CANADA
DEPARTMENT OF MINES

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

BUREAU OF ECONOMIC GEOLOGY
GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF FILLMORE No. 96 SASKATCHEWAN

BY

B. R. MacKay, H. N. Hainstock & G. L. Scott

Water Supply Paper No. 51

OTTAWA
1936

CANADA

DEPARTMENT OF MINES

BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF FILLMORE NO. 96 SASKATCHEWAN

BY

B.R. MacKAY, H.N. HAINSTOCK, and G.L. SCOTT.

WATER SUPPLY PAPER NO. 51

CONTENTS

Illustrations

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY
OF FILLMORE, NO. 96,
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 purposes and the smaller supplies of ground water required for domestic and stock-raising purposes by settlers, villages, and Indian reserves. The drought conditions resulted in repeated crop failures, and in a large number of farms in the acute drought areas of Saskatchewan and Alberta being abandoned. In an effort to relieve the serious situation a number of special studies of the water problem were begun by both Federal and Provincial Governments and allied organizations. The Federal Department of Agriculture undertook among other phases of the drought problem an investigation into the existing supplies of surface water, their conservation by means of dams and dug-outs, and how they could be made more generally available for irrigation. The Geological Survey of the Federal Department of Mines began an extensive study of the underground water conditions of southern Saskatchewan, this water being used principally for domestic and stock-raising purposes. For many years past the water problem in this and other provinces of Canada have engaged the attention of the Geological Survey, and considerable information had already been collected. A number of short reports dealing with the ground water conditions of special areas in Manitoba, Saskatchewan and Alberta have been published by both the Federal and Provincial Geological Surveys, but no systematic study of the ground water resources has been made up to the present.

Field Work

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

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

Publication of Results

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

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

How to Use the Report

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

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

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

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

Glossary of Terms Used

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

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

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

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

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

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

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

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

Flood-plain. A flat section in a river valley that is covered by water when the river is in flood.

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

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

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

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

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

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

Hydrostatic Pressure. The pressure exerted by the water at any given point. It is due mainly to the weight of the column of water occurring at higher levels in the same aquifer or water-bearing bed.

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

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

Potable. Suitable for drinking.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Eastend Formation. The local name given to a series of fine-grained sands and silts. It has been recognized at various localities over the southern part of the province, from the Alberta boundary east to the eastern escarpment of the Missouri coteau. The The thickness of the formation seldom exceeds 40 feet.

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

WATER-BEARING HORIZONS OF THE MUNICIPALITY

The rural municipality of Fillmore is an area of 324 square miles in the southeastern part of Saskatchewan. It consists of nine townships, described as townships 10, 11, and 12, ranges 10, 11, and 12, west of the 2nd meridian. The municipality contains the towns of Osage, Fillmore, and Creelman; Fillmore, near the centre of the municipality, being 65 miles southeast of Regina.

The Canadian Pacific railroad traverses the municipality a few miles south of its southeast-northwest diagonal. South of the railroad the ground surface is flat, and the elevation is approximately 2,000 feet above sea-level. North of the railroad, the ground surface is slightly undulating and it gradually becomes rougher as the elevation increases in a northeasterly direction. The maximum elevation of 2,220 feet is reached 3 miles southwest of Huronville post office, from where it decreases northeasterly to an elevation of 2,150 at the northeastern corner of the municipality. In contrast with the flat or slightly undulating, treeless nature of the ground surface in most of the municipality, the northeastern corner, in part of township 11, range 10, and in township 12, ranges 10 and 11, has many patches of poplar growth and is quite rough and hilly with many undrained depressions.

The municipality is overlain with a blanket of glacial drift which varies in thickness from 15 feet in the southwestern part to 150 feet in the northeastern part. The glacial drift is composed of red, yellow, grey, black, and blue clays, sand and gravel, stones, and boulders. The lighter clays, when they occur, always overlie the blue or black clays. Generally speaking, the glacial deposits may be classified according to the topography in this municipality. The rough, hilly country in the northeast is covered by a glacial moraine, the slightly rolling territory in the north, central, and southern part, is mantled by glacial till, and the flat plains in the southwestern and western parts are underlain by glacial lake clay, glacial lake sands, and glacial outwash sands.

Water-bearing Horizons in the Unconsolidated Deposits

The aquifers of all the wells in the glacial drift are formed of sand or gravel deposits, the occurrence and nature of which vary in different parts of the municipality.

The moraine is composed of a mass of material deposited in front of the ice-sheet during a halt in its recession and, consequently, the sand and gravel deposits that occurs in it are only partly sorted. They do not occur as continuous layers, but generally as isolated pockets surrounded by clay, and these pockets vary greatly in size and thickness. The pockets seldom occur at any definite level within the moraine, but in this municipality they have generally been found to lie within 70 feet of the surface. In the moraine-covered area of township 11, range 10, the sand and gravel pockets are not so numerous as they are in the moraine area of township 12, ranges 10 and 11. In the areas of terminal moraine well water conditions are always patchy, and often one farmer can obtain an abundant supply of water from one or more water-bearing horizons, whereas his neighbour cannot strike sand or gravel at any depth. Due to the pocket arrangement of the sand and gravel, the supply of water obtained in a well depends upon three factors, namely, the extent and shape of the pocket, the thickness of the pocket, and the location in the pocket tapped by the well. It is not uncommon to find that when two wells tap the same pocket, one of the wells will yield water under a high pressure, whereas the other receives only a small supply which is not under pressure. Naturally, a large, thick sand pocket will yield more water than a small pocket. The water is hard and contains variable quantities of dissolved mineral salts.

To the southeast of the terminal moraine there is a strip of country approximately 3 miles wide, covered by glacial till, within which lenses and layers of fine sand occur at depths from 35 to 70 feet below the surface. The region within which the sand occurs has been outlined on the map. Wells that are dug or bored to the fine sand beds yield an abundant supply of water that acts under hydrostatic pressure. In some wells the pressure is so high that the water will rise to within 10 feet of the surface, and in one instance it overflows the cribbing. The quality of the water in all these wells is almost identical. It is hard, "alkaline", and contains iron. In some cases it is salty. It is not potable for humans, but it is suitable for watering stock. The drought of 1930-1934 did not diminish the supply to any great extent, and the average well will supply sufficient water for 35 head of stock. Farmers who live in this territory are advised to dig or bore to depths of at least 40 feet for a good supply of stock water. It is possible that the southern boundary of this area extends farther than shown into township 10, range 10.

South and west of this area sand layers are very scarce in the glacial till. The glacial drift also thins out towards the southwest, so that water horizons are confined to a depth of 15 to 30 feet from the surface. It is in this district that the water situation has been most critical in the drought period. The towns of Osage, Fillmore and Creelman lie within this district. Deep wells have been drilled at Fillmore and Creelman without obtaining water, and all three towns lack a suitable water supply. In this southern district, the yellow or red clay usually overlies the only sand horizon in the glacial drift and the water delivered is dependant almost entirely on rainfall seepage. There are probably not more than 12 wells in this part of the glacial till covered district that yield an abundant supply of water. The drought of 1930 to 1934 caused many wells to become dry, and the majority of the other wells cannot be depended upon to water more than 10 head of stock. Farmers usually dig their wells beside shallow depressions in order to secure the maximum amount of seepage water. This water is almost always too "alkaline" for household use.

The districts in the southwestern part of the municipality that are mantled by glacial clay do not contain any suitable water-bearing horizon. Small supplies of highly "alkaline" water are found within 20 feet of the surface and the wells are practically useless for either stock or domestic purposes, owing to the small quantity and poor quality of the water derived from them. The nearly impervious character of the gumbo soil prevents any rapid downward seepage of rain water.

In the parts of township 11, range 12, and township 12, range 12 occupied by glacial lake sands extensive and thick beds of sand are found. It is strange but true, that only small amoumts of water can be obtained from these sand beds in these districts. The sands extend northwestward to the village of Tyvan, and in that vicinity large quantities of water are obtained at shallow depths in the sand. The reason for this difference in water conditions in the same beds at different places is not known.

Two small areas of glacial outwash sands and gravels in the northwestern part of the municipality furnish abundant quantities of excellent water from shallow depths.

Water-bearing Horizons in the Bedrock

The Marine shale formation underlies the glacial deposit throughout the municipality. This shale, which is locally termed "soapstone", is often confused with glacial blue clay. It is usually of a grey colour, and when it is exposed to the weather it breaks along joint planes or cracks into small cubes, which causes it to be sometimes referred to as "joint clay". Unlike the glacial clay it does not contain pebbles, but may contain fossils. Fossils are rarely found in glacial blue clay. In the southwestern half of the municipality the Marine shale bedrock formation lies at a maximum depth of 75 feet below the surface. It lies from 15 to 30 feet below the surface in the western part of township 10, range 11, and in the eastern part of township 10, range 12. In township 10, range 10, and in township 11, range 11, it has been located at 60 to 70 feet from the surface. In the northeastern half of the municipality the glacial covering becomes thicker and in township 12, range 10, the Marine shale probably lies at a depth of 150 feet from the surface.

The Marine shale formation does not contain any good water-bearing horizons and it is useless to drill or bore into it in an effort to obtain usable water. In places water has been found at great depths in the shale but it was so salty that it could not be used even for stock. Farmers are strongly advised to refrain from the expense of drilling or boring into this material.

The water conditions of the municipality may be summarized as follows. The northeastern half of the municipality, due to the thicker deposit of glacial drift, contains more water-bearing horizons and the supply of water as a whole is much better than in the southwestern half of the municipality, where the deposit is thinner and more compacted. Except in the glacial outwash areas, the water obtained is "alkaline", but not too "alkaline" to be used for stock. Non-flowing artesian wells are restricted to the northeastern part of the municipality. The water-bearing horizons in the southwestern half of the municipality depend almost entirely on rainfall seepage for their supply, and in this district the excavation of dugouts is recommended. The large, deep depressions in the rough country to the northeast are ideal locations for dugouts and the many ravines and coulées are suitable places for the construction of small dams. In making a well farmers are advised to confine their efforts to the glacial drift, and not to attempt deep drilling into the shale. The municipality of Fillmore has done much to alleviate the condition of water shortage during the drought period. Municipal wells and dugouts were seen in many places by the field party, and these are used as a source of both stock and household water by the farmers. In the southern and western parts of the municipality dugout construction is apparently the only method by which a permanent supply of water can be obtained and stored.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 10, Range 10

This township is overlain with a mantle of glacial drift, which is approximately 75 feet thick. The bedrock Marine shale formation underlies the glacial deposit. The shale is a bluish grey colour, having a sticky consistency, and it is often mistaken for glacial blue clay. For instance, a drilled hole in the town of Creelman was reported to have been sunk 400 feet into the blue clay, but is believed that at least 300 feet of the so-called "blue clay" is bedrock Marine shale. Well drillers sometimes use the term "soapstone" in referring to this shale.

The glacial drift consists of red, grey, white, black, and blue clays, red and yellow fine sand, and layers of stones and boulders. The lighter coloured clays usually occupy the initial 15 to 20 feet of glacial covering, followed by black and blue clays. Occasionally the light clays are absent and black clay underlies the top soil. The blue clay is almost always encountered within 30 feet of the surface. Beds of sand may occur at any level in the glacial drift, and they apparently exist in the form of lenses or tongue-like masses which lie in a northeast-southwest direction. The sand is not uniformly distributed through the glacial drift, since dry holes 70 feet deep have been sunk without striking an aquifer.

The supply of water yielded by the wells in this township is exceedingly variable even in wells that strike the sand at the same depth from the surface. The possibility of striking water that is under pressure is greater in the northeastern part than in the remainder of the township. Generally, the water is hard and highly "alkaline" and it often contains iron. The water is not fit for human consumption, but can be used for stock. "Non-alkaline" water will more probably be found in thick sand or gravel beds that lie close to the surface. Wells deeper than 20 feet almost always yield "alkaline" water, especially if blue or black clay overlies the water-bearing horizon. The drought of 1930 to 1934 diminished the supply in the non-artesian wells far more than in the non-flowing artesian wells. The best wells of the township supply sufficient water for 25 to 35 head of stock.

Farmers who contemplate digging a well are advised to test in various places with a 2-inch auger. In this manner a bed of sand may be struck with a minimum amount of effort. Tests should be made to a maximum depth of 60 feet, but it is almost certain that the water that is obtained at depths greater than 20 feet will be heavily "alkaline". Boring and drilling operations should be confined to the glacial drift. The Marine shale formation, which lies 75 feet from the surface, does not contain any good water-bearing horizons.

At least 75 per cent of the farms in this township have dugouts in which to retain the run-off water. The majority of these dugouts are too shallow, as they should be at least 12 feet deep. Dugout excavation is strongly recommended where tests in the glacial drift do not reveal suitable water supplies.

Township 10, Range 11

The entire township is covered with glacial till. The depth of the glacial deposit at one place has been accurately determined by a well in section 19. Fossil remains of "Baculites", locally termed "fossil fish", were found at a depth of 17 feet from the surface. These fossils never occur in place in the glacial drift. Their location is taken as marking the contact between the glacial drift and the bedrock Marine shale formation. Since the bedrock lies at a depth of 70 to 100 feet in township 10, range 10, the bedrock surface rises in elevation from east to west. This rise in elevation is probably only local, since in the vicinity of Weyburn, still farther to the west, the Marine shale has been definitely established as lying at a depth of 80 feet below the surface. The glacial drift, therefore, varies in depth from 15 feet to approximately 50 feet or more in this township. It consists of yellow, brown, or red clays, which contain sand and gravel pockets, and blue clay. Except in the western part of the township where the bedrock is near the surface, the lighter coloured clays occur beneath the top soil and they are from 8 to 20 feet thick. The dark blue clay always underlies the yellow or red clays, and where the bedrock is within 20 feet of the surface it lies directly beneath the top soil without any overlying yellow or red clay.

In the southern half of the township sand beds are extremely difficult to locate at any depth. Due to the almost total absence of sand or gravel there is not a single well that yields a substantial supply of water.

In the central part of the northern half of the township sand beds that yield a good supply of water have been tapped by five or six wells at a depth of 30 to 45 feet from the surface. Several other wells in this area yield a small supply of water. A fine white sand, which lies in layers at a depth of 30 to 45 feet from the surface, serves as the aquifer. In general, abundant supplies of water are very difficult to obtain in this township due to the rare occurrence of sand in the glacial drift. The water is hard and "alkaline" and usually contains iron. Wells located in SE.$\frac{1}{4}$, section 20, SW.$\frac{1}{4}$, section 26, SW.$\frac{1}{4}$, section 27, SE.$\frac{1}{4}$, section 32, and NW.$\frac{1}{4}$, section 33, contain water which acts under a slight hydrostatic pressure, and which is ample to water 25 to 50 head of stock. The remaining wells in the township cannot be depended upon to yield enough water for 10 head of stock in periods of drought. If water cannot be obtained from horizons in the glacial drift it will not be obtained at all. The bedrock Marine shale does not contain water-bearing horizons that will yield usable water and it is useless to drill into it. In section 19 a hole was drilled to a depth of 1,100 feet. Shale, locally called soapstone, was encountered at 20 feet from the surface and it continued to the bottom of the hole without the slightest indication of containing any water. Any further drilling into the shale would doubtless produce the same result. Farmers are forced to confine their efforts in obtaining water to the glacial drift. Test borings with an auger would be of advantage in locating water-bearing sand pockets. The construction of large, deep dugouts in suitable places in which to collect and store the spring run-off, is strongly advised for farmers in this township, especially in the southern district.

Township 10, Range 12

The southwestern corner and the north-central part of the township form part of what is known as the Regina glacial lake bed. The flat topography of these lake clay districts clearly distinguishes them from the undulating remainder of the township covered by glacial till.

In the eastern sections the glacial drift is approximately 25 feet thick, and in the central and western sections it is probably not more than 40 or 50 feet thick. This deposit is composed of yellowish brown clay, blue clay, and small layers and pockets of sand. Yellow clay, when present, always occurs beneath the top soil and is underlain by blue clay. There are places where the yellow clay is absent, in which case the blue clay underlies the top soil. Small layers or pockets of sand may occur at any depth in the glacial drift. Frequently sand is completely absent and blue clay underlies the yellow clay and extends to the bedrock. There is no continuous layer of sand extending over the entire township. The sand where found is very fine and is either white, blue, or brownish.

Due to the absence of thick layers or large pockets of sand in the glacial till, water in large quantities is very difficult to obtain. Moreover, the water is highly "alkaline", is not fit for human use, and is often unsuitable for stock. Farmers occasionally strike a large supply of water which, due to its high mineral salt content, must be abandoned. The supply of water is easily affected by drought conditions and in the drought of 1930 to 1934 the water problem was of major importance to farmers in this township.

The bedrock Marine shale formation underlies the glacial drift and does not yield usable water. Drilling into the bedrock in search of water therefore is not recommended. If usable water is not encountered within 25 to 40 feet of the ground surface it is not likely to be found at depth.

Excavation of dugouts is the only means by which large quantities of usable water can be collected and stored. The depth and location of these dugouts are of prime importance if they are to prove satisfactory. The minimum depth should be 12 feet and the location should be such that a maximum amount of spring run-off water can be collected.

Shallow wells dug beside the dugout will provide suitable household water, if the seepage water is properly filtered and the well water kept fresh by frequent pumping.

Township 11, Range 10

The elevation of the southwestern corner of this township is approximately 2,075 feet above sea-level. The ground surface rises gradually in a northeasterly direction to a maximum elevation of 2,210 feet in NE.$\frac{1}{4}$, section 27, and then falls gradually to an elevation of 2,100 feet in NE.$\frac{1}{4}$, section 36. The ascending gradient of approximately 0.5 per cent northeast from section 6 to section 27, has a direct influence on the water supply in some of the wells in the township.

A terminal moraine, 2 miles wide, occurs in the northeastern part of the township and trends in a southeast-northwest direction, at right angles to the rise in elevation. The ground surface of the moraine is exceedingly undulating, whereas that of the remainder of the township, which is mantled by glacial till, or ground moraine is gently rolling. Thousands of years ago, the ice-sheet moved over this township in a south-westerly direction, carrying with it a mass of material part of which was later deposited in the form of a terminal moraine.

The water issuing from the melting ice front washed down quantities of sand and gravel from this load and deposited them in beds in the lower area, to be later covered by the glacial till laid down by the advancing ice-sheet. The tongues of gravel and sand so deposited form the aquifer tapped by many of the wells in the southwestern half of the township.

The water conditions in the moraine district and the glacial till districts are different and will be discussed separately. There are two distinct water-bearing horizons in the glacial till. In section 20 the first horizon consists of a bed of gravel 15 to 20 feet thick, that underlies the top soil. In the remaining sections there is usually a deposit of yellow, red, or black clay, 3 feet to 12 feet thick, which separates the top soil from a sand or gravel aquifer 4 to 10 feet thick. The water supply contained in this first horizon is dependant entirely on rainfall seepage. In years of scanty rainfall wells dug to this aquifer are not dependable and many become completely dry. The water is medium hard to soft, and is not under pressure. Wells that tap the first horizon are not suitable for stock purposes because of the limited and variable supply of water, but they do make good wells for household use on account of the low mineral salt content of the water.

The second horizon occurs at a depth of 35 to 65 feet from the surface. This aquifer is formed by the gravel and sand carried out from the moraine by water action. The sands and gravel that form the first horizon may not overlie this second horizon, in which case yellow, red, grey, or blue clay overlies the gravel and sand and extends up to the top soil. Wells that tap this aquifer yield an abundant supply of hard, "alkaline" water that is not potable for humans but can be used for stock. This water is under a high hydrostatic pressure, due to the difference in elevation between the moraine country to the northeast and the area in the southwest that is covered by glacial till. Usually the water rises to within 20 feet of the top of the well, but in a strip of country paralleling the moraine on the southwest, there are three wells in which the water rises to within 4, 8, and 14 feet of the surface. In NE.$\frac{1}{4}$, section 10, there is a municipal well in which the water barely flows over the top of the casing. There are places in section 11 where flowing artesian wells may possibly be obtained. Some farmers are unable to locate this second horizon due to the tongue-like nature of the deposit. The drought of 1930 to 1934 had little effect on the water supply in these non-flowing artesian wells, and 25 to 50 head of stock may be watered at one well without difficulty. The flowing artesian well will supply 20 tanks of water a day.

Farmers residing in the terminal moraine-covered district have difficulty in striking a good supply of water. The small gravel and sand pockets that occur in the terminal moraine may or may not be encountered within 60 feet of the surface. Numerous dry holes have been bored to a maximum depth of 80 feet without passing through a water-bearing horizon. Layers of boulders and stones are frequently struck at a depth of 40 feet. It is possible to obtain a good water supply in this area provided a gravel or sand pocket is tapped. Farmers will find a 2-inch auger useful in testing for these pockets which may lie at any depth up to 60 feet from the surface.

The thickness of the glacial drift, which covers the bedrock is not definitely known. The Marine shale formation underlies the glacial drift in this district, and it is very probable that it is not more than 100 feet below the surface.

This Marine shale does not contain water-bearing horizons that yield usable water and farmers are advised not to drill or bore into it. They should confine their efforts to prospecting for water in the upper 100 feet of glacial drift which overlies this shale, or "soapstone" as it is sometimes termed.

Township 11, Range 11

A small area of glacial outwash sands occurs in the northern part of sections 31 and 32, whereas the remainder of the township is overlain with a mantle of glacial till. The glacial drift is approximately 60 feet thick, and overlies the bedrock Marine shale formation.

A straight line drawn from section 12 to section 32 roughly divides the township into two parts in which the water conditions are totally different. In the southwestern part the glacial drift consists, in descending order, of: 2 feet of soil; 20 feet of yellow boulder clay; gravel and sand beds, 1 to 4 feet thick; and approximately 40 feet of blue clay. Water can be obtained from the sand and gravel beds at a depth of about 25 feet from the surface, but the supply is small and is easily affected by drought conditions. The water is not under pressure and it is too "alkaline" for domestic use, often even being too "alkaline" to be used for stock. Two wells, one in NE.$\frac{1}{4}$, section 5, and the other in SE.$\frac{1}{4}$, section 9, yield sufficient water for 25 to 40 head of stock, but the remaining wells may not yield sufficient water for 10 head of stock. Many holes were drilled in the town of Fillmore in an effort to secure a permanent supply of water. These holes range from 100 to 1,000 feet in depth and no water-bearing horizon was found. Both the quality and quantity of the water from wells in the southwestern part of the township are very poor.

In the northeastern part of the township the water-bearing horizon in the glacial drift is found 40 to 50 feet below the surface. The aquifer is either sand or gravel and it is overlain by yellow or blue clay, or both. Blue clay invariably underlies the aquifer. The water from this aquifer is very hard, highly "alkaline", and sometimes is salty. It is not suitable for household use even after it has been boiled. The water is under pressure and rises 20 to 40 feet above its source. This same type of well is found in the glacial till area of township 11, range 10, and it is quite probable that the water has its source in the highland area to the northeast. These wells supply sufficient water for 25 to 50 head of stock and the supply is not easily affected by drought conditions. Two farmers, located on SE.$\frac{1}{4}$, section 24, and N.$\frac{1}{2}$, section 33, have been unable to locate this aquifer. The quality of the water from wells in the northeastern part of the township is poor, but the wells yield large supplies. Very large supplies of water can be obtained from the glacial outwash sands in section 31. Within this area the coarse sand extends from the surface to a depth of 9 feet. The water is of good quality, but the drought of 1930 to 1934 slightly diminished the supply.

If water is not found within 60 feet of the surface it probably will not be found at greater depths. Once the Marine shale, or soapstone as it is locally termed, is struck it is useless to continue further drilling.

Township 11, Range 12

Glacial lake clay, glacial lake sands, and glacial till form the glacial deposits in this township. The southwestern corner is covered by glacial lake clay. The ground surface is very flat and the top soil is of the heavy gumbo clay type. The central and northwestern parts of the township are overlain with glacial lake sands. The topography is identical to the lake clay region, since the sand and the clay were deposited by water action, but the top soil is light and sandy. The remainder of the township is mantled with glacial till and the ground surface is slightly undulating.

Water conditions in the lake clay and glacial till sections are extremely poor and there is not one well in these areas that will yield a permanent, substantial supply of water. Yellow clay, containing small sand streaks, underlies the top soil to a depth of from 3 to 15 feet. Usually a small layer of fine sand separates the yellow clay from the blue clay. This sand layer forms the only water-bearing horizon in the lake clay and till covered districts. The supply of water in this sand is easily affected by drought conditions so that in the drought of 1930 to 1934 the wells barely furnished enough water for household use. Farmers usually dig their wells beside a slough or adjacent to a dugout, and in that way they derive the maximum amount of seepage water. Dry holes, 100 feet deep, have been dug and bored, and "soapstone" is reported as being struck at an approximate depth of 50 feet from the surface. "Soapstone" is the local name applied to the bedrock Marine shale formation. This formation is about 800 feet thick and it, so far as known, contains no water-bearing horizons that yield usable water for farm purposes.

The ground water conditions in the lake sand area are slightly better than in the lake clay or till covered districts, but they are not satisfactory. The upper 25 to 35 feet is usually composed of yellow clay and thick beds of fine sand. In places the yellow clay is absent. A well in NE.$\frac{1}{4}$, section 32, was dug 50 feet deep and sand was found to occur from the surface to the bottom of the well. With sand deposits present in such thickness it would be expected that large supplies of water would be obtained, but apparently this is not so. This area of glacial lake sands extends in a northwesterly direction as far as Tyvan. In the vicinity of Tyvan water can be obtained by driving a sand -point to a maximum depth of 15 feet. No satisfactory explanation can be given for this marked difference in water conditions within a short distance in the same deposit. A well in SE.$\frac{1}{4}$, section 16, and another in SE.$\frac{1}{4}$, section 27, yield sufficient water for 30 to 50 head of stock, but apart from these two wells there are no others that furnish an abundant supply of water. The above-mentioned wells supply hard usable water, but in the vicinity of the village of Osage the water is unfit for drinking. Glacial lake sand areas in other parts of the province are notable for the fact that large supplies of water of good quality can be obtained from them, but this particular area is an exception to the rule.

The construction of dugouts is the only feasible manner in which permanent quantities of water can be collected and stored. Deep drilling will not locate a permanent water supply.

Township 12, Range 10

The western half of the township is covered by a terminal moraine and the ground surface is extremely rough, being characterized by sharp hillocks and ridges and numerous undrained depressions or sloughs. A large depression, covering approximately 90 acres, is situated in SE.$\frac{1}{4}$, section 20, and is locally termed Bedford lake. During the drought period of 1930 to 1934 it was completely dry. The comparatively high elevation of the moraine in the west gradually decreases to the eastward where the moraine merges into glacial till or ground moraine.

The area of glacial till extends in a north to south direction and its lowest part is covered by a marsh in years of average rainfall. This marsh runs through sections 1, 12, 13, 14, 23, 24, 26, and 35. In wet years a small area in SW.$\frac{1}{4}$, section 21, is filled with water and it is locally termed Dry lake. At the extreme northeastern part of the township the elevation rises sharply.

The depth of the glacial drift in this township varies considerably. In the highest parts of the area of terminal moraine it is at least 150 feet thick, whereas in the lower glacial till covered district it is probably not more than 70 to 90 feet thick. The glacial moraine deposit is a mass of material dumped by the ice-sheet during its recession. Consequently, the clays, sands, and gravels that compose this deposit are not layered or sorted. Some wells dug in the morainic deposit may strike sand or gravel within 10 feet of the surface, whereas other wells may be dug 80 feet deep without striking any water-bearing pocket. The moraine in this township fortunately contains a fairly large quantity of sand and gravel, and farmers do not experience undue difficulty in striking these pockets. Both the quantity and quality of the water derived from wells in the moraine are extremely variable. For instance, a well 13 feet deep in NW.$\frac{1}{4}$, section 4, has yielded a sufficient supply to water 50 head of stock for the last thirty years. On the other hand, a well in SW.$\frac{1}{4}$, section 16, $1\frac{1}{4}$ miles distant, and having the same depth, became dry in 1930. Similar comparisons can be made of wells up to a depth of 65 feet. Usually the water in the deeper wells is under slight hydrostatic pressure. The size and shape of the sand or gravel pocket, and the point at which the pocket is tapped appear to have a direct bearing on the quantity of water obtained. A well 60 feet deep, in section 1, had its supply greatly diminished by the drought and the water is soft, and not under pressure, whereas a well 65 feet deep, in section 6, has had a good supply of water at all times, the water is hard, and is under hydrostatic pressure.

In the glacial till covered area the sands and gravels in or below the till appear to have been more or less sorted by water action and a layer of sand is found at a depth of 20 to 25 feet below the surface. Yellow, white, red, or blue clay overlies this aquifer. A fairly good supply is obtained from wells tapping this horizon.

The water situation has not been acute in this township. Fairly abundant supplies of water can be found in most places and farmers who as yet have not obtained a good well are advised to prospect with a test auger in an effort to tap a sand or gravel pocket. Suitable places for constructing dugouts are numerous, and a few ravines offer sites for the damming up of run-off water. Springs also occur in this township, a particularly good one being located in SE.$\frac{1}{4}$, section 24.

Township 12, Range 11

The northeastern part of the township is covered by a terminal moraine, the summit of which is approximately 2,150 feet above sea-level. The surface of the moraine is rolling and hilly and it contains many deep, undrained depressions. From the edge of the moraine the ground surface drops gradually to an elevation of 2,050 feet at the southwest corner of the township. This part of the township is underlain by glacial till or boulder clay and the ground surface is not so undulating as that of the moraine covered district.

Practically all the wells have been bored, and their depths range from 30 feet to 80 feet. The top soil is underlain by a heavy, yellow clay layer, 30 to 40 feet thick. A bed of sand is usually struck underneath the yellow clay, but in places blue clay follows the yellow clay and the sand is not encountered until 75 feet below the surface. The water in some of the wells, notably those in SE.$\frac{1}{4}$, section 4, NW.$\frac{1}{4}$, section 10, NW.$\frac{1}{4}$, section 30, and NE.$\frac{1}{4}$, section 31, is under a high hydrostatic pressure which causes it to rise to within 6 to 30 feet of the surface. These wells produce an abundant supply of water that did not fail during the drought of 1930 to 1934, whereas other wells bored to the same depths, and which apparently tap the same aquifer, obtain water that is not under pressure and the supply of which during the drought period decreased greatly. In other places no water is obtained.

The quality of the water appears to be much the same in each well. It is hard, strongly "alkaline," contains iron, and is sometimes salty. This fact leads to the belief that the same aquifer is struck by each well. It is possible that the sand which forms the aquifer in the glacial till was washed down and deposited in tongues or streaks by the streams issuing from the ice front when the moraine was being formed. The source of the water is believed to be in this highland area and this would account for the water being under hydrostatic pressure in the wells in the lower country that is mantled by glacial till.

The uneven topography of the township, especially in the morainic part, furnishes numerous locations for the excavation of dugouts or the construction of dams. The surface water collected would be of much better quality than the water from the wells, which is heavily charged with mineral salts.

Drilling or boring to a depth greater than 70 feet is not advised. The Marine shale bedrock formation underlies the glacial drift and does not contain water-bearing horizons that would yield usable water for farm purposes.

Township 12, Range 12

Two small areas of glacial outwash sands occur in sections 1, 11, and 12, and in parts of sections 7, 18, and 19. With the exception of the southwestern corner, which contains glacial lake sand, the remainder of the township is covered with a mantle of glacial till.

Wells that are dug in the glacial outwash deposits provide large quantities of medium hard water. These wells are only 10 feet deep and a blue or brown, fine sand bed, which grades into gravel, extends from the top soil down to the bottom of the wells. The municipal well in NW.$\frac{1}{4}$, section 7, and a well in SE.$\frac{1}{4}$, section 11, are located in the glacial outwash deposits. The sand and gravel bed extends to at least 16 feet below the surface.

Three water-bearing horizons occur in the area that is mantled by glacial till. The first horizon is formed by deposits of gravel that underlie the top soil or outcrop on the surface as gravel knolls; it is encountered by wells dug only 12 to 14 feet deep. The water yielded is hard but is usable. Wells in NW.$\frac{1}{4}$, section 32, and SW.$\frac{1}{4}$, section 34, yield a sufficient supply to water 30 to 50 head of stock, and the drought of 1930 to 1934 is reported to have diminished the supply very little.

The second horizon is formed by a small sand bed that underlies 15 to 25 feet of yellow or brownish clay. These wells have proved unsatisfactory in times of prolonged drought and in many cases they became completely dry. The water is not suitable for domestic use on account of its high content of salts in solution, and because of their small, intermittent supply. The wells are not satisfactory for the watering of stock.

The third horizon has been tapped by two wells located in NE.$\frac{1}{4}$, section 26, and NE.$\frac{1}{4}$, section 28. These wells are approximately 70 feet deep and they penetrate a bed of white sand that underlies a thick layer of blue clay. The water is hard, strongly "alkaline," and contains iron. It is unsuitable for human consumption, but may be used for stock. The water is under a high hydrostatic pressure and rises to within 6 feet of the surface in the well in NE.$\frac{1}{4}$, section 28. It is probable that this third horizon will be found to exist only in the northeastern part of the township, since holes drilled to a depth of 140 feet, in section 15, failed to locate it. The water from these two wells is similar to that found in a large number of others located at the base of the highland area that lies to the northeast, and it is probable that this highland area is the source of the water in all these wells.

Glacial lake sands occur abundantly in the southwest corner of the township but only small supplies of water are obtained from wells sunk in them.

STATISTICAL SUMMARY OF WELL INFORMATION IN
RURAL MUNICIPALITY OF FILLMORE, NO.96, SASKATCHEWAN

Township	10	10	10	11	11	11	12	12	12	Total No. in Munici-pality
West of 2nd Meridian Range	10	11	12	10	11	12	10	11	12	
Total No. of Wells in Township	86	81	100	179	103	74	92	50	54	819
No. of wells in bedrock	5	5	7	-	11	1	-	-	2	31
No. of wells in glacial drift	81	76	93	179	92	73	92	50	52	788
No. of wells in alluvium	-	-	-	-	-	-	-	-	-	-
Permanency of Water Supply										
No. with permanent supply	38	31	15	28	35	24	36	22	19	248
No. with intermittent supply	7	5	7	11	8	6	8	6	9	67
No. dry holes	41	45	78	140	60	44	48	22	26	504
Types of Wells										
No. of flowing artesian wells	-	-	-	1	-	-	-	-	-	1
No. of non-flowing artesian wells	18	12	1	12	14	1	11	8	2	79
No. of non-artesian wells	27	24	21	26	29	29	33	20	26	235
Quality of Water										
No. with hard water	41	32	18	37	42	28	41	27	22	288
No. with soft water	4	4	4	2	1	2	3	1	6	27
No. with salty water	-	2	1	-	3	-	-	1	-	7
No. with "alkaline" water	22	23	15	22	24	15	21	20	10	172
Depths of Wells										
No. from 0 to 50 feet deep	77	79	97	147	91	70	81	47	49	738
No. from 51 to 100 feet deep	7	1	3	32	9	4	11	3	4	74
No. from 101 to 150 feet deep	1	-	-	-	1	-	-	-	1	3
No. from 151 to 200 feet deep	-	-	-	-	-	-	-	-	-	-
No. from 201 to 500 feet deep	1	-	-	-	1	-	-	-	-	2
No. from 501 to 1,000 feet deep	-	-	-	-	1	-	-	-	-	1
No. over 1,000 feet deep	-	1	-	-	-	-	-	-	-	1
How the Water is used										
No. usable for domestic purposes	28	15	8	24	31	19	35	12	19	191
No. not usable for domestic purposes	17	21	14	15	12	11	9	16	9	124
No. usable for stock	41	32	19	39	42	24	42	26	28	293
No. not usable for stock	4	4	3	-	1	6	2	2	-	22
Sufficiency of Water Supply										
No. sufficient for domestic needs	38	30	15	28	35	23	36	22	19	246
No. insufficient for domestic needs	7	6	7	11	8	7	8	6	9	69
No. sufficient for stock needs	25	19	4	23	22	5	25	16	14	153
No. insufficient for stock needs	20	17	18	16	21	25	19	12	14	162

ANALYSES AND QUALITY OF WATER

General Statement

Samples of water from representative wells in surface deposits and bedrock were taken for analyses. Except as otherwise stated in the table of analyses the samples were analysed in the laboratory of the Borings Division of the Geological Survey by the usual standard methods. The quantities of the following constituents were determined; total dissolved mineral solids, calcium oxide, magnesium oxide, sodium oxide by difference, sulphate, chloride, and alkalinity. The alkalinity referred to here is the calcium carbonate equivalent of all acid used in neutralizing the carbonates of sodium, calcium and magnesium and unless the figure is very high it does not imply that the water is too alkaline for irrigation purposes. The analyses are given in parts per million--that is, in parts by weight of the constituents in 1,000,000 parts by volume of water; for example, 1 ounce of material dissolved in 10 gallons of water is equal to 625 parts per million. The samples were not examined for bacteria, and thus a water that may be termed suitable for use on the basis of its mineral salt content might be condemned on account of its bacteria content. Waters that are high in bacteria content have usually been polluted by surface waters.

Total Dissolved Mineral Solids

The term "total dissolved mineral solids" as here used refers to the residue remaining when a sample of water is evaporated to dryness. It is generally considered that waters that have less than 1,000 parts per million of dissolved solids are suitable for ordinary uses, but in the Prairie Provinces this figure is often exceeded. Nearly all waters that contain more than 1,000 parts per million of total solids have a taste due to the dissolved mineral matter. Residents accustomed to the waters may use those that have much more than 1,000 parts per million of dissolved solids without any marked inconvenience, although most persons not used to highly mineralized water would find such waters highly objectionable.

Mineral Substances Present

Calcium and Magnesium

The calcium (Ca) and magnesium (Mg) content of water is dissolved from practically all rocks, but in larger amounts from limestone, dolomite, and gypsum. The calcium and magnesium salts impart hardness to water. The magnesium salts are laxativo, especially magnesium sulphate (Epsom Salts, $MgSO_4$), and they are more detrimental to health than the lime or calcium salts. The calcium salts have no laxative or other deleterious effects. The scale found on the inside of steam boilers and teakettles is formed from these mineral salts.

Sodium

The salts of sodium are next in importance to those of calcium and magnesium. Of these, sodium sulphate, (Glauber's salt, Na_2SO_4) is usually in excess of sodium chloride, (common salt, $NaCl$). These sodium salts are dissolved from rocks and soils. When there is a large amount of sodium sulphate present the water is laxative and unfit for domestic use. Sodium carbonate (Na_2CO_3) "black alkali", sodium sulphate "white alkali", and sodium chloride are injurious to vegetation, and waters that contain a large amount of them cannot be used for irrigation.

Sulphates

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

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

Chlorides

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

Iron

Iron (Fe) is dissolved from many rocks and the surface deposits derived from them, and also from well casings, water pipes, and other fixtures. More than 0.1 part per million of iron in solution will settle out as a red precipitate upon exposure to the air. A water that contains a considerable amount of iron will stain porcelain, enamelled ware, and clothing that is washed in it, and when used for drinking purposes has a tendency to cause constipation.but the iron can be almost completely removed by aeration and filtration of the water.

Hardness

Calcium and magnesium salts impart hardness to water. Hardness of water is commonly recognized by its soap-destroying powers as shown by the difficulty of obtaining lather with soap. The total hardness of a water is the hardness of the water in its original state. Total hardness is divided into "permanent hardness" and "temporary hardness". Permanent hardness is the hardness of the water remaining after the sample had been boiled and it represents the amount of mineral salts that cannot be removed by boiling. Temporary hardness is the difference between the total hardness and the permanent hardness and represents the amount of mineral salts that can be removed by boiling. Temporary hardness is due to the bicarbonates of calcium and magnesium, and permanent hardness to the sulphates, and chlorides of calcium and magnesium. The permanent hardness can be partly eliminated by adding simple chemical softeners such as ammonia or sodium carbonate, or many prepared softeners. Water that contains a large amount of sodium carbonate and small amounts of calcium and magnesium salts is soft, but if the calcium and magnesium salts are present in large amounts the water is hard. The following table from "The Examination of Water and Water Supplies" by Thresh and Beale, London, 1925 , can be used for determining the relative hardness of a water.

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

Many of the Saskatchewan water samples analysed by the Geological Survey have a total hardness greatly in excess of 300 parts per million; when the total hardness exceeded 3,000 parts per million no exact hardness determination was made. Also no determination for temporary hardness was made on waters having a total hardness less than 50 parts per million.

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

Analyses of Water Samples from the Municipality of Fillmore, No. 96, Saskatchewan.

No.	LOCATION					Depth of Well, Ft.	Total dis'vd solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS									Source of Water
	Qtr.	Sec.	Tp.	Rge.	Mer.			Total	Perm.	Temp.	Cl.	Alkalinity	CaO	MgO	SO_4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	$CaCl_2$	
1.	SW.	16	10	10	2	30	969										969	(3)	(1)		(2)		(4)		(5)	x 1
2.	NE.	10	11	10	2	35	2,300	1,300	900	400	27	660	360	227	1054		2,141	644		13	659		780	45		x 1
3.	NE.	31	11	11	2	16	2,020	1,100	1100	nil	165	265	280	184	164			265			Anomalous					x 1
4.	NE.	28	12	12	2	76	2,060	550	450	100	38	385	30	119	1021	714	1,914	54		249		37	1,511	63		x 1

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

Water from the Unconsolidated Deposits

The analyses of water from four wells in the municipality are shown on the accompanying table.

The first sample is from a shallow well in the town of Creelman. The water is relatively low in dissolved solids but the analyses showed that it contained a trace of nitrites and organic material.

The second sample was taken from the artesian well dug by the municipality on Mr. Mustard's land in township 11, range 10. This sample shows a total dissolved content of 2,141 parts per million. In some parts of the world this concentration of salts would be termed high, but in Saskatchewan it is not considered as excessive. However, it will be noted that this sample contains a high proportion of magnesium sulphate and sodium sulphate, two undesirable salts on account of their laxative properties. These salts render the water unfit for domestic purposes, but it is suitable for stock.

The third sample taken from a well dug in a glacial outwash deposit shows a total dissolved content of 2,020 parts per million. It will be noted that this water contains nitrates. The fact that nitrates are present in the sample indicate that the well water may be contaminated. Practically all nitrates found in water are derived from the oxidation of nitrogenous organic matter of animal origin. Very small amounts are yielded by the oxidation of vegetable matter. In a sand formation of such large extent the pollution of one well may affect other wells a considerable distance away. It is advised that this water be sent to the provincial analyst for determination of the bacteria content. The municipal well dug in NW.$\frac{1}{4}$, section 7, tp. 12, range 12, does not lie in the same bed of glacial outwash sands as that from which this sample was taken and it would be impossible for it to be contaminated from the above well. However, since the municipal well is used by a great many farmers and by the population of Osage, it is recommended that the water from it be also examined for bacteria.

The fourth sample is from a 76-foot well drilled in the glacial drift. Seventy-five per cent of the total dissolved solid content of 2,060 parts per million is composed of sodium sulphate (Glauber's Salt). The presence of such a large amount of this salt in solution in the water makes it unfit for drinking. Small quantities of calcium carbonate ($CaCO_3$) and magnesium carbonate impart temporary hardness to the water, but they produce no ill effects in drinking water and they are tasteless.

Water from the Bedrock

No producing well in this municipality has been drilled into the shale or "soapstone", although dry holes have been made in Fillmore and Creelman and elsewhere in the municipality. Water that is obtained from the Marine shale formation at other places contains so large a quantity of dissolved mineral salts that the water is unfit for drinking or for stock. A total dissolved solid content of 5,000 parts per million or more is usually found, and the major constituents are sodium chloride, magnesium sulphate, sodium sulphate. Consequently those wells that have tapped a water horizon in the Marine shale are useless as a source of usable water for farm purposes.

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	SE.	2	10	10	2	Bored	35	2,045	− 8	2,037	31	2,014	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for 33 head stock.
2	NW.	2	"	"	"	Dug	24	2,040	− 20	2,020	20	2,020	" sand	Hard,clear		D, S	Insufficient for 14 head stock.
3	SW.	4	"	"	"	"	26	2,020	− 10	2,010	25	1,995	" gravel	", ", "alkaline"		S	Sufficient for 10 head stock.
4	NW.	4	"	"	"	"	26	2,030	− 22	2,008	26	2,004	" sand	", hard, clear		S	" " 25 " ".
5	SE.	6	"	"	"	"	50	2,025	− 12	2,013	28	1,997	" gravel	", ", "alkaline"		S, I	" " 20 " ".
6	NE.	7	"	"	"	"	22	2,020	− 15	2,005	20	2,000	" sand	Hard, clear		S	Abundant supply.
7	NE.	8	"	"	"	"	17	2,020	− 10	2,010	13	2,007	" "	Soft, "		D, S	Sufficient for 24 head stock.
8	SE.	9	"	"	"	"	50	2,025	− 20	2,005	28	1,997	" "	Hard, "		D, S	Seepage from dugout; intermittent.
9	SW.	10	"	"	"	Bored	28	2,025	− 5	2,020			"	", "		D	Sufficient for domestic use only.
10	NW.	12	"	"	"	Dug	35	2,055	− 25	2,030	27	2,028	" "	", ", "alkaline,iron"		D, S, I	" " 30 head stock.
11	SE.	12	"	"	"	Bored	40	2,055					"	", ", hard, clear		S	" " 40 " ".
12	SE.	14	"	"	"	Dug	35	2,045	− 20	2,025			" "	", ", "alkaline"		D, S	Good supply.
13	SW.	14	"	"	"	"	30	2,045	− 28	2,017			" clay	Soft, clear		D	Intermittent supply.
14	SW.	15	"	"	"	"	18	2,040	− 3	2,037			"	Hard, "		D	Seepage from dugout.
15	SW.	16	"	"	"	"	30	2,025	− 10	2,015	21	2,004	" sand	", "		D, S	Insufficient for local needs; #.
16	NE.	17	"	"	"	"	18	2,025	0	2,025	14	2,011	" "	", ", "alkaline"		D, S	Intermittent supply; well located in slough.
17	SE.	18	"	"	"	Bored	33	2,020	− 24	1,996	30	1,990	" "	Hard, clear, "alkaline"		S	Insufficient for 15 head stock.
18	NE.	19	"	"	"	Dug	19	2,040	0	2,040	1	2,039	" clay	Hard, clear		D, S	Seepage from dugout.
19	NE.	20	"	"	"	"	14	2,040	− 4	2,036			" "	", "		D	Abundant supply.
20	NW.	22	"	"	"	"	40	2,045					" sand	", "		D,	Sufficient for 50 head stock.
21	NW.	23	"	"	"	Bored	45	2,055			44	2,011	" "	", ", "alkaline"		S	" " 20 " ".
22	NE.	24	"	"	"	"	30	2,065	− 10	2,055	30	2,035	" "	", hard, clear		S	Abundant " 16 " ".
23	NW.	25	"	"	"	Dug	12	2,075	0	2,075			" clay	", ", "alkaline"		D	Intermittent well.
24	SW.	27	"	"	"	Bored	45	2,055	− 20	2,035	42	2,013	" sand	", hard, clear		D, S	Abundant supply for 25 head stock.
25	NE.	28	"	"	"	"	32	2,055	− 17	2,038			"	", ", "alkaline,iron"		S	" " " 25 " ".
26	SW.	28	"	"	"	Dug	22	2,055	− 5	2,050	21	2,034	" gravel	Hard,clear		D	Sufficient " " 15 " ".
27	SE.	30	"	"	"	Bored	50	2,030	− 10	2,020	43	1,987	" sand	Soft, "		D, S	Has trouble with quicksand plugging.

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	PRINCIPAL WATER-BEARING BED: Elev.	PRINCIPAL WATER-BEARING BED: Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
28	NE.	31	10	10	2	Bored	15	2,050	− 8	2,042			Glacial	Hard, clear, "alkaline"		S	Sufficient for 20 head stock.
29	SE.	32	"	"	"	"	55	2,050	− 25	2,025	53	1,997	" drift	" ,hard, clear		S	" " 32 " " .
30	NE.	33	"	"	"	Dug	16	2,075	− 7	2,068	4	2,071	" gravel	" , "		S	Insufficient for 75 head stock.
31	NW.	34	"	"	"	"	20	2,070	− 10	2,060	1	2,069	" sand	" , "		D, S, I	Sufficient " 35 " " .
32	SW.	35	"	"	"	Bored	65	2,080	− 8	2,072			" gravel	" , "		D	Insufficient " 90 " " .
33	SE.	36	"	"	"	Dug		2,085	− 8	2,077			" sand	Soft, clear		D, S	Sufficient " 7 " " .
34	NE.	36	"	"	"	"	16	2,060	− 12	2,048			" gravel	Hard, " , "alkaline"		S	" " 15 " " .
1	NE.	1	10	11	2	Dug	20	2,016					"			N	Dry hole.
2	NE.	4	"	"	"	Bored	295	2,006	0	2,006	29	1,977	" clay	Soft, clear		D	Dug beside slough; intermittent well.
3	SE.	5	"	"	"	Dug	30	2,009	− 15	1,994	30	1,979	" sand	" , "		D	Slow seepage; sufficient for domestic use only.
4	SW.	6	"	"	"	"	10	1,998	0	1,998	10	1,988	" clay	" , cloudy		D	Seepage from dugout; intermittent supply.
5	NE.	10	"	"	"	Bored	39	2,017	− 20	1,997	39	1,978	" gravel	Hard,clear		D, S	Sufficient for 10 head stock.
6	NE.	12	"	"	"	"	35	2,025	− 25	2,000	35	1,990	"	" , " , "alkaline"		S	Insufficient for 16 head stock.
7	SW.	16	"	"	"	"	27	2,001	− 15	1,986	27	1,974	"	Hard,clear		D	Sufficient for domestic use only.
8	NE.	16	"	"	"	"	40	2,000					"			N	Paltry supplies of heavily alkaline water found at a depth of 35 feet.
9	NW.	19	"	"	"	"	17	2,003	0	2,003	17	1,986	" sand	" , "		D	Intermittent supply.
10	SE.	20	"	"	"	Dug	30	2,000	− 15	1,985	30	1,970	" "	Soft, " , "alkaline"		D	Abundant supply.
11	SW.	22	"	"	"	Bored	30	2,008	− 12	1,996	30	1,978	" "	Hard, clear		D	Sufficient for domestic use only. Supply decreases in winter.
12	NE.	22	"	"	"	"	32	2,021	− 10	2,011	32	1,989	" "	" , " , "alkaline"		D, S	Sufficient for 4 head stock and domestic use.
13	NW.	23	"	"	"	"	36	2,017	− 26	1,991	36	1,981	" gravel	" , hard, clear		S	" " 8 " " .
14	SW.	26	"	"	"	"	30	2,019	− 20	1,999	30	1,989	"	" , " , "alkaline"		S	Abundant supply for 30 head stock.
15	SW.	27	"	"	"	Dug	45	2,012	− 15	1,997	44	1,968	" ",sand	" , hard, clear		S	Sufficient for 25 head stock in dry years.
16	NE.	28	"	"	"	Bored	40	1,999	− 10	1,989	40	1,959	" clay	" , " , "alkaline"		D, S	Good supply.
17	SW.	29	"	"	"	"	36	2,004	− 20	1,984	36	1,968	" drift	Hard,clear		D, S	Abundant supply.
18	SE.	32	"	"	"	"	42	2,022	− 18	2,004	42	1,980	" sand	" , " , salty, iron, "alkaline"		S	Sufficient for 50 head stock .
19	NW.	33	"	"	"	"	32	2,011	− 20	1,991	32	1,979	" "	" ,hard, iron,clear		S	" " 40 " " .

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
20	NE.	33	10	11	2	Bored	25	2,019	- 10	2,009	25	1,994	Glacial sand	Hard, "alkaline" iron, clear		D	Slow seepage; intermittent supply.
21	NW.	34	"	"	"	"	26	2,009	- 8	2,001	26	1,983	" "	Hard, "		D	Small supply; horse use only.
22	NW.	35	"	"	"	Dug	38	2,018	- 28	1,990	38	1,980	" clay	" , " , bad odour, "alkaline", iron		S	Intermittent supply, very slow seepage; 1 barrel a day.
23	NE.	36	"	"	"	"	25	2,029	- 8	2,021	25	2,004	"	Hard, clear		D, S	Sufficient for 10 head stock in winter.
1	SE.	2	10	12	2	Dug	20	1,996	- 14	1,982	17	1,979	" gravel	" , " , "alkaline"		S	Sufficient for 100 head stock.
2	NW.	2	"	"	"	"	16	1,980	0	1,980			" sand	Soft, clear, iron		N	Well beside slough; intermittent supply; seldom used.
3	NW.	4	"	"	"	Bored	25	1,986	- 16	1,970			" "	Hard, " , "alkaline"		N	Putrid yellow water, never used.
4	NW.	4	"	"	"	Dug	15	1,986					"			N	Dry hole.
5	SW.	7	"	"	"			1,981					"			N	" " .
6	NW.	9	"	"	"	"	25	1,981					" clay	Hard, clear, "alkaline"		N	Water unfit for consumption; dry hole.
7	NW.	9	"	"	"	"	25	1,981					"			N	Dry hole.
8	NW.	10	"	"	"	"	25	1,980	- 7	1,973			" sand	" , hard, clear		N	Intermittent supply.
9	SE.	14	"	"	"	"	12	1,987	0	1,987			" clay	Soft, iron, "alkaline"		D	Well becomes dry in winter.
10	SE.	16	"	"	"	"	15	1,981	- 9	1,972			" sand	" , hard, iron, clear		D, S	Intermittent well.
11	NE.	18	"	"	"	"	18	1,981	- 10	1,971			" "	Hard, "		D	" " .
12	NE.	20	"	"	"	"	30	2,005	- 25	1,980			" "	", "alkaline" blue colour		S	Poor supply; poor quality.
13	NW.	24	"	"	"	"	24	1,997	- 2	1,995			" gravel	Hard, clear, "alkaline"		D	Slow seepage used for house only.
14	NW.	25	"	"	"	"	15	1,999	- 5	1,994			"	Soft, clear		D	Seepage from slough; house use only.
15	NE.	26	"	"	"	Bored	30	2,003	- 10	1,993			" clay	Hard, "alkaline" salty, clear		N	Not usable; condemned by analyst.
16	NE.	26	"	"	"	"	30	2,003					"			N	Dry hole.
17	SE.	28	"	"	"	Dug	15	1,983	- 14	1,969			" gravel	Hard, clear, "alkaline"		N	Very small supply and it is unfit for any use.
18	NE.	31	"	"	"	"	65	1,987					Bedrock Marine shale			N	Dry hole.
19	NE.	33	"	"	"	Bored	12	1,998	- 7	1,991			Glacial	Soft, clear, iron		D	Intermittent supply; house use only.
20	NW.	34	"	"	"	Dug	18	1,990					" clay	Hard, "		D	Seepage from dugout; " " " .
21	NW.	36	"	"	"	"	15	1,990	- 10	1,980			" sand	" , "		D	" " " ; " " " .
1	NW.	1	11	10	2	Bored	45	2,105					"			N	Dry hole.
2	SW.	2	"	"	"	"	50	2,105	- 30	2,075	50	2,055	" gravel	" , " "alkaline"		S	Sufficient for 15 head stock.

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
3	NW.	4	11	10	2	Dug	14	2,075	- 3	2,072	4	2,071	Glacial sand	Hard, clear		D, S	Direct seepage from slough.
4	NE.	6	"	"	"	Bored	44	2,065	- 16	2,049	43	2,022	" "	", "alkaline", iron, clear		D, S	Sufficient for 20 head stock.
5	NW.	7	"	"	"	"	34	2,075	- 17	2,058	32	2,043	" gravel	Hard, " "alkaline"		S	" " 30 " ".
6	NW.	8	"	"	"	"	50	2,090	- 20	2,070			"	", hard, clear		S	" " 26 " ".
7	NE.	10	"	"	"	"	35	2,130	0	2,130	23	2,107	" sand	", ", "alkaline"		S	Yields 17 tanks a day; #.
8	SE.	12	"	"	"	"	32	2,155	- 10	2,145	30	2,125	" "	", ", clear		D	Intermittent supply.
9	NE.	12	"	"	"			2,150					"			N	Dry hole.
10	NW.	13	"	"	"	Dug	50	2,155	- 30	2,125			" "	Hard, clear, "alkaline"		D, S	Insufficient for 20 head stock.
11	NE.	14	"	"	"			2,155					"			N	Dry hole.
12	SE.	15	"	"	"	Bored	58	2,145	- 4	2,141			" sand	", hard, clear, gfey sediment		D, S	Sufficient for 13 head stock.
13	NE.	15	"	"	"	"	82	2,160					"			N	Dry hole.
14	NE.	16	"	"	"	"	46	2,140	- 27	2,113			" gravel	Hard, cloudy, "alkaline"		S	Sufficient for 20 head stock; water kills plants.
15	SW.	16	"	"	"	Dug	12	2,110	- 9	2,101	11	2,099	" "	Hard, clear		D	Intermittent supply.
16	SE.	18	"	"	"	Bored	40	2,090	- 26	2,064	35	2,055	" sand	Hard, clear, "alkaline"		S	Abundant supply for 15 head stock.
17	SW.	20	"	"	"	Dug	18	2,140	- 3	2,137	1	2,139	" gravel	Hard, clear		D, S	Quantity depends on rainfall.
18	NW.	20	"	"	"	"	14	2,140	- 6	2,134	1	2,139	" "	", "		D, S	Insufficient for 27 head stock.
19	SW.	24	"	"	"	Bored	16	2,155	- 12	2,143	12	2,143	" sand	", ", "alkaline"		D	" " 15 " ".
20	SW.	25	"	"	"	"	75	2,160					"			N	Dry hole.
21	SW.	26	"	"	"	Dug	24	2,180	- 18	2,162	7	2,173	" "	", hard, clear		D, S	Insufficient for 13 head stock.
22	NE.	27	"	"	"	Bored	60	2,200	- 20	2,180	40	2,160	" gravel	", "		D	Sufficient " 50 " ".
23	SW.	27	"	"	"	"	86	2,175					"			N	Dry hole.
24	SE.	28	"	"	"	Dug	12	2,160	- 6	2,154	11	2,149	" "	Hard, clear		D	Direct seepage from dugout.
25	NW.	28	"	"	"	Bored	56	2,175	- 41	2,134	46	2,129	" "	", ", "alkaline"		D, S	Sufficient for 75 head stock.
26	SE.	29	"	"	"	"	63	2,150	- 8	2,142	62	2,088	" "	", hard, clear		D, S, I	Abundant for 20 " ".
27	SE.	30	"	"	"	"	65	2,155	- 50	2,105			" gravel	", ", "alkaline"		D, S	Sufficient for 20 " ".
28	SW.	31	"	"	"	"	40	2,150	- 14	2,136	30	2,120	" sand	", hard, iron, clear		D, S, I	" " 50 " ".
29	SW.	32	"	"	"	"	63	2,200	- 48	2,152	53	2,147	" gravel	Hard, "		D, S, I	" " 30 " ".

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
30	NW.	33	11	10	2	Bored	46	2,210	- 20	2,190	43	2,167	Glacial sand	Hard, clear, iron		D, S	Varies with amount of rainfall.
31	SE.	34	"	"	"		45	2,220					"			N	Dry hole.
32	NW.	35	"	"	"	Dug	24	2,140	- 10	2,130	21	2,119	" "	Soft, clear		D, S	Sufficient for 20 head stock.
33	NW.	36	"	"	"	"	12	2,100	0	2,100	8	2,092	" "	" , "		D, S	" " 15 " " .
1	SE.	3	"	11	"	"	25	2,020					"			N	Dry hole or water obtained is heavily "alkaline".
2	NW.	3	"	"	"	Bored	30	2,017	- 27	1,990			" gravel	Hard, clear, "alkaline"		D, S	Town of Fillmore; sufficient for town use but poor quality.
3	SW.	3	"	"	"	"	30	2,017	- 27	1,990			" "	" , hard, iron, clear		D, S	For town use but poor quality.
4	NW.	3	"	"	"	Dug	30	2,041					"	Hard, " , "alkaline"		N	Very poor supply.
5	NE.	3	"	"	"	Bored	20	2,041	- 13	2,028			"	Hard, clear		D	Sufficient for domestic use only.
6	NE.	4	"	"	"	Dug	24	2,034	- 8	2,026	20	2,014	" sand	" , "		D, S	Intermittent supply.
7	SW.	5	"	"	"			2,000					"				No well; dry holes.
8	NE.	5	"	"	"	Dug	20	2,002	- 10	1,992	18	1,984	" gravel	Hard, clear		D, S	Sufficient for 50 head stock.
9	NE.	7	"	"	"	"	20	2,000	- 18	1,982	18	1,982	" clay	" , "		D, S	Insufficient for local needs.
10	NE.	8	"	"	"	Bored	22	2,026	- 6	2,020			" sand	" , " , iron		D, S	Used for house.
11	SE.	9	"	"	"	Dug	25	2,028	- 19	2,009	21	2,007	" "	Hard, " , "alkaline"		S	Sufficient for 15 head stock.
12	NW.	12	"	"	"	Bored	45	2,062	- 15	2,047			"	" , hard, soda, clear		S	Good supply; strong laxative for man.
13	SW.	14	"	"	"	"	40	2,052	- 8	2,044			" "	Hard, " , iron salty, "alkaline"		S	Yields 1 tank a day.
14	NW.	14	"	"	"	"	50	2,060	- 20	2,040	50	2,010	" gravel	Hard, " , clear		D, S	Good supply.
15	SW.	15	"	"	"	Dug	25	2,048	- 8	2,040			"	" , " , hard, iron		D	Seepage from dugout.
16	SE.	16	"	"	"	"	20	2,041	- 10	2,031			"	" , clear		D	House use only.
17	SE.	18	"	"	"	"	20	2,023	- 8	2,015			"	" , "		D	Sufficient for 6 head stock in winter.
18	SW.	22	"	"	"	Bored	21	2,047					"	" , "		D	Intermittent supply.
19	SE.	24	"	"	"	Dug	80	2,100					"			N	Dry hole.
20	SW.	24	"	"	"	Bored	37	2,092	- 18	2,074			"	" , " , "alkaline"		S	Sufficient for 26 head stock.
21	SW.	25	"	"	"	"	50	2,106	- 12	2,094			"	" , hard, clear		D, S	" " 15 " " .
22	SW.	26	"	"	"	Dug	30	2,095	- 15	2,080			"	" , "alkaline" hard, salty		S	" " 40 " " .
23	NW.	26	"	"	"	Bored	35	2,100					"	" , clear, "alkaline"		D, S	" " 12 " " .

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
24	NW.	27	11	11	2	Bored	43	2,083	- 12	2,071			Glacial	Hard, clear, "alkaline"		D, S	Sufficient for 35 head stock.
25	SE.	28	"	"	"	"	40	2,058	- 20	2,038	32	2,026	" gravel	" , hard, clear, salty		S	" " 15 " " in winter.
26	NE.	28	"	"	"	"	40	2,068	- 10	2,058	39	2,029	" sand	", "alkaline", iron, hard		S	" " 50 " " .
27	SW.	29	"	"	"	Dug	22	2,039	- 14	2,025			" clay	Hard, clear		D	" " domestic use only.
28	NE.	31	"	"	"	"	16	2,041	- 9	2,032			" sand	" , "		D, S	Abundant supply; #.
29	NW.	33	"	"	"	"	18	2,083	- 8	2,075			" "	" , " , alkaline		D	Sufficient for domestic use only.
30	NE.	33	"	"	"	"	14	2,116	- 6	2,110			" "	Soft, clear		D	Seepage from slough; intermittent supply.
31	SE.	35	"	"	"	"	38	2,124	- 10	2,114			"	Hard, " , "alkaline"		D, S	Sufficient for 100 head stock.
1	SE.	2	11	12	2	Dug	18	1,991	- 5	1,986			" "	Hard, clear		D, S	Seepage from dugout; intermittent supply.
2	SW.	3	"	"	"			1,989					"			N	Dry hole.
3	NE.	10	"	"	"	Bored	30	2,000			30	1,970	"	"		D, S	Yields 6 gallons a day.
4	SE.	16	"	"	"	"	42	1,995	- 15	1,980	20	1,975	" gravel	" , "		D, S	Sufficient for 50 head stock.
5	NW.	16	"	"	"	Dug	15	1,974	- 11	1,963			" sand	" , " , "alkaline"		D	Seepage from slough; intermittent supply.
6	SW.	18	"	"	"	"	12	1,991	- 10	1,981			" "	Hard, clear		D	" " " ; house use only.
7	SE.	19	"	"	"	"	30	2,000					"			N	Water unfit for stock; never used.
8	NE.	19	"	"	"	Bored	40	1,990	- 25	1,965	40	1,950	" clay	" , " , iron		D	Sufficient for domestic use and a few horses.
9	SE.	20	"	"	"	Dug	23	1,981	- 3	1,978			" sand	Hard, " , "alkaline"		S	Sufficient for 20 head stock usually.
10	SE.	22	"	"	"	Bored	33	1,999					"	Hard, clear, iron		S	Intermittent supply.
11	NW.	23	"	"	"	"	30	2,006	- 24	1,982			" "	" , "alkaline" hard, clear		D, S	" " .
12	SE.	24	"	"	"	"	40	2,010	- 36	1,974			"	" , " , "alkaline"		D	Sufficient for domestic use only.
13	SE.	27	"	"	"	Dug	36	2,002	- 21	1,981	35	1,967	" gravel	Hard, clear		D, S	" " 35 head stock.
14	NE.	28	"	"	"	"	26	1,993	- 12	1,981	15	1,978	" sand	" , "		D, S	Small supply; good drinking water.
15	SE.	30	"	"	"	"	32	1,992	- 9	1,983			" "	Soft, "		D, S	Intermittent supply.
16	NE.	32	"	"	"	Bored	50	2,004	- 20	1,984			" "	Hard, " , "alkaline"		S	Sufficient for 25 head stock; well pumps dry.
17	NW.	33	"	"	"	Dug	25	1,998					" "	Hard, clear		D	Seepage from dugout; used for house.
18	NE.	33	"	"	"	"	18	2,007	- 6	2,001	15	1,992	" gravel	", "alkaline", green colour		N	Good supply but condemned.
19	NW.	34	"	"	"	"	18	2,012	- 15	1,997			" clay	Hard, clear		D	Slow seepage; sufficient for house.

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN.

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (−) Surface	Elev.	Depth	Elev.	Geological Horizon				
20	SW.	35	11	12	2	Dug	17	2,009	− 9	2,000	9	2,000	Glacial sand	Hard, clear		D, S	Sufficient for 10 head stock.
21	NW.	36	"	"	"	"	16	2,021	− 12	2,009			" "	" , "		D	Sufficient for domestic use.
1	SW.	1	12	10	2	Bored	60	2,100	− 50	2,050	50	2,050	" "	Soft, " , #alkaline#		S	Supply varies greatly with rainfall.
2	SE.	2	"	"	"	"	26	2,100	− 10	2,090	23	2,077	" "	" , clear, soft		D	Insufficient for 40 head stock.
3	SE.	3	"	"	"	Dug	28	2,160	− 22	2,138	25	2,135	" gravel	Hard, " , iron		D, S	Sufficient " 12 " " .
4	NE.	4	"	"	"	Bored	30	2,155	− 12	2,143	30	2,125	" "	Hard, "		D, S, I	" " 55 " " .
5	NW.	4	"	"	"	"	13	2,220	− 10	2,210	9	2,211	" "	" , " , #alkaline#		D, S	" " 45 " " .
6	SW.	5	"	"	"	"	48	2,200	− 18	2,182	47	2,153	" "	Hard, clear		D, S	" " 50 " " .
7	SW.	6	"	"	"	"	65	2,175	− 33	2,142	65	2,110	" "	" , " , iron		D	" " 18 " " .
8	SE.	7	"	"	"	"	23	2,180	− 17	2,163			" sand	Hard, clear, iron#alkaline#		D, S	Barely sufficient for 30 head stock. Well dry in 1934.
9	SE.	10	"	"	"	Dug	22	2,130	− 18	2,112	20	2,110	" "	Hard, clear		D, S	Sufficient for 15 head stock.
10	NE.	10	"	"	"	"	20	2,100	− 10	2,190			" "	" , " , #alkaline#		D, S, I	" " 100 " " .
11	NW.	12	"	"	"	"	28	2,080	− 10	2,070	0	2,080	" "	Hard, clear		D, S	" " 10 " " .
12	SE.	14	"	"	"	Bored	25	2,115	− 17	2,098	24	2,091	" gravel	" , " , #alkaline#		D, S	Insufficient for 14 head stock; slow seepage.
13	SW.	14	"	"	"	Dug	25	2,115	− 21	2,094	15	2,100	" "	Hard, clear		D, S	Sufficient for 35 head stock.
14	NW.	15	"	"	"	Bored	32	2,120	− 8	2,112	32	2,088	" sand	" , " , #alkaline#iron		S	" " 52 " " .
15	NE.	16	"	"	"	"	60	2,125	− 45	2,080	60	2,065	" "	" , " hard, clear		S	" " 40 " " .
16	SW.	16	"	"	"	Dug	13	2,140	− 7	2,133	13	2,127	" gravel	" , " , #alkaline#		D, S	Insufficient for 16 head stock.
17	SE.	17	"	"	"	Bored	23	2,130	− 21	2,109	16	2,114	" sand	Hard, clear		D	Intermittent well.
18	NE.	20	"	"	"	Dug	12	2,130	− 8	2,122	8	2,122	" gravel	Soft, "		S	Sufficient for 20 head stock.
19	SE.	21	"	"	"	"	20	2,110	− 17	2,093	19	2,091	" "	Hard, "		D, S	" " 32 " " .
20	NW.	22	"	"	"	"	12	2,100	− 6	2,094	6	2,094	" sand	" , "		D	" " house use.
21	SE.	22	"	"	"	"	12	2,115	− 2	2,113	1	2,114	" gravel	" , "		D, S	Abundant for 30 head stock.
22	SE.	24	"	"	"	"	32	2,120	− 24	2,096	24	2,096	" sand	" , "		S	Sufficient for 50 head stock.
23	SE.	25	"	"	"	"	25	2,105	− 15	2,090			" gravel	" , " , #alkaline#		D, S	" " 15 " " .
24	SE.	28	"	"	"	Bored	40	2,110	− 30	2,080	32	2,078	" "	" , hard, clear		S	Intermittent well.
25	SW.	28	"	"	"	Dug	35	2,110	− 23	2,087			" sand	" , " #alkaline#.		D, S	Sufficient for 25 head stock.

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 94, SASKATCHEWAN

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED: Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
26	NW.	28	12	10	2	Bored	11	2,120	− 7	2,113	8	2,112	Glacial sand	Hard, clear		D, S	Sufficient for 12 head stock.
27	SE.	29	"	"	"	"	26	2,120	− 18	2,102	23	2,097	" "	" , "		D, S	" " 10 " " .
28	NE.	30	"	"	"	"	14	2,120	− 8	2,112	12	2,108	" "	" , " , "alkaline"		D, S	Insufficient for 20 head stock.
29	NE.	32	"	"	"	"	22	2,115	− 18	2,097	18	2,097	" "	" , hard, clear		D, S, I	Sufficient for 20 " " .
30	NW.	36	"	"	"	"	22	2,100	− 19	2,081	10	2,090	" gravel	" , "		D, S	Small permanent supply; house use only.
1	NW.	3	12	11	2	"	26	2,123					"	Hard, cloudy		S	Intermittent "; seepage from dugout.
2	SE.	4	"	"	"	"	42	2,105	− 4	2,101	42	2,063	" "	" , salty, clear		S	Abundant supply of highly mineralised water.
3	SW.	5	"	"	"	Dug	8	2,054	− 4	2,050			" sand	" , hard		D	Sufficient for domestic use only.
4	SE.	6	"	"	"	Bored	37	2,051	− 18.5	2,033			"	" , " , iron, "alkaline"		N	Intermittent supply; not potable.
5	SW.	7	"	"	"	"	50	2,054	− 20	2,034			"	" , " , hard, clear		S	Slow seepage; sufficient for 19 head stock.
6	SE.	8	"	"	"	"	49	2,112					"	" , " , "alkaline", iron		S	Sufficient for 30 head stock.
7	SW.	8	"	"	"	"	50	2,072					"			N	Dry hole.
8	SW.	10	"	"	"	"	60	2,142					"	" , hard, clear		S	Sufficient for 10 head stock.
9	NW.	10	"	"	"	"	32	2,152	− 8	2,144	32	2,120	"	" , " , "alkaline"		D, S	" " 400 " " .
10	SW.	17	"	"	"	"	75	2,110					"	" , hard, clear		S	" " 20 " " .
11	SW.	19	"	"	"	"	40	2,114	− 35	2,079	35	2,079	" gravel	" , iron, "		S	" " 25 " " .
12	SW.	22	"	"	"	"	40	2,178					"	" , " , "		D, S	" " 30 " " .
13	SE.	24	"	"	"	Dug	18	2,150	− 5	2,145			" clay	Soft, clear		D	" " domestic use.
14	SW.	27	"	"	"	Bored	50	2,185	− 40	2,145			"	Hard, " , "alkaline"		S	" " 16 head stock.
15	NE.	28	"	"	"	"	35	2,176	− 19	2,157			"	" , hard, clear, iron		D, S	" " 22 " " .
16	SE.	29	"	"	"	"	45	2,164	− 30	2,134			"	Hard, " , brown		D, S	" " 30 " " .
17	NW.	30	"	"	"	"	42	2,152	− 18	2,134			"	Hard, "alkaline" iron, cloudy		S	" " 20 " " in winter.
18	NE.	31	"	"	"	"	70	2,162	− 30	2,132			"	Hard, clear, "alkaline"		D, S	" " 75 " " .
19	SW.	33	"	"	"	"	40	2,166	− 25	2,141			" sand	Hard, iron, clear		D, S	" " 32 " " .
1	SW.	2	12	12	2	Dug	22	2,019	− 15	2,004			" gravel	" , hard		D, S	" " 8 " " and domestic use.
2	SW.	3	"	"	"	"	25	2,003	0	2,003			" sandy clay	" , " , "alkaline"		S	Intermittent supply.
3	SE.	5	"	"	"			2,000					"			N	Dry hole.

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

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

WELL RECORDS—RURAL MUNICIPALITY OF FILLMORE, NO. 96, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
4	NE.	5	12	12	2	Dug	22	2,035					Glacial sand	Hard, clear		D, S	Sufficient for domestic use and 35 head stock. Slow seepage.
5	SE.	6	"	"	"	"	20	1,993	- 10	1,983	10	1,983	" clay	Soft, "		D, S	Sufficient for local needs.
6	NW.	7	"	"	"	"	10	2,000	- 4	1,996	6	1,994	" gravel	Hard, "		D, S	Yields 20 tanks a day.
7	NE.	9	"	"	"	Bored	35	2,006	- 15	1,991	25	1,981	" sand	", ", iron		D, S	Sufficient for 20 head stock.
8	SE.	10	"	"	"	Dug	25	2,024	0	2,024			" clay	Soft, ", iron		D	Intermittent supply.
9	SE.	11	"	"	"	"	10	2,016	- 2	2,014	2	2,014	" sand	Soft, "		D, S, I	Abundant supply; neighbours take from well.
10	NW.	13	"	"	"	"	16	2,042					"	Hard, ", alkaline		D, S	Sufficient for 16 head stock.
11	SE.	14	"	"	"	"	21	2,038					"	", hard, iron, clear		D, S	Intermittent supply.
12	NE.	26	"	"	"	Bored	66	2,135					"	", ", alkaline, hard		S	Sufficient for 35 head stock.
13	SW.	26	"	"	"	Dug	12	2,070	- 3	2,067			" sand	Hard, clear		D, S	" " local needs.
14	SE.	27	"	"	"	Bored	26	2,065	- 18	2,047			" gravel	", ", iron	43	D, S	" " " ".
15	NE.	28	"	"	"	"	76	2,097	- 6	2,091	75	2,022	" sand	Hard, sulphur, alkaline, iron clear		D, S	Abundant supply; #.
16	SE.	29	"	"	"	Dug	13	2,038	- 10	2,028	4	2,034	" gravel	Soft, clear		D, S, I	Well cannot be pumped dry.
17	NW.	30	"	"	"			2,030					"			N	Many dry holes on this section.
18	NW.	32	"	"	"	Dug	12	2,067	- 9	2,058	7	2,060	" "	Hard, ", iron		D, S	Sufficient for 50 head stock.
19	SW.	34	"	"	"	"	7	2,121	- 5	2,116			" "	Soft, ", alkaline		D, S	" " 32 " ".
20	SE.	36	"	"	"	Bored	35	2,156					"	", hard, iron		S	Seepage water from dugout.

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

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