " | D.S. | " |
| 4 | S.W. 4 | 40 | 25 | 3 | Bored | 30 | 2184 | -20 | 2164 | 30 | 2154 | " " | Soft | " | " |
| 5 | S.W.23 | 40 | 25 | 3 | " | 90 | 2260 | -70 | 2190 | 63 | 2197 | " " | Hard | " | " |
| 6 | S.W.26 | 40 | 25 | 3 | Dug | 30 | 2131 | Flows | 2131 | 25 | 2106 | | " | " | " |
| 7 | S.E.27 | 40 | 25 | 3 | Drilled | 276 | 2271 | | | 160 | 2111 | | | | Dry hole |
| | | | | | | | | | | 276 | 1995 | Dry sand | | | |
| 8 | N.E.28 | 40 | 25 | 3 | Bored | 108 | 2235 | -48 | 2187 | 103 | 2132 | | Hard | D.S. | Sufficient |
| 9 | N.E.34 | 40 | 25 | 3 | Dug | 72 | 2185 | -67 | 2118 | 72 | 2113 | Sand | " | " | Limited |
| 1 | S.E. 2 | 40 | 26 | 3 | Dug | 42 | 2186 | -27 | 2159 | 42 | 2144 | Glacial | Hard | D.S. | Sufficient |
| 2 | S.E. 5 | 40 | 26 | 3 | Bored | 56 | 2185 | | | 56 | 2129 | " | " | " | Poor supply |
| 3 | S.E. 6 | 40 | 26 | 3 | " | 64 | 2200 | -40 | 2160 | 64 | 2136 | Pale Beds ? | " | " | Waters 22 head, water with coal.? |
| 4 | N.W. 6 | 40 | 26 | 3 | Bored | 46 | 2221 | -26 | 2195 | 46 | 2175 | Gl. gravel | " | D. | Poor supply |
| 5 | S.W. 9 | 40 | 26 | 3 | " | 113 | 2327 | Low | | 112 | 2215 | Blue clay | | D. | |
| 6 | S.E.12 | 40 | 26 | 3 | Dug | 40 | 2167 | -28 | 2139 | 40 | 2127 | Gravel | Hard | D.S. | Limited |
| 7 | N.E.18 | 40 | 26 | 3 | Bored | 140 | 2350 | -120 | 2230 | 140 | 2210 | Blue sand | " | " | Sufficient |
| 8 | N.E.20 | 40 | 26 | 3 | " | 60 | 2270 | -40 | 2230 | 60 | 2210 | | Soft | " | Good supply |
| 9 | S.W.28 | 40 | 26 | 3 | " | 85 | 2213 | | | 85 | 2128 | | Hard | " | Sufficient |
| 10 | N.W.30 | 40 | 26 | 3 | " | 76 | 2237 | | | | | | | | Dry hole |
| 11 | N.E.32 | 40 | 26 | 3 | Drilled | 303 | 2215 | -120 | 2095 | 147 | 2068 | Gravel | | | |
| | | | | | | | | | | 237 | 1978 | Pale Beds | Soft | B. | 2700 gals. per hour. |
| | | | | | | | | | | 285 | 1930 | " " | " | " | C.P.R. Well at Senlac |
| 12 | S.W.36 | 40 | 26 | 3 | Bored | 98 | 2175 | -28 | 2147 | 98 | 2077 | Blue sand | Hard | D.S. | Waters 15 head |
| 1 | S.W. 4 | 40 | 27 | 3 | Dug | 24 | 2127 | | | 24 | 2103 | Glacial | Hard | D.S. | Poor supply |
| 2 | N.E.10 | 40 | 27 | 3 | Drilled | 310 | 2221 | -25 | 2196 | 310 | 1911 | Pale Beds | Soft | " | Sufficient |
| 3 | S.E.13 | 40 | 27 | 3 | Bored | 70 | 2298 | | | 70 | 2228 | Glacial gravel | Hard | D. | Poor supply |
| 4 | S.W.14 | 40 | 27 | 3 | Drilled | 310 | 2246 | -130 | 2116 | 310 | 1936 | Pale Beds | Soft | D.S. | Abundant supply |

x.- D.- Domestic, S.- Stock, Alk.- Alkaline, Fe.- Iron.

| Well No. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | S.E.15 | 40 | 27 | 3 | Drilled | 320 | 2231 | -150 | 2081 | 320 | 1911 | Pale Beds | Soft | D.S. | Good supply |
| 6 | N.W.19 | 40 | 27 | 3 | Dug | 6 | 2097 | | | 6 | 2091 | Glacial | Hard | " | Sufficient |
| 7 | N.E.24 | 40 | 27 | 3 | Bored | 62 | 2205 | | | 62 | 2143 | " gravel | Soft | " | " |
| 8 | S.W.25 | 40 | 27 | 3 | " | 50 | 2193 | | | 50 | 2143 | | Hard | " | " |
| 9 | S.E.26 | 40 | 27 | 3 | " | 34 | 2204 | -16 | 2188 | 34 | 2170 | Glacial gravel | Soft | " | " |
| 10 | S.W.27 | 40 | 27 | 3 | " | 48 | 2115 | -40 | 2075 | 48 | 2067 | | Hard | " | " |
| 11 | S.W.28 | 40 | 27 | 3 | Dug | 16 | 2087 | | | 16 | 2071 | Sand | Soft | " | " |
| 12 | S.W.32 | 40 | 27 | 3 | Bored | 100 | 2155 | | | | | | | | Dry hole |
| 13 | N.E.35 | 40 | 27 | 3 | " | 72 | 2284 | -24 | 2260 | 72 | 2212 | Glacial sand | Hard | D.S. | Sufficient |
| 1 | S.E. 1 | 40 | 28 | 3 | Bored | 100 | 2197 | | | 100 | 2097 | Fine sand | Hard | D.S. | Sufficient |
| 2 | N.W. 4 | 40 | 28 | 3 | " | 68 | 2188 | -40 | 2148 | 68 | 2120 | Sand | " | " | " |
| 3 | N.E. 5 | 40 | 28 | 3 | Drilled | 290 | 2172 | -60 | 2112 | 290 | 1882 | Variegated Beds? | Soft | " | " |
| 4 | S.E. 9 | 40 | 28 | 3 | Bored | 90 | 2175 | -20 | 2155 | 90 | 2085 | Sand | Hard | " | " |
| 5 | N.E. 9 | 40 | 28 | 3 | " | 105 | 2188 | -60 | 2128 | 105 | 2083 | " | " | " | " |
| 6 | S.W.13 | 40 | 28 | 3 | Dug | 30 | 2132 | -20 | 2112 | 30 | 2102 | | " | " | " |
| 7 | S.E.15 | 40 | 28 | 3 | Bored | 82 | 2169 | -74 | 2095 | 82 | 2087 | Sand | " | " | " |
| 8 | N.W.15 | 40 | 28 | 3 | Drilled | 190 | 2205 | -100 | 2105 | 190 | 2015 | " | " | " | " |
| 9 | S.E.16 | 40 | 28 | 3 | " | 200 | 2160 | -20 | 2140 | 200 | 1960 | Pale Beds | Soft | " | " |
| 10 | N.E.17 | 40 | 28 | 3 | Dug | 32 | 2152 | | | 32 | 2120 | Sand | Hard | " | " |
| 11 | N.E.23 | 40 | 28 | 3 | Bored | 40 | 2104 | -15 | 2089 | 40 | 2064 | " | " | " | " |
| 12 | S.W.24 | 40 | 28 | 3 | " | 75 | 2143 | -45 | 2098 | 75 | 2068 | " | " | " | " |
| 13 | S.E.28 | 40 | 28 | 3 | Drilled | 280 | 2184 | -40 | 2144 | 280 | 1904 | Pale or Variegated Beds | " | D. | " School Well. |
| 14 | S.E.28 | 40 | 28 | 3 | Drilled | 200 | 2202 | -70 | 2132 | 200 | 2002 | " " " " | Hard | D.S. | " |
| 15 | N.W.28 | 40 | 28 | 3 | " | 209 | 2202 | -80 | 2122 | 209 | 1993 | " " " " | " | " | " |
| 16 | N.E.33 | 40 | 28 | 3 | " | 229 | 2157 | -100 | 2057 | 229 | 1928 | " " " " | Soft | " | " |
| 1 | N.W. 1 | 41 | 25 | 3 | Bored | 82 | 2137 | | | 82 | 2055 | | Hard | D. | Poor supply |
| 2 | N.E. 9 | 41 | 25 | 3 | " | 88 | 2165 | -70 | 2095 | 88 | 2077 | Fine sand | " | D.S. | Limited some Gas. |
| 3 | N.W. 9 | 41 | 25 | 3 | Drilled | 208 | 2159 | -60 | 2099 | 208 | 1951 | Coarse " | | | Yields 6 gals per minute |
| 4 | N.E.10 | 41 | 25 | 3 | Dug | 70 | 2146 | | | 70 | 2076 | Glacial gravel | Poor | S. | Poor supply |
| 5 | S.W.12 | 41 | 25 | 3 | Drilled | 195 | 2110 | -50 | 2060 | 195 | 1915 | Gravel ? | Hard Alk. | D.S. | Sand trouble |
| 6 | N.W.12 | 41 | 25 | 3 | Dug | 14 | 2040 | - 9 | 2031 | 14 | 2026 | Fine sand | | " | Waters 20 head of stock. |
| 7 | N.W.16 | 41 | 25 | 3 | " | 44 | 2080 | -22 | 2058 | 44 | 2036 | | Hard | " | Sufficient |
| 8 | S.W.17 | 41 | 25 | 3 | Drilled | 220 | 2156 | | | 220 | 1936 | | | | Well not completed, water supply from Well 15' deep. |

| Well No. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | N.W.17 | 41 | 25 | 3 | Bored | 60 | 2142 | | | 60 | 2082 | | | | | |
| 10 | N.W.22 | 41 | 25 | 3 | " | 60 | 2126 | -57 | 2069 | 60 | 2066 | | Soft | | D.S. | Sufficient |
| 11 | S.E.27 | 41 | 25 | 3 | " | 60 | 2094 | Low | | 60 | 2034 | Gravel | " | | " | " |
| 12 | S.E.32 | 41 | 25 | 3 | " | 56 | 2057 | -41 | 2016 | 56 | 2001 | Glacial gravel | Hard | | " | " |
| 1 | N.E. 5 | 41 | 26 | 3 | Dug | 14 | 2178 | -10 | 2168 | 14 | 2164 | Glacial sand | Hard | | D.S. | Sufficient |
| 2 | N.W. 6 | 41 | 26 | 3 | " | 12 | 2226 | | | 12 | 2214 | " " | " | | " | " |
| 3 | S.W. 6 | 41 | 26 | 3 | Bored | 45 | 2246 | | | 45 | 2201 | " " | " | | " | " |
| 4 | S.E. 7 | 41 | 26 | 3 | Dug | 35 | 2210 | | | 35 | 2175 | " " | " | | " | " |
| 5 | S.E.12 | 41 | 26 | 3 | " | 30 | 2199 | -20 | 2179 | 30 | 2169 | " gravel | " | | " | " |
| 6 | S.W.15 | 41 | 26 | 3 | " | 4 | 2165 | +4 | 2169 | 4 | 2161 | Gravel ? | " | | " | Continuous flow |
| 7 | S.E.15 | 41 | 26 | 3 | Bored | 60 | 2160 | -20 | 2140 | 60 | 2100 | | " | | " | Good supply |
| 8 | S.W.17 | 41 | 26 | 3 | " | 73 | 2211 | | | 73 | 2138 | Glacial gravel | | | | " " |
| 9 | S.E.18 | 41 | 26 | 3 | Bored | 60 | 2211 | | | 60 | 2151 | Glacial sand | Hard | | D.S. | Sufficient |
| 10 | S.E.19 | 41 | 26 | 3 | Dug | 40 | 2211 | -35 | 2176 | 40 | 2171 | " " | " | | " | " |
| 11 | N.W.21 | 41 | 26 | 3 | Bored | 40 | 2116 | +2 | 2118 | 40 | 2076 | Gray sand | " | Fe. | " | Continuous flow |
| 12 | N.W.22 | 41 | 26 | 3 | " | 81 | 2184 | -50 | 2134 | 81 | 2103 | Blue " | " | | " | Sufficient |
| 13 | S.W.22 | 41 | 26 | 3 | " | 75 | 2183 | -50 | 2133 | 75 | 2108 | | Soft | | " | " |
| 14 | S.W.25 | 41 | 26 | 3 | " | 50 | 2219 | -40 | 2179 | 50 | 2169 | Glacial sand | Hard | Fe. | " | Waters 75 head |
| 15 | S.E.26 | 41 | 26 | 3 | " | 40 | 2172 | -30 | 2142 | 40 | 2132 | Blue sand | " | " | " | Sufficient |
| 1 | S.W. 1 | 41 | 27 | 3 | Bored | 60 | 2281 | -50 | 2231 | 60 | 2221 | Fine white sand | Hard | Alk. | D.S. | Sufficient |
| 2 | S.W. 5 | 41 | 27 | 3 | " | 60 | 2216 | -20 | 2196 | 60 | 2156 | Blue sand | " | " | " | " |
| 3 | S.W. 7 | 41 | 27 | 3 | " | 60 | 2166 | | | 60 | 2106 | Sand | " | Fe. | " | |
| 4 | N.W. 7 | 41 | 27 | 3 | Dug | 53 | 2135 | | | 53 | 2082 | " | | | " | |
| 5 | N.W.12 | 41 | 27 | 3 | " | 14 | 2186 | | | 14 | 2172 | Glacial gravel | Hard | | " | Good supply |
| 6 | S.W.19 | 41 | 27 | 3 | " | 15 | 2116 | | | 15 | 2101 | Sand | | | " | Sufficient |
| 7 | S.E.21 | 41 | 27 | 3 | " | 8 | 2081 | | | 8 | 2073 | | Hard | | " | " , Spring |
| 8 | S.W.22 | 41 | 27 | 3 | " | 18 | 2181 | -14 | 2167 | 18 | 2163 | Blue Clay | " | Alk. | " | " |
| 9 | S.E.24 | 41 | 27 | 3 | Bored | 60 | 2126 | -55 | 2071 | 60 | 2066 | Gravel | " | | " | Limited supply |
| 10 | S.W.24 | 41 | 27 | 3 | Dug | 15 | 2076 | | | 15 | 2061 | Sand | " | | " | " " |
| 11 | N.E.27 | 41 | 27 | 3 | " | 20 | 2096 | | | 20 | 2076 | In sand | | | " | Limited " |
| 12 | S.W.31 | 41 | 27 | 3 | " | 20 | 2186 | | | 20 | 2166 | Glacial sand | | | " | Sufficient |
| 13 | S.E.34 | 41 | 27 | 3 | " | 12 | 2106 | | | 12 | 2094 | Sand | | | " | Good supply |
| 14 | S.W.35 | 41 | 27 | 3 | Bored | 60 | 2140 | -55 | 2085 | 60 | 2080 | Coarse sand | Hard | | " | Limited supply |
| 1 | N.W. 2 | 41 | 28 | 3 | Dug | 12 | 2240 | | | 12 | 2228 | | Hard | | D.S. | |
| 2 | N.W. 3 | 41 | 28 | 3 | Drilled | 300 | 2279 | -200 | 2079 | 300 | 1979 | Variegated Beds? | " | | " | Good supply |
| 3 | S.E. 3 | 41 | 28 | 3 | Dug | 45 | 2174 | | | 45 | 2129 | | | | " | Poor " |

| Well No. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | S.E. 5 | 41 | 28 | 3 | Drilled | 230 | 2263 | -120 | 2143 | 230 | 2033 | | Hard Fe. | D.S. | Sufficient |
| 5 | N.E. 9 | 41 | 28 | 3 | Dug | 25 | 2181 | | | 25 | 2156 | Sand | Soft | " | Good supply |
| 6 | N.W.10 | 41 | 28 | 3 | " | 22 | 2179 | | | 22 | 2155 | Glacial sand | " | " | " " |
| 7 | S.W.10 | 41 | 28 | 3 | Bored | 60 | 2230 | | | 60 | 2170 | Sand | Hard | " | " " |
| 8 | N.E.13 | 41 | 28 | 3 | Dug | 17 | 2123 | | | 17 | 2106 | " | | " | " " |
| 9 | N.W. 24 | 41 | 28 | 3 | " | 20 | 2194 | | | 20 | 2174 | Glacial sand | | " | Sufficient |
| 10 | S.W.25 | 41 | 28 | 3 | Bored | 68 | 2239 | | | 68 | 2171 | Sand | Hard | " | " |
| 11 | S.E.25 | 41 | 28 | 3 | Dug | 24 | 2130 | | | 24 | 2106 | | | " | " |
| 12 | S.E.36 | 41 | 28 | 3 | " | 18 | 2184 | | | 18 | 2166 | Glacial | | " | " |
| 13 | S.W.36 | 41 | 28 | 3 | " | 18 | 2175 | | | 18 | 2157 | " | | " | " |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S.E. 6 | 42 | 27 | 3 | Dug | 15 | 2232 | | | 15 | 2217 | Sand | Hard | D.S. | Sufficient |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S.E. 1 | 42 | 28 | 3 | Dug | 12 | 2233 | -10 | 2223 | 12 | 2221 | Fine sand | Hard | D.S. | Sufficient |