CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 171

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF LACADENA NO. 228 SASKATCHEWAN

By

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

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INTRODUCTION

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

Publication of Results

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

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

How to Use the Report

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

If one intends to sink a well and wishes to find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are given on the figure. Where contour lines are not shown on the figure, the elevations of adjacent wells as indicated in the Table of Well Records accompanying each report can be used. The approximate elevation of the water-bearing horizon at the well-site can be obtained from the Table of Well Records by noting the elevation of the water-bearing horizon in surrounding wells and by estimating from these known elevations its elevation at the well-site.[1] If the water-bearing horizon is in bedrock the depth to water can be estimated fairly accurately in this way. If the water-bearing horizon is in unconsolidated deposits such as gravel, sand, clay, or glacial debris, however, the estimated elevation is less reliable, because the water-bearing horizon may be inclined, or may be in lenses or in sand beds which may lie at various horizons and may be of small lateral extent. In calculating the depth to water, care should be taken that the water-bearing horizons selected from the Table of Well Records be all in the same geological horizon either in the glacial drift or in the bedrock. From the data in the Table

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[1] If the well-site is near the edge of the municipality, the map and report dealing with the adjoining municipality should be consulted in order to obtain the needed information about nearby wells.

of Well Records it is also possible to form some idea of the quality and quantity of the water likely to be found in the proposed well.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground-waters. In the Prairie Provinces, a water is usually described as "alkaline" when it contains a large amount of salts, chiefly sodium sulphate and magnesium sulphate in solution. Water that tastes strongly of common salt is described as "salty". Many "alkaline" waters may be used for stock. Most of the so-called "alkaline" waters are more correctly termed "sulphate waters".

Alluvium. Deposits of earth, clay, silt, sand, gravel, and other material on the flood-plains of modern streams and in lake beds.

Aquifer or Water-bearing Horizon. A water-bearing bed, lens, or pocket in unconsolidated deposits or in bedrock.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Cypress Hills Formation. The name given to a series of conglomerates and sand beds which occur in the southwest corner of Saskatchewan, and rests upon the Ravenscrag or older formations. The formation is 30 to 125 feet thick.

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

Whitemud Formation. The name given to a series of white, grey, and buff coloured clays and sands. The formation is 10 to 75 feet thick. At its base this formation grades in places into coarse, limy sand beds having a maximum thickness of 40 feet.

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

Bearpaw Formation. The Bearpaw consists mostly of incoherent dark grey to dark brownish grey, partly bentonitic shales, weathering light grey, or, in places where much iron is present, buff. Beds of sand occur in places in the lower part of the formation. It forms the uppermost bedrock formation over much of western and southwestern Saskatchewan and has a maximum thickness of 700 feet or somewhat more.

Belly River Formation. The Belly River consists mostly of non-marine sand, shale, and coal, and underlies the Bearpaw in the western part of the area. It passes eastward and northeastward into marine shale. The principal area of transition is in the western half of the area where the Belly River is mostly thinner than it is to the west and includes marine zones. In the southwestern corner of the area it has a thickness of several hundred feet.

Marine Shale Series. This series of beds consists of dark grey to dark brownish grey, plastic shales, and underlies the central and northeastern parts of Saskatchewan. It includes beds equivalent to the Bearpaw, Belly River, and older formations that underlie the western part of the area.

WATER-BEARING HORIZONS OF THE MUNICIPALITY

The rural municipality of Lacadena, No. 228, is an area of approximately 455 square miles in western Saskatchewan. It consists of ten full townships, described as townships 21, 22, 23, and 24, ranges 16 and 17, and townships 23 and 24, range 18; and five partial townships, described as townships 20, ranges 16 and 17, townships 21 and 22, range 18, and township 24, range 15; all west of the Third meridian. Only sections 6, 7, 18, and 19 of the last-mentioned township occur in this municipality and they are set aside as a Bird Sanctuary. South Saskatchewan river forms the southern boundary of the municipality, and the centre of the area lies approximately 132 miles north of the International Boundary line and 75 miles east of the Fourth meridian, or the Alberta-Saskatchewan border. The municipality is served by the Lacadena branch of the Canadian National railways, which trends in a northwest-southeast direction, entering the municipality in township 24, range 18, and having its terminus in township 22, range 16. On this line are located the hamlets of Tyner, Lacadena, and White Bear. The Matador branch of the Canadian Pacific railway runs in a general north-south direction along the eastern boundary of the area, and on it are located Mondou and Tuberose.

Although the maximum difference in topographic relief amounts to more than 650 feet, most of the municipality is a fairly level, slightly rolling plain. The maximum elevation of more than 2,470 feet above sea-level is attained in the hilly area in townships 24, ranges 16 and 17, and the minimum is in South Saskatchewan River valley, where the river has an elevation of 1,790 to 1,820 feet above sea-level. Other highland areas occur in the municipality, but they do not attain as great an elevation as the hills in the northern sections. A few small valleys and coulées occur in the highland areas, and during the spring months and after heavy rainfall they contain small, intermittent streams.

The banks of the South Saskatchewan valley in townships 20, ranges 16 and 17, are high and fairly steep, but along the western townships they are less steep.

Recent dune sands mantle an area in the central part of township 22, range 18, and glacial lake sands cover a narrow area surrounding the dune sand-covered area. A fairly large area in the northeastern part of the municipality is covered by moraine, and the remainder of the municipality is mantled by glacial lake clay and boulder clay or glacial till. Glacial till is exposed at the surface along the South Saskatchewan valley; in an area surrounding the moraine deposits; in parts of townships 21 and 22, range 17, and township 24, range 18; and in a few other localities. The glacial lake clay is not thought to be more than 40 feet thick at any place and is underlain by boulder clay.

It was found impossible to outline any general or continuous water-bearing horizons in either the unconsolidated deposits or the underlying bedrock in this municipality. Most of the wells appear to tap small water-bearing deposits. In general, water conditions are poor in most parts of the area, and the collection of surface water by means of dams and dugouts has become almost a necessity.

Water-bearing Horizons in the Unconsolidated Deposits

The Recent dune sands that occur in township 22, range 18, have not been tested for water, at least no records of investigation is at hand, but water should be obtained from these deposits at shallow depth. Water from dune sand in other areas is moderately soft and suitable for domestic purposes. The supply should be sufficient for ordinary farm needs.

From the information at hand it appears that the glacial lake sands are a good source of ground water. A number of wells derive water at depths of less than 20 feet from these deposits, and other wells sunk in this area should obtain water at similar depth. However, to eliminate the possibility of digging a dry hole, the proposed well site should be tested with a small auger before a well is sunk. The supply obtained from the wells sunk in the lake sands has been found sufficient for local requirements and the water is moderately hard. It is not particularly highly mineralized and most of it should be suitable for domestic purposes as well as for stock.

The glacial lake clay yields little or no water to wells, but a few shallow wells derive small supplies of hard water from scattered deposits of sand and gravel that occur near the contact of the lake clay and underlying boulder clay.

The deposits of glacial till and moraine appear to be composed of an upper zone of weathered or yellow boulder clay, which contains scattered deposits of sand and gravel, and a lower zone of unweathered or blue boulder clay which extends to the bedrock and also contains scattered deposits of sand and gravel. Most of the shallow wells in this municipality tap water-bearing deposits that occur in the weathered zone of the drift, in most places within 25 feet of the surface. The deposits do not appear to form either a general or a continuous horizon, but in a few small, isolated areas they appear to be fairly numerous. This is particularly true along the ravines and coulées. Shallow wells sunk beside undrained depressions or sloughs will in many cases yield sufficient water for domestic needs and a few head of stock, but their supply is easily affected by variations in rainfall, and during drought periods and winters they may cease to yield water. The supply from the wells tapping sand and gravel deposits varies, and some wells yield insufficient water for domestic needs, whereas others yield an abundant supply. Most of the water is fairly hard, and that from a few wells is highly mineralized, but with few exceptions it is used for domestic purposes as well as for stock.

The lower part of the drift has not proved particularly productive, but a few wells obtain water from scattered deposits of sand and gravel that occur at depths ranging from 30 to 167 feet. In no area do the deposits appear to form continuous aquifers, and wells sunk to depth in the drift may not obtain water. It would be less expensive to construct dams or excavate dugouts to retain surface water, and this is a more certain method of obtaining a supply of water. Most of the water obtained from the deeper producing wells in this municipality is very hard and highly mineralized, and that from some wells cannot be used for domestic purposes.

The supply of water from wells in this municipality is supplemented by that obtained from springs, dams, and dugouts, and by hauling. The springs occur along the river and near the base of some of the larger hills, and some of them have an abundant flow, whereas others flow during only part of the year. The flow from most of the springs can be increased if the spring be deepened, and the quantity available for use can be considerably increased by cribbing the spring or by making a reservoir to conserve the overflow. The spring waters are moderately hard, but most of them can be used for drinking as well as for stock.

Dugouts are common in most townships of this municipality, and are a successful method of retaining surface water. In some sections dams have been constructed across ravines to impound surface water. The dugouts should be excavated in natural depressions, and should be at least 12 feet deep in order to retain sufficient water for a supply that will last throughout the year. Shallow wells sunk beside the impounded water will yield sufficient water for domestic purposes. Many residents in the southern part of the municipality haul water from the river, especially for household needs. It is advisable to sink a shallow well near the river and use the water from it rather than use the river water. If the river water is used it should be filtered and boiled.

It appears that the supply of water obtained from the unconsolidated deposits does not warrant the sinking of wells to depths greater than 35 feet. If water is not derived within 35 feet of the surface at one well site, the hole should be abandoned. The use of reservoirs to conserve surface water is strongly recommended.

Water-bearing Horizons in the Bedrock

Over most of this municipality the Bearpaw formation immediately underlies the glacial drift and overlies the Belly River formation. Southwest of the geological boundary shown on Figure 1, of the accompanying map, the Bearpaw formation has been removed by erosion, and the Belly River formation underlies the drift. Both formations outcrop along the river, the Belly River being recorded as occurring at one place at an elevation of 1,837 feet above sea-level. The maximum elevation at which the Bearpaw outcrops has not been determined, and over most of the area the formation is not thought to be of great thickness. No. definite contacts of the drift and the Bearpaw formation were established, but in some areas there appears to be at least 200 feet of drift. The surface of the bedrock throughout the municipality is very uneven, and bedrock was reported at an elevation of 1,985 feet above sea-level in a dry hole on sec. 22, tp. 22, range 17, whereas it was not reported in a dry hole in section 19, in the same township at an elevation of 1,880 feet above sea-level.

No wells are definitely known to be obtaining water entirely from aquifers located within the Bearpaw formation, and it is doubtful if there are any important water-bearing horizons in this formation in the municipality. Possibly three wells, located in sec. 10, tp. 21, range 16, sec. 16, tp. 21, range 17, and sec. 12, tp. 22, range 16, are drawing from aquifers partly or wholly within this formation, but the logs of the wells obtained in the field are too indefinite to make a definite statement. The well in sec. 16, tp. 21, range 17, is assumed to be drawing water chiefly from the glacial drift. The well in sec. 10, tp. 21, range 16, is plugged with fine sand, and that in sec. 16, tp. 21, range 17, is used only for stock, whereas that in section 12, tp. 22, range 16, was used for all farm needs, but it was not in use in 1935.

Most of the wells that tap aquifers in the bedrock in this municipality obtain water from the Belly River formation. They range in depth from 172 to 468 feet, and the aquifers that they tap occur at elevations of 1,825 to 1,650 feet above sea-level. In no area do the water-bearing deposits appear to form a general or continuous wzter-bearing horizon, and dry holes have been drilled within short distances of producing wells. From the information at hand it cannot be definitely said that wells drilled into the bedrock will obtain water, although when aquifers are tapped they usually yield abundant supplies of water. The water from a few wells is soft, but that from most of them is hard. It is highly mineralized, but with few exceptions it is being used for drinking as well as for stock.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 20, Range 16

South Saskatchewan river forms the southern boundary of the municipality and only that part of this township north of the river, an area of approximately 30 square miles, is included in this report. A small part of this area is under cultivation. The river trends in an easterly direction from section 6 to section 12 and its banks are steep and dissected by many coulées or ravines, giving the surface a rough and rugged appearance. The water-level in the river is slightly less than 1,800 feet above sea-level. The surface north of the river rises in a series of rolling hills that attain an elevation of more than 2,300 feet above sea-level in the northeastern part of the township. Most of the surface is covered by glacial lake clay, but a narrow strip along the river and a small area in sections 34 and 35 are covered by glacial till or boulder clay. Boulder clay underlies the lake clay at depths ranging from a few feet to at least 30 feet.

The glacial lake clay yields little or no water, but a few scattered deposits of sand and gravel occur at or near the contact of the lake clay and the underlying boulder clay. These deposits are somewhat similar to the scattered pockets of sand and gravel that occur at or near the base of the weathered or yellow boulder clay in the areas where the glacial till outcrops at the surface. The water-bearing deposits are not continuous or numerous, but two wells tap these deposits in section 36. The deposits are thought to be more numerous in the coulées leading to the river, and also in or near undrained depressions, although wells located in these areas obtain at least part of their supply by direct seepage from surface water. In order to eliminate the chance of digging dry holes, the deposits should be located by means of a test auger before a well is sunk. The supply from the shallow wells in both the lake clay and moraine-covered areas varies, to some extent, with the amount of annual rainfall, but the wells usually yield sufficient water for domestic needs and a few head of stock. The water should be satisfactory for domestic needs. The zone of unweathered or blue boulder clay does not appear to contain many water-bearing deposits, and no producing wells obtain water from this part of the drift; in places dry holes have been sunk to depths of 90 feet.

Two wells located in sections 16 and 32, drilled to depths of 432 and 468 feet, respectively, tap sand aquifers at elevations of 1,782 and 1,747 feet above sea-level. Probably both wells were drilled through the Bearpaw formation, and it is thought that the aquifers are located within the Belly River formation. If one aquifer is common to both wells then the water-bearing bed slopes downward towards the north, but it is more probable that each well taps a localized bed or lens in the bedrock. When the wells were first drilled they yielded an abundant supply of water, but the well in section 32 is now plugged by sand and the supply from it is inadequate for local needs. The water from both wells is hard and although it is quite highly mineralized it is usable for drinking as well as for stock.

Water is also obtained from springs, dams, dugouts, and South Saskatchewan river. One spring, in section 7, yields a large supply. No doubt other springs occur along the river and tributary coulées. The quality of the water was not recorded, but it is probably suitable for stock and may be usable for drinking. Many dams and dugouts are in use, and there does not appear to be a great deal of difficulty in impounding sufficient water for stock needs. A few residents haul drinking water from the river. It would appear advisable to sink a shallow well near the river and obtain water from it rather than take it directly from the river, especially if the water is to be used for domestic purposes.

Township 20, Range 17

South Saskatchewan river flows in a general southeasterly direction and forms the southern boundary of the municipality, and only that part of this township lying northeast of the river, an area of approximately 22 square miles, occurs in the municipality of Lacadena. The slope of the river valley is very steep and is cut by many small ravines. The elevation rises gradually towards the north, and the northeastern part of the township is fairly level. Boulder clay or glacial till appears at the surface along the river bank, but elsewhere in the township it is concealed by glacial lake clay. The lake clay is not thought to be more than 30 feet thick.

The ground water conditions of the drift and bedrock have not been extensively investigated in this area. The municipality sank a well in section 33 that yielded a large supply of drinkable water and many residents hauled water from it, but it was not in use during the summer of 1935. A spring is located in section 15, and no doubt others occur along the river or coulées. It should be possible to obtain small supplies of water from shallow wells sunk in the coulées or near undrained depressions. Such well sites, however, should be prospected for water-bearing deposits by means of a test auger, in order to eliminate the chance of sinking a dry hole. A large supply of water is not to be expected from the glacial drift in this township.

Water should be derived from the bedrock, as two wells in the part of this township that lies in the municipality to the south obtain abundant supplies of soft water at depths of 185 and 299 feet. It is not known if the aquifers tapped by these wells extend to the north, but similar aquifers should occur in this part of the township.

Dams are used to impound surface water in this township, and a number of favourable locations exist for their construction. Surface water can also be collected in dugouts. Some water for stock is hauled from the river.

Township 21, Range 16

The surface of this township is gently rolling or undulating, and it is covered by glacial lake clay. Boulder clay or glacial till underlies the lake clay at depths up to 35 feet or more.

Very little information was obtained on the ground water conditions in this township, but that obtained showed that few water-bearing deposits exist in the glacial drift. Possibly wells sunk near undrained depressions or sloughs will yield sufficient water for household needs during part of the year. Surface water is collected in dugouts or impounded by dams on most farms, and water is hauled from the river or stock is pastured near the river.

The underlying bedrock has not proved particularly productive in this township and only one well in section 10 obtains water. This well is drilled to a depth of 286 feet and encountered a fine, blue sand aquifer at an elevation of 1,885 feet above sea-level. The formation in which this aquifer occurs is not definitely known, but the aquifer is thought to be located near the base of the Bearpaw formation or in the upper part of the Belly River. The areal extent of the aquifer has not been determined. The well yielded a considerable amount of water, but it has become plugged with fine sand and is no longer used. Dry holes were drilled to depths of 425 and 413 feet in sections 25 and 32. This would appear to indicate that water-bearing beds are not numerous in the bedrock in this area. Both wells encountered a hard ironstone band at an elevation of 1,725 feet above sea-level;

it could not be penetrated and drilling was suspended. Water-bearing beds may exist below this hard layer.

The uncertainty of obtaining water from the drift and bedrock in this township makes the use of dams and dugouts the most economical method of obtaining water. If the dugouts are excavated in natural depressions where the maximum amount of run-off collects, and if they are dug to depths of at least 12 feet, they should retain water throughout the greater part of the year. A shallow well sunk near a dugout or near water impounded by a dam should yield sufficient water for domestic purposes.

Township 21, Range 17

South Saskatchewan river flows across the southwestern corner of section 6. Its bank is steep and is dissected by many coulées, and the land surface rises towards the north in a series of low, rolling hills. The southern two-thirds of the township is covered by glacial lake clay, whereas the remainder is mantled by boulder clay or glacial till. Glacial till underlies the glacial lake clay.

Ground water conditions in this township are very poor. Most of the residents obtain water for stock by means of dams or dugouts, and for domestic needs by hauling from the river. Wells have been sunk in the glacial drift to a maximum depth of 126 feet, and only small quantities of highly mineralized water have been obtained. Wells sunk near undrained depressions or in the coulées should yield small supplies of water during part of the year, especially in years of normal rainfall. The glacial lake clay contains little or no water, but in places water may be obtained from water-bearing deposits that occur at the contact of the lake and the underlying boulder clay. In this township, however, such deposits are few. Deposits of sand and gravel usually occur in the yellow boulder clay of the drift, often within 30 feet of the surface, but in this township this zone has not been extensively investigated.

The boulder clay of the glacial drift that extends from the base of the yellow clay to the underlying bedrock, has been penetrated by a few wells. Water-bearing deposits, however, are not numerous and they do not form a continuous horizon, as a dry hole was sunk to a depth of 114 feet in section 4. The blue sand that forms the aquifer in the well in section 16 may possibly be part of the Bearpaw formation, but the information on this well is indefinite, and it is assumed that the aquifer is located wholly within the glacial drift.

No doubt dry holes, other than those recorded, have been sunk in this township. The conservation of surface water by the use of dams or dugouts appears to be the best method of increasing the supply of water in this township.

Township 21, Range 18

Approximately 13 square miles of this township are in the municipality of Lacadena. The river bank is steep and is dissected by many small coulées. The land above the valley is rolling and in some parts is rough. The boulder clay or glacial till in this township is concealed by lake deposits, most of which are in the form of clay, but in a small area in sections 28 and 33 they are sandy.

Small supplies of water should be derived from the glacial lake sands, but the lake clay is not thought to contain water. In many cases some water can be obtained from scattered deposits of sand and gravel that in some places occur at the contact of the lake clay and boulder clay. These deposits are not extensive, but they appear to be more numerous in the valleys and depressions than elsewhere. It is advisable, however, to locate them by means of a test auger before sinking a well, in order that a dry hole will not be dug. The 16-foot well in section 24 is the only recorded well that obtains water from the upper part of the drift. In years of normal rainfall it yields an adequate supply for local requirements and the water can be used for drinking as well as for stock.

The lower part of the drift, which consists of unweathered blue boulder clay, is not thought to contain many water-bearing deposits, but it has not been extensively investigated. A well on section 36, no longer in use, obtained hard, "alkaline" water at a depth of 132 feet. The water could be used only for stock. A dry hole was sunk to a depth of 60 feet in section 35. From the data at hand it would appear that the water-bearing deposits are scattered, and it is improbable that any water-bearing horizons of large extent will be found.

No wells have been drilled into the bedrock in that part of this township to the north of the river. South of the river dry holes were drilled to a maximum depth of 600 feet. Aquifers may occur in the bedrock but the uncertainty of encountering them may not warrant the expense of drilling deep wells.

The best method of obtaining water in this area is to conserve surface water by constructing small dams across the coulées and by excavating dugouts in natural depressions on the uplands. The dugouts should be at least 12 feet deep. Water for domestic needs can be obtained from wells sunk beside the dugouts or dams and connected to them by a filter channel. If water from the river is used for domestic purposes it should be filtered and boiled.

Township 22, Range 16

Most of the surface of this township is relatively flat and the elevation averages approximately 2,100 feet above sea-level. A shallow coulée trends in a general northerly direction through the northwestern corner of the area. The township is mantled by glacial clay except in the NW.$\frac{1}{4}$, section 31, where boulder clay occurs at the surface. The lake clay has a maximum thickness of at least 30 feet, and is underlain by boulder clay.

The ground water resources of the township have not been thoroughly investigated, but from the evidence obtained they appear to be poor. The drift does not seem to contain many water-bearing deposits, and no wells were recorded that derive a supply from the drift. Small pockets of sand and gravel might be located along the ravines and depressions. Surface water is collected by the use of dams or dugouts for the stock on most farms, and water for domestic needs is hauled. Shallow wells sunk beside the artificial reservoirs and connected to them by a filter channel should yield water that will be usable for domestic purposes.

A few wells have been sunk into the bedrock formations, but none is in use. They are located in sections 12, 20, and 35, and are sunk to depths of 200, 350, and 192 feet, respectively. Aquifers were tapped at elevations of 1,900, 1,750, and 1,825 feet above sea-level. The aquifers of the last two wells are probably located within the Belly River formation, whereas that of the first is probably in the Bearpaw formation. The areal extent of the aquifers is unknown, but the presence of dry holes in sections 12 and 17, sunk to depths of 450 and 220 feet, respectively, indicate that no water-bearing horizons of large areal extent are present. The uncertainty of obtaining water at depth makes deep drilling in this township inadvisable. The conservation of surface water by the use of dams or dugouts is highly recommended.

Township 22, Range 17

The surface of most of this township is rolling, and a low range of hills occurs in the central part. Glacial till or boulder clay appears at the surface in the highland area in the central part of the township, and in other parts glacial lake clay overlies boulder clay. The thickness of the lake clay is not thought to exceed 25 feet.

A small supply of ground water is obtained in the eastern half of the township, and most of the residents use surface water that is collected in dugouts. In the western half of the area the supply is better, and a number of wells obtain water from small deposits of gravel that are usually located within 30 feet of the surface. In the area covered by lake clay the deposits are located at or near the contact of the lake clay and the underlying boulder clay, whereas in the glacial till-covered area the deposits are located near the base of the yellow boulder clay. The water-bearing deposits appear to be fairly numerous in the coulées, but they do not form a general water-bearing horizon. In order to eliminate the expense of sinking a dry hole, the deposits should be located by means of a test auger before a final selection of a well site is made. In years of normal rainfall the shallow wells provide sufficient water for local needs, and it can be used for drinking as well as for stock.

The unweathered, blue boulder clay of the glacial drift has not been thoroughly investigated, but producing wells were sunk in the SE.¼, section 6, and the SE.¼, section 22. They are sunk to depths of 80 and 167 feet and tap aquifers at elevations of 1,895 and 2,053 feet above sea-level, respectively. It appears improbable that any general water-bearing horizons are present in this part of the drift, but scattered deposits of water-bearing sand and gravel should occur. The two producing wells yield an abundant supply, but the water obtained from the well in section 22 is too highly mineralized for drinking.

Springs are located in sections 5, 20, and 28. The flow from a spring may be increased by deepening it, and the supply available for use may be considerably augmented if the spring is cribbed or if the overflow is retained in some kind of reservoir.

The supply from the springs in sections 5 and 20 is abundant, and many residents haul drinking water from those sources. The water from the spring in section 28 is too highly mineralized to be used for drinking.

A 172-foot well in the NE.¼, section 18, taps an aquifer at an elevation of 1,768 feet above sea-level. This aquifer probably occurs within the Bearpaw formation, but part of the supply appears to be derived from the Belly River formation. The areal extent of the aquifer is not known, but the presence of a 650-foot dry hole in the SE.¼, section 22, indicates that no general water-bearing horizons of large areal extent are present. Deep drilling does not appear to be advisable, and in those areas where water is difficult to obtain the excavation of dugouts to collect and retain surface water is recommended. The dugouts should be located in natural depressions and excavated to a depth of at least 12 feet in order to retain sufficient water to last throughout the year.

Township 22, Range 18

Only the part of this township that lies to the east of South Saskatchewan river, an area of approximately 27 square miles, is within the municipality of Lacadena. The east bank of the river is not steep and the plain level is approximately 100 feet above water-level, the elevation of the river being 1,815 feet above sea-level. A range of small sand hills occurs in the central part of the township. A narrow area surrounding the dune sands and extending along the river is mantled by glacial lake sands. The remainder of the township is covered by glacial lake clay. The thickness of dune sands has not been determined, but it is improbable they are more than 20 feet thick. The lake sands are probably about the same thickness, and the lake clay may attain a thickness of 30 feet. Boulder clay or glacial till underlies the sands and lake clay forming the deposits at the surface throughout the township.

The Recent dune sands have not been investigated for water, but they should contain water at shallow depth. The water should be moderately soft and suitable for drinking as well as for stock. Almost all the shallow wells in this township derive water from the glacial lake sands. The wells are usually less than 20 feet deep and the supply obtained is sufficient for farm needs. Other wells dug in these sands should obtain water at similar depths and it should be suitable for drinking. The glacial lake clay yields little or not water, but some water may be obtained from deposits of sand and gravel that occur at or near the contact of the lake clay and the underlying boulder clay.

In the unweathered or blue boulder clay, that is, in the lower part of the glacial drift, scattered deposits of water-bearing sand and gravel may occur. A well located in section 1 probably tapped such a deposit, but it became dry. The deposits of sand and gravel in the lower part of the drift in this township do not appear to be numerous, and dry holes will probably be dug before a producing pocket is tapped. If water cannot be derived from shallow wells, dugouts should be excavated to collect and retain surface water. They should provide sufficient water for stock, and shallow wells sunk beside them will yield enough water for household purposes.

A well located in section 35 was drilled to a depth of 198 feet, and tapped an aquifer at an elevation of 1,712 feet above sea-level. This aquifer probably occurs in the Belly River formation and it does not appear to be of large areal extent as a dry hole was drilled to a depth of 350 feet in the same section. This dry hole was sunk to an elevation of 1,606 feet above sea-level. The fine sand that formed the aquifer in the 198-foot well plugged the screen and the supply was shut off. The quality of the water from this well was not recorded. Deep drilling does not appear advisable in this township, and the conservation of surface water by dugouts is the most economical method of increasing the water supply.

Township 23, Range 16

The southern part of this township is comparatively level. It is cut by a large valley that extends from section 7 to section 13, and two smaller valleys drain into the main valley from the south. In years of abundant precipitation these valleys contain intermittent streams. North of the main valley the elevation rises to approximately 2,225 feet above sea-level. Most of the northern half of the township is covered by glacial till or boulder clay, but parts of sections 32, 33, and 34 are mantled by moraine and are characterized by small hills and undrained depressions. Stones are common at the surface in the hilly areas. In the southern part of the township glacial lake clay, which is non-water-bearing, overlies boulder clay. A few water-bearing deposits, however, occur at the contact of the lake clay and boulder clay. These deposits are not continuous, but along the floors of the valleys they appear to be fairly numerous. They should be located with a small hand test auger before a well is dug. In the northern part of the township pockets of sand and gravel are widely scattered and only a few have been tapped at shallow depth. These deposits occur at or near the base of the yellow boulder clay in both the moraine and till-covered areas, at depths of usually less than 30 feet. In many places it is possible to obtain sufficient water for domestic purposes from wells sunk near undrained depressions or sloughs. These wells obtain their supply by direct seepage from surface water, but they may become dry during winters and drought periods. The shallow wells that tap pockets of water-bearing sand and gravel are more dependable, and although they do not yield large supplies of water the supply is usually sufficient for farm needs. The water from all these wells, with the exception of one, is usable for drinking as well as for stock.

The lower part of the drift, the unweathered or blue boulder clay, has not proved particularly productive in this township, and only one well, located in section 25, obtains water from it. The supply from this well is small, but the water can be used for drinking. A dry hole was sunk to a depth of 168 feet in section 28 without penetrating the drift, and in section 27 it was necessary to drill to a depth of 187 feet before water was encountered. This well may have passed through the drift. The supply of water was not sufficient and the well was filled in. If water cannot be located at shallow depth the best method of increasing the water supply is by the conservation of surface water. Favourable locations exist for the construction of small dams, and dugouts can also be excavated to collect surface water. Water might be obtained from the Belly River formation at a depth of approximately 275 feet.

Township 23, Range 17

3 The difference in topographic relief in this township is approximately 200 feet, the highest area occurring in the northeastern corner and the lowest in the valley in the south-eastern part. The valley is approximately 50 feet deep and one-half mile wide, and the banks are fairly steep and are strewn with stones. Boulder clay or glacial till appears at the surface in the northeastern corner, but elsewhere in the township it is concealed by glacial lake clay that may attain a thickness of 30 feet.

With few exceptions the only area in which water is obtained at shallow depth is in the valley in the southeastern corner of the township. Abundant supplies of water are located in this valley at depths of less than 20 feet, in deposits of sand

and gravel. The deposits may occur at the base of the lake clay, at its contact with the boulder clay; the lake clay is thought to contain little or no water. The water from some of the shallow wells is highly mineralized and is not usable for drinking.

The lower part of the drift has not proved productive in this township, and those residents who have been unable to obtain water at shallow depth have found it necessary to drill into the underlying bedrock. Prior to drilling into the bedrock it is advisable to thoroughly prospect the upper 30 feet of the drift for water-bearing deposits.

The deep wells that are drilled into the bedrock are sunk to depths of 208 to 293 feet, or to elevations of 1,775 to 1,629 feet above sea-level. Dry holes have been drilled to a maximum depth of 860 feet, or to an elevation of 1,062 feet above sea-level. This indicates that no general water-bearing horizons of large areal extent are present in the bedrock to the depths investigated, but two wells located in sections 19 and 20 appear to be obtaining water from the same aquifer. Other wells in this immediate vicinity may tap the same water-bearing horizon, but a dry hole in section 21 limits the areal extent of the aquifer in this direction. All the other wells appear to tap small, localized aquifers, and it is difficult to ascertain their possible areal extent. The supply in some wells may be partly obtained from the Bearpaw formation, but most of the aquifers are thought to be located wholly within the Belly River. The sand deposits in the Belly River formation are probably lenticular in shape, and dry holes may be drilled before a producing deposit is encountered. Most of the producing wells yield large quantities of water, which is used for drinking as well as for stock. That from two wells located in sections 19 and 20 is soft.

Township 23, Range 18

The eastern part of this township is very level, and is locally known as the "Tynor flats". The elevation rises gradually to the north where it is approximately 1,900 feet above sea-level. It rises more rapidly in the western part and reaches 1,970 feet above sea-level. The southwestern corner is hilly and South Saskatchewan river flows through part of section 6. The elevation of the river is approximately 1,826 feet above sea-level. Glacial lake clay overlies boulder clay throughout the township except in the southwest corner; glacial lake sands occur in part of section 6.

With the exception of two wells located in sections 4 and 6, and a spring in section 6, no wells derive water from the glacial drift in this township. The two wells obtain water from sand aquifers at depths of less than 20 feet. As the lake clay as a rule does not yield water it is probable that the water-bearing beds occur near the contact of the lake clay and the boulder clay. The areal extent of the sand deposits is not known, but other wells in this immediate vicinity may also obtain water. The water from both wells is used for drinking. The spring in section 6 has been deepened and cribbed, and it yields an abundant supply of water that is used by many of the residents for drinking and for stock.

No wells encounter water in the lower part of the drift, and the presence of several dry holes shows that this part of the drift contains few water-bearing deposits.

The bedrock has been tapped by a few wells in this township, but most of them did not encounter water. Producing wells are located in sections 2, 14, and 30, and are sunk to depths of 198, 204, and 167 feet, respectively. The well in section 30 may be obtaining part of its supply from the lower part of the drift, but probably most of it is obtained from the Bearpaw formation. The aquifers of the other two wells are thought to be located wholly within the Belly River formation. The wells in sections 2 and 14 may tap a common aquifer, but it is more probable that each well taps a local water-bearing deposit. The areal extent of the sand aquifers are unknown, but wells drilled in other localities may obtain water. The supply from the producing wells is more than adequate for local requirements. The water from the well in section 2 is recorded as soft, whereas that from two other wells is hard, but it can all be used for stock.

The conservation of surface water would greatly alleviate the acute shortage of water in this township. Dugouts can be excavated in natural depressions where the maximum amount of run-off water collects, and they should be at least 12 feet deep in order to retain sufficient water to last throughout the year. Shallow wells dug beside the reservoirs and connected to them by filter channels will yield sufficient water for local needs.

Township 24, Range 15

Sections 6, 7, 18, and 19 of this township are included in this municipality. These sections are reserved as a Bird Sanctuary; during years of normal rainfal they are swampy.

Township 24, Range 16

The eastern part of this township is fairly flat, the elevation ranging from 1,920 to 2,000 feet above sea-level. Most of this part is covered by glacial lake clay. All of the western half of the township and part of the eastern half are rolling and hilly, and the elevation increases from 2,050 feet in the south to more than 2,400 feet above sea-level along the northern boundary. Small ravines and undrained depressions occur throughout the hilly sections. The western 2½ miles is covered by moraine, and a strip to the east of the moraine-covered area is mantled by boulder clay or glacial till.

A few wells obtain water from sand aquifers at shallow depth. In the lake clay-covered area these sand deposits are probably located at the contact of the lake clay and boulder clay, but in the other areas they occur at or near the base of the weathered or yellow boulder clay. The deposits are fairly numerous along the ravines, but are difficult to locate in other parts of the township. It may be possible to obtain small supplies of water, sufficient for at least domestic purposes, from wells sunk near undrained depressions or sloughs. In years of normal rainfall such wells should be satisfactory, but in drought periods they may become dry. The supply from the shallow wells that tap sand aquifers is in most cases sufficient for local needs, and the water obtained from them can, with few exceptions, be used for domestic purposes.

The unweathered or blue boulder clay of the drift is fairly productive in this township, and wells ranging in depth from 33 to 85 feet are thought to be drawing water from aquifers located within this part of the drift. No correlation can be established in most places in the occurrence of the sand and gravel deposits that form the aquifers in this zone, but two wells located in sections 2 and 10 appear to tap a common aquifer. Other wells sunk in this vicinity should encounter water. The well in section 10 is now filled in. The supply from wells tapping deposits in this part of the drift is sufficient for stock needs, but the water from two wells is too highly mineralized to be used for drinking.

In areas where water is difficult to obtain, the use of dugouts is common. These artificial reservoirs should be located in natural depressions where the maximum amount of run-off water collects, and they should be at least 12 feet deep in order to retain water throughout the year. Small dams could be constructed in some parts of the township.

Township 24, Range 17

The northeastern half of this township is hilly and rolling and in part of section 35 the elevation rises to more than 2,450 feet above sea-level. The southwestern part of the township is fairly level to gently undulating, and is at an approximate elevation of 1,900 feet above sea-level. An intermittent stream flows in a small valley through parts of sections 32, 33, 34, and 35. The hilly part of this township is covered by moraine. Glacial till or boulder clay covers a narrow strip bordering the moraine-covered area, and elsewhere in the township glacial lake clay overlies boulder clay.

Only the upper part of the drift has been found to contain water-bearing deposits in this township, but very few wells have been dug. Three shallow wells obtain sufficient water for farm needs from sand and gravel aquifers. The sand and gravel deposits are not thought to be numerous in any part of the area, and dry holes may be encountered before a producing well is obtained. In order to save the expense involved in digging a dry hole the aquifer should be located by means of a test auger before the well is dug. The water from the producing wells is hard, and although somewhat highly mineralized it is used for drinking without producing any noticeable ill effects. It should be possible to obtain small supplies of water from shallow wells sunk near undrained depressions or sloughs. Such wells, however, derive their supply by direct seepage from the impounded surface water, and they are readily affected by drought conditions and may become completely dry. The water from springs in sections 25 and 32 is used for watering stock, and that from a second spring in section 25 is used both for drinking and for stock. The supply from the springs can be considerably increased if the source is dug out, and the amount of water available for use can be increased if the overflow is collected in some type of reservoir.

No water is obtained from the lower part of the drift, and dry holes have been dug to depths of 50 and 70 feet, respectively, in sections 16 and 20. No producing wells are recorded. No doubt scattered deposits of water-bearing sand and gravel occur within this part of the drift, but it is not advisable to attempt to locate them unless one is prepared to drill into the underlying bedrock. Dugouts are used at many places in the township, and are a satisfactory means of obtaining water for stock. In the hilly areas the topography may be more suitable for the construction of small dams. The dugouts should be excavated in natural depressions, and they should be at least 12 feet deep in order to retain sufficient water to last throughout the year. Shallow wells sunk beside the reservoirs will yield water for domestic needs. Water-bearing deposits may be located at depth in the Belly River bedrock formation.

Township 24, Range 18

The surface of this township is fairly level, but the difference in topographic relief is approximately 100 feet. Boulder clay or glacial till appears at the surface in the northwestern part of the township, and elsewhere glacial lake clay overlies boulder clay.

No wells obtain water from the drift in this township. The lake clay probably contains little or no water, but pockets of water-bearing sand and gravel should occur in the boulder clay. Prior to digging shallow wells, water-bearing deposits should be located with a small hand auger. Ravines and depressions are suitable locations for shallow wells. Dugouts are used to retain surface water for stock, and water for domestic use is hauled.

The glacial drift has not been thoroughly investigated, but one well was sunk to a depth of 80 feet in section 34 and yielded only a very small supply. The water became contaminated and the well was filled in. In sections 6 and 29 it was found necessary to drill into the bedrock before water was encountered. Water-bearing deposits do not appear to be numerous in the drift, and unless holes are drilled into the bedrock it is advisable to collect surface water by means of dugouts.

The two wells located in sections 6 and 29 obtain water from sand aquifers located at depths of 417 and 350 feet, respectively, or at elevations of 1,623 and 1,674 feet above sea-level. From the limited information at hand it does not appear that one aquifer is common to both wells, and probably each well taps a localized deposit of sand. The areal extent of the aquifers is unknown, but water may be obtained at similar depths in other parts of the township. The water is moderately hard and is being used for both domestic and stock needs.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL
MUNICIPALITY OF LACADENA, NO. 228, SASKATCHEWAN

Township Range West of 3rd mer.	20 16	20 17	21 16	21 17	21 18	22 16	22 17	22 18	23 16	23 17	23 18	24 16	24 17	24 18	Total No. in Municipality
Total No. of Wells in Township	9	2	5	4	3	7	18	12	9	15	11	11	8	3	117
No. of wells in bedrock	2	0	3	0	0	5	2	2	0	9	7	0	0	2	32
No. of wells in glacial drift	7	2	2	4	3	2	16	10	9	6	4	11	8	1	85
No. of wells in alluvium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permanency of Water Supply															
No. with permanent supply	6	2	1	3	2	3	16	9	8	11	7	11	6	3	88
No. with intermittent supply	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
No. dry holes	3	0	4	1	1	4	2	2	1	4	4	0	2	0	28
Types of Wells															
No. of flowing artesian wells	1	0	0	0	0	0	2	0	0	0	1	1	2	0	7
No. of non-flowing artesian wells	2	0	1	2	1	3	3	1	0	6	4	4	0	2	29
No. of non-artesian wells	3	2	0	1	1	0	11	9	8	5	2	6	4	1	53
Quality of Water															
No. with hard water	6	2	1	3	2	3	15	8	8	6	6	11	5	3	79
No. with soft water	0	0	0	0	0	0	1	2	0	5	1	0	1	0	10
No. with salty water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Depths of Wells															
No. from 0 to 50 feet deep	5	2	0	1	1	1	14	9	6	6	4	7	7	0	63
No. from 51 to 100 feet deep	2	0	1	1	1	0	1	0	1	0	0	4	1	1	13
No. from 101 to 150 feet deep	0	0	1	2	1	0	0	1	0	0	0	0	0	0	5
No. from 151 to 200 feet deep	0	0	0	0	0	2	2	1	2	0	2	0	0	0	9
No. from 201 to 500 feet deep	2	0	3	0	0	4	0	1	0	8	5	0	0	2	25
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
How the Water is used															
No. usable for domestic purposes	5	2	1	1	1	1	12	7	6	9	7	7	2	2	63
No. not usable for domestic purposes	1	0	0	2	1	2	4	3	2	2	0	4	4	1	26
No. usable for stock	5	2	1	3	2	3	16	10	8	10	7	10	6	3	86
No. not usable for stock	1	0	0	0	0	0	0	0	0	1	0	1	0	0	3
Sufficiency of Water Supply															
No. sufficient for domestic needs	4	2	0	3	0	3	14	9	7	11	6	11	6	2	78
No. insufficient for domestic needs	2	0	1	0	2	0	2	1	1	0	1	0	0	1	11
No. sufficient for stock needs	4	2	0	3	1	3	13	8	7	10	6	11	4	2	74
No. insufficient for stock needs	2	0	1	0	1	0	3	2	1	1	1	0	2	1	15

ANALYSES AND QUALITY OF WATER

General Statement

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

Total Dissolved Mineral Solids

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

Mineral Substances Present

Calcium and Magnesium

The calcium (Ca) and magnesium (Mg) content of water is dissolved from rocks and soils, but mostly from limestone, dolomite, and gypsum. The calcium and magnesium salts impart hardness to water. The magnesium salts are laxative, especially magnesium sulphate (Epsom salts, $MgSO_4$), and they are more detrimental to health than the lime or calcium salts. The calcium salts have no laxative or other deleterious effects. The scale found on the inside of steam boilders and tea-kettles is formed from these mineral salts.

Sodium

The salts of sodium are next in importance to those of calcium and magnesium. Of these, sodium sulphate (Glauber's salt, Na_2SO_4) is usually in excess of sodium chloride (common salt, NaCl). These sodium salts are dissolved from rocks and soils. When there is a large amount of sodium sulphate present the water is laxative and unfit for domestic use. Sodium carbonate (Na_2CO_3) "black alkali", sodium sulphate "white alkali", and sodium chloride are injurious to vegetation.

Sulphates

Sulphates (SO_4) are one of the common constituents of natural water. The sulphate salts most commonly found are sodium sulphate, magnesium sulphate, and calcium sulphate ($CaSO_4$). When the water contains large quantities of the sulphate of sodium it is injurious to vegetation.

Chlorides

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

Iron

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

Hardness

Calcium and magnesium salts impart hardness to water. Hardness of water is commonly recognized by its soap-destroying powers as shown by the difficulty of obtaining lather with soap. The total hardness of a water is the hardness of the water in its original state. Total hardness is divided into "permanent hardness" and "temporary hardness". Permanent hardness is the hardness of the water remaining after the sample has been boiled and it represents the amount of mineral salts that cannot be removed by boiling. Temporary hardness is the difference between the total hardness and the permanent hardness and represents the amount of mineral salts that can be removed by boiling. Temporary hardness is due mainly to the bicarbonates of calcium and magnesium and iron, and permanent hardness to the sulphates and chlorides of calcium and magnesium. The permanent hardness can be partly eliminated by adding simple chemical softeners such as ammonia or sodium carbonate, or many prepared softeners. Water that contains a large amount of sodium carbonate and small amounts of calcium and magnesium salts is soft, but if the calcium and magnesium salts are present in large amounts the water is hard. Water that has a total hardness of 300 parts per million or more is usually classed as excessively hard. Many of the Saskatchewan water samples have a total hardness greatly in excess of 300 parts per million; when the total hardness exceeded 3,000 parts per million no exact hardness determination was made. Also no determination for temporary hardness was made on waters having a total hardness less than 50 parts per million. As the determinations of the soap hardness in some cases were made after the samples had been stored for some time, the temporary hardness of some of the waters as they come from the wells probably is higher than that given in the table of analyses.

Analyses of Water Samples from the Municipality of Lacadena, No. 228, Saskatchewan

	LOCATION					Depth of Well, Ft.	Total disv'd solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS								Source of Water
No.	Qtr.	Sec	Tp.	Rge	Mer.			Total	Perm.	Temp	Cl.	Alka-linity	CaO	MgO	SO_4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	
1	SE.	16	20	16	3	432	1,774															(2)		(1)	* 2
2	NW.	21	22	17	3	16	620	700	650	50	9	440	155	110	111	9	566	277		137	137		3	15	* 1
3	NW.	13	23	17	3	245	1,620	900	800	100	49	435	320	144	738	212	1,520	435	187		428		389	81	* 2
4	SE.	29	24	18	3	350	1,220	800	700	100	47	510	240	133	418	156	1,139	430		67	301		264	77	* 2

Water samples indicated thus, * 1, are from glacial drift or other unconsolidated deposits.
Water samples indicated thus, * 2, are from bedrock, Belly River formation.
Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5) are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water.
Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).
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

Only one sample of water from the unconsolidated deposits in the municipality of Lacadena was analysed. The water from the glacial drift varies greatly in quality and the striking of water unfit for use at one locality does not necessarily indicate widespread conditions.

The water that is derived from the glacial lake sands is reported to be moderately soft, and is usable for all farm needs. It will be found in many cases that water from large deposits of sand or gravel that lie near or outcrop at the surface does not contain a large amount of dissolved mineral salts in solution, as the water does not come into contact with clay, the source of most of the dissolved mineral salts in water from the drift. Care should be taken to see that the water from wells tapping deposits of sand that outcrop at the surface does not become contaminated by polluted surface water. The water from the springs in this area is more highly mineralized than that from the lake sands, but it is suitable for stock and most of it is used for domestic needs.

Sample 2 is of water from the upper part of the glacial drift. It contains 620 parts per million of dissolved solids, is very hard, but is usable for all farm needs. This sample may be representative of water from shallow wells that tap large deposits of sand or gravel, but that from small water-bearing deposits usually contains considerably more mineral salts in solution. The water from most shallow wells in this municipality can be used for drinking, and all of it is suitable for stock.

The water from the lower part of the drift is more highly mineralized, as it comes into contact with a large amount of clay. It is reported as being hard and "alkaline", and that from some wells contains a considerable amount of iron. The water is in many cases used for stock, but only that from approximately half the wells can be used for domestic purposes. The water that cannot be used for drinking probably contains at least 2,500 parts per million of dissolved solids, and the greater percentage will be composed of the laxative producing salts, magnesium sulphate and sodium sulphate.

Water from the Bedrock

No samples of water from the Bearpaw formation were analysed. Two wells, located in sec. 10, tp. 21, range 16, and sec. 12, tp. 22, range 16, probably derived water from this formation, but are not in use. The water is reported to have been used for all farm purposes without any apparent ill effects. It probably is quite highly mineralized.

Three samples of water from the Belly River formation were analysed and the results are listed in the accompanying table. Samples 3 and 4 are quite hard, but are not very highly mineralized. They are suitable for stock, and are being used for drinking with no apparent ill effects. Sample 1 is also being used, but it may have a slightly salty taste. The water from three wells that tap this formation is soft, contains a large amount of sodium salts in solution, and may have a "baking soda" taste. Iron is reported in the water from some of the wells. The water from the Belly River formation in this municipality will be suitable for stock, and that from at least ten wells is being used for drinking. It will have injurious effects on vegetation if used continually for irrigation, as it contains a considerable amount of sodium carbonate (black alkali) in solution.

WELL RECORDS—Rural Municipality of LACADENA, NO. 228, 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	NE.	7	20	16	3	Spring		1,900					Glacial gravel				This is a flowing spring.
2	NW.	15	"	"	"	Bored	90	2,195									Dry hole; base in glacial drift.
3	SE.	16	"	"	"	Drilled	432	2,214	-375	1,839	432	1,782	Belly River sand	Hard, brown sediment		D, S	Abundant supply.
4	SE.	20	"	"	"	Bored	80	2,225									Dry hole; base in glacial drift.
5	NE.	25	"	"	"	Bored	44	2,345									Dry hole; base in glacial drift; 22-foot well unused.
6	SE.	32	"	"	"	Drilled	468	2,215	-418	1,797	468	1,747	Belly River	Hard, brown sediment		D, S	Now completely choked with sand.
7	SW.	36	"	"	"	Dug	14	2,220	- 12	2,208	12	2,208	Glacial gravel	Hard		D	Small supply.
8	NW.	36	"	"	"	Dug	20	2,270	- 15	2,255	15	2,255	Glacial fine sand	Hard		D, S	Sufficient; supplies many neighbours.
1	NW.	15	20	17	3	Spring		2,000					Glacial drift	Hard, iron			
2	NW.	33	"	"	"	Dug	12	2,026	- 4	2,022	4	2,022	Glacial fine sand	Hard, black sediment		D, S, M	Was sufficient; not used at present; in need of repair.
1	SW.	2	21	16	3	Dug	60	2,160									Dry hole; base in glacial drift.
2	SE.	10	"	"	"	Drilled	286	2,171	-100	2,071	286	1,885	Bearpaw (?)	Hard		N	Plugged with quicksand.
3	SE.	15	"	"	"	Drilled	110	2,186									Dry hole; base in glacial drift.
4	NW.	25	"	"	"	Drilled	425	2,150									Dry hole; base in Belly River.
5	NE.	32	"	"	"	Drilled	413	2,125									Dry hole; base in Belly River.
1	SW.	4	21	17	3	Bored	114	2,196									Dry hole; base in glacial drift; has large stock watering dam.
2	SW.	16	"	"	"	Drilled	126	2,079	- 89	1,990	126	1,953	Glacial(?)drift	Hard, iron, "alkaline"		S	Hauls domestic supply.
3	NE.	17	"	"	"	Dug	36	2,056	- 31	2,025	31	2,025	Glacial drift	Hard, "alkaline"		S	Sufficient supply; not suitable for human consumption.
4	SE.	19	"	"	"	Bored	72	2,086	- 47	2,039	72	2,014	Glacial drift	Hard, "alkaline"		D, S	Not used at present; needs cleaning.
1	NW.	24	21	18	3	Dug	16	2,011	- 10	2,001	10	2,001	Glacial sand	Hard		D, S	Insufficient in dry years.
2	NW.	35	"	"	"	Bored	60	1,909									Dry hole; base in glacial drift.
3	NW.	36	"	"	"	Bored	132	2,091			132	1,959	Glacial drift	Hard, "alkaline"		S	Unused now; used to water 72 head stock.
1	SE.	2	22	16	3	Bored	35	2,117									Dry hole; base in Belly River.
2	SW.	12	"	"	"	Drilled	450	2,110									Dry hole; base in Belly River.
3	SW.	12	"	"	"	Drilled	200	2,100	-140	1,960	200	1,900	Bearpaw (?)	Hard		D, S	Ample supply; no longer used.
4	SE.	17	"	"	"	Drilled	216	2,100									Dry hole; base in Bearpaw (?).
5	SE.	17	"	"	"	Drilled	220	2,100									Dry hole; base in glacial drift.

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 LACADENA, NO. 228, 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
6	NE.	20	22	16	3	Drilled	350	2,100	-270	1,830	350	1,750	Belly River	Hard		S	Sufficient supply.
7	NW.	35	"	"	"	Drilled	192	2,017	-140	1,877	192	1,825	Belly River (?)	Hard, soda		S	Abundant supply; not used at present.
1	SW.	5	22	17	3	Spring		1,953						Hard		D, S	Abundant supply; supplies neighbours.
2	SE.	6	"	"	"	Bored	80	1,975	- 40	1,935	80	1,895	Glacial fine sand	Hard		D, S	Sufficient supply.
3	SW.	6	"	"	"	Dug	10	1,960	- 5	1,955	5	1,955	Glacial drift	Hard, "alkaline"			Insufficient supply.
4	NW.	18	"	"	"	Dug	30	1,940	- 18	1,922	18	1,922	Glacial drift	Hard		D, S	Insufficient supply.
5	NW.	18	"	"	"	Bored	172	1,940	-150	1,790	172	1,768	Belly River (?)	Hard		S	Not used at present; dugout.
6	SW.	19	"	"	"	Dug	38	1,918									Dry hole; base in glacial drift; hauls all water.
7	NE.	19	"	"	"	Dug	14	1,902	- 10	1,892	10	1,892	Glacial gravel	Hard, "alkaline"		D, S	Sufficient supply.
8	SE.	20	"	"	"	Flowing Spring		1,927						Hard		D, S	Ample supply; flows all year.
9	NW.	21	"	"	"	Dug	16	2,110	- 8	2,102	8	2,102	Glacial sand and gravel	Hard		D, S	Sufficient supply; waters 8 horses; #.
10	SE.	22	"	"	"	Drilled	167	2,220	-155	2,065	167	2,053	Glacial gravel	Hard, iron, "alkaline"		S	Ample supply.
11	SE.	22	"	"	"	Drilled	650	2,285									Dry hole; base in Belly River.
12	NW.	28	"	"	"	Dug	20	2,063	- 9	2,054	9	2,054	Glacial gravel	Hard, iron, slightly "alkaline"		D, S	Insufficient supply.
13	NW.	28	"	"	"	Spring		2,078					Glacial drift	Soft		S	
14	SE.	30	"	"	"	Bored	7	1,903	- 4	1,899	4	1,899	Glacial gravel	Hard		D, S	Sufficient only for house use; 20-foot well waters stock.
15	SE.	32	"	"	"	Dug	12	1,899	- 5	1,894	5	1,894	Glacial gravel	Hard, slightly "alkaline"		D, S	Sufficient for 50 head stock.
16	NW.	32	"	"	"	Dug	12	1,895					Glacial drift	"Alkaline"			Ample supply.
17	SE.	33	"	"	"	Dug	8	2,013	- 5	2,008	5	2,008	Glacial gravel	Hard		D, S	Sufficient supply.
1	SW.	1	22	18	3	Bored	120	2,015	- 92	1,923	120	1,895	Glacial coarse gravel	Hard, "alkaline"		S	Intermittent supply; now dry.
2	NW.	2	"	"	"	Dug	14	1,840	- 10	1,830	10	1,830	Glacial sand	Soft		D, S	Sufficient supply.
3	SE.	4	"	"	"	Dug	18	1,835	- 16	1,819	16	1,819	Glacial sand	Hard		D, S	Sufficient supply.
4	NE.	4	"	"	"	Dug	18	1,831	- 16	1,815	16	1,815	Glacial fine sand	Hard, iron		D, S	Sufficient; waters 50 head stock.
5	SE.	9	"	"	"	Dug	16	1,827	- 14	1,813	14	1,813	Glacial sand	Hard		D, S	Sufficient supply.
6	SW.	12	"	"	"	Dug	15	1,960	- 10	1,950	10	1,950	Glacial gravel	Hard,		D, S	Sufficient supply.
7	SE.	13	"	"	"	Bored	32	1,925									Dry hole; base in glacial drift.

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 LACADENA, NO. 228, 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
8	NE.	33	22	18	3	Dugout	7	1,937	- 3	1,934	3	1,934	Glacial sand	Soft		S	Sufficient supply.
9	SW.	34	"	"	"	Dug	14	1,833	- 9	1,824	9	1,824	Glacial sand	Hard		D, S	Sufficient for 15 head stock.
10	NW.	34	"	"	"	Dug	14	1,925	- 10	1,915	10	1,915	Glacial fine sand	Hard		D, S	Sufficient for 8 head stock.
11	NE.	35	"	"	"	Drilled	198	1,910	-138	1,772	198	1,712	Belly River	Hard		N	Plugged with sand.
12	NE.	35	"	"	"	Drilled	304	1,910									Dry hole; base in Belly River.
1	SW.	5	23	16	3	Dug	10	1,935	- 7	1,928	7	1,928	Glacial gravel	Hard		D, S, M	Sufficient supply.
2	NW.	5	"	"	"	Dug	15	1,930	- 11	1,919	11	1,919	Glacial gravel	Hard		D, S	Sufficient supply; not now in use.
3	NW.	7	"	"	"	Dug	8	1,920	- 2	1,918	2	1,918	Glacial fine sand	Hard		D, S	Sufficient supply.
4	NW.	11	"	"	"	Dug	22	1,940	- 18	1,922	18	1,922	Glacial sand	Hard		D, S	Sufficient; yields 10 barrels daily.
5	NE.	25	"	"	"	Bored	60	1,913	- 50	1,863	50	1,863	Glacial drift	Hard, iron		D, S	Insufficient; dugout in valley yields large supply.
6	SW.	27	"	"	"	Bored	187	2,041	-185	1,856	185	1,856	Glacial sand (?)	Hard, iron		S	Insufficient; now filled in.
7	SW.	28	"	"	"	Bored	168	2,223									Dry hole; base in glacial drift.
8	NW.	28	"	"	"	Dug	30	2,123	- 26	2,097	26	2,097	Glacial fine sand	Hard		S	Waters stock; dugout supplies house and stock.
9	NW.	35	"	"	"	Dug	25	2,037	- 20	2,017	20	2,017	Glacial drift	Hard		D, S	Was sufficient; now caved in.
1	SE.	3	23	17	3	Dug	12	2,055	- 1	2,054	1	2,054	Glacial sand	Soft		D, S	Yields 100 barrels daily.
2	SW.	3	"	"	"	Dug	20	2,030	- 11	2,019	20	2,010	Glacial gravel	Hard, "alkaline"		D, S	Abundant supply.
3	SW.	4	"	"	"	Drilled	208	1,910	- 47	1,863	208	1,702	Belly River (?)	Hard, "alkaline"		D, S	Sufficient supply; small requirements.
4	SW.	6	"	"	"	Bored	25	1,882	- 20	1,862	20	1,862	Glacial sand	Hard, "alkaline"		N	Not suitable for humans.
5	NW.	12	"	"	"	Dug	12	1,910	- 8	1,902	8	1,902	Glacial fine sand	Soft		D, S	Sufficient supply.
6	NW.	12	"	"	"	Dug	13	1,910	- 7	1,903	7	1,903	Glacial fine sand	Hard		S	Sufficient supply.
7	NW.	12	"	"	"	Dug	8	1,950	- 5	1,945	5	1,945	Glacial sand	Soft		D, S	Sufficient supply; no longer used.
8	NW.	13	"	"	"	Drilled	245	2,020	-232	1,788	245	1,775	Belly River (K)	Hard, iron, cloudy		D, S	Sufficient supply; #.
9	SE.	17	"	"	"	Drilled	448	1,935									Dry hole; base in Belly River.
10	SE.	17	"	"	"	Drilled	246	1,935									Dry hole; base in Belly River.
11	NE.	19	"	"	"	Drilled	265	1,915	-130	1,785	265	1,650	Belly River	Soft		D, S	Abundant supply.
12	NE.	20	"	"	"	Drilled	293	1,956	-233	1,723	293	1,663	Belly River	Soft		D, S	Abundant supply.
13	NW.	21	"	"	"	Drilled	560	1,922									Dry hole; base in Belly River.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of LACADENA, NO. 228, 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
14	NE.	32	23	17	3	Drilled	290	1,916	− 80	1,836	290	1,626	Belly River	Hard		D	Plugged with sand.
15	NE.	32	"	"	"	Drilled	490	1,916									Dry hole; base in Belly River.
1	SW.	2	23	18	3	Bored	198	1,918	−140	1,778	198	1,720	Belly River (?)	Soft, soda		D, S	Sufficient for 10 head stock.
2	SE.	4	"	"	"	Dug	16	1,971	− 10	1,961	10	1,961	Glacial sand	Hard		D, S	Sufficient; yields 11 barrels at a time.
3	NE.	6	"	"	"	Spring		1,900								D, S, M	Abundant supply.
4	NW.	6	"	"	"	Bored	12	1,910	− 9	1,901	9	1,901	Glacial quick-sand	Medium hard		D, S	Abundant supply.
5	NW.	8	"	"	"	Bored	162	1,950	−151	1,799	162	1,788	Belly River (?)	Medium hard			Caved in.
6	SE.	14	"	"	"	Drilled	204	1,900	−140	1,760	204	1,696	Belly River	Hard		D, S	Abundant supply.
7	SW.	19	"	"	"	Bored	50	1,965									Dry hole; base in glacial (?) drift.
8	SE.	23	"	"	"	Dug	225	1,925									Dry hole; base in Belly River.
9	NW.	30	"	"	"	Drilled	167	2,000	−137	1,863	167	1,833	Bedrock (?)	Hard, iron		D, S	
10	NE.	34	"	"	"	Drilled	269	1,904									Dry hole; base in Belly River.
11	NE.	34	"	"	"	Drilled	291										Dry hole; base in Belly River.
1	NW.	2	24	16	3	Drilled	85	1,933	− 70	1,863	70	1,863	Glacial sand	Hard		S	Supplies 12 horses; drinking water hauled.
2	SW.	3	"	"	"	Dug	20	2,052	− 10	2,042	20	2,032	Glacial fine sand	Medium hard		D, S	Sufficient supply.
3	NW.	4	"	"	"	Dug	33	2,087	− 21	2,066	33	2,054	Glacial sand	Hard		D, S	Sufficient supply.
4	NE.	9	"	"	"	Dug	8	2,067	0	2,067			Glacial sand	Hard, iron		S	Abundant supply; spring-fed; also a flowing spring.
5	SE.	10	"	"	"	Bored	76	1,924	− 65	1,859	76	1,848	Glacial sand	Hard			Well became contaminated and was filled in.
6	NW.	12	"	"	"	Dug	46	2,060					Glacial sand	Hard		D, S	
7	SE.	21	"	"	"	Spring		1,980					Glacial drift	Hard, iron		S	Insufficient supply.
8	SW.	22	"	"	"	Bored	64	1,988	− 48	1,940	64	1,924	Glacial drift	Hard		D, S	Sufficient for 7 head stock.
9	SE.	24	"	"	"	Dug	15	1,936	− 7	1,929	7	1,929	Glacial sand	Hard		D, S, M	Sufficient supply.
10	NW.	24	"	"	"	Bored	60	1,967	− 56	1,911	56	1,911	Glacial sand	Hard		S	Yields 2 barrels an hour.
1	SE.	16	24	17	3	Dug	14	1,900	− 7	1,893	7	1,893	Glacial gravel	Hard		D	Sufficient supply.
2	NW.	16	"	"	"	Bored	50	1,890									Dry hole; base in glacial drift; dugout for stock; hauls domestic supply.
3	NE.	20	"	"	"	Bored	70	1,895									Dry hole; base in glacial drift.
4	NW.	21	"	"	"	Dug	7	1,928	0	1,928			Glacial drift	Hard, iron		S	Sufficient for 50 head stock.

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WELL RECORDS—Rural Municipality of LACADENA, NO. 228, 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
5	SE.	25	24	17	3	Spring		2,350					Glacial drift	Soft, iron		D, S	
6	SW.	25	"	"	"	Flowing Spring		2,325					Glacial drift	Hard		S	
7	SW.	30	"	"	"	Dug	20	1,900	- 16	1,884	16	1,884	Glacial sand	Hard, "alkaline"		S	Insufficient in dry years.
8	SE.	32	"	"	"	Flowing Spring							Glacial drift	Hard, "alkaline"		S	Abundant supply.
1	NE.	6	24	18	3	Drilled	417	2,040	-180	1,860	417	1,623	Belly River	Hard		D, S	Sufficient supply.
2	SE.	29	"	"	"	Drilled	350	2,024	-100	1,924	350	1,674	Belly River	Medium hard		D, S	Sufficient supply; #.
3	NW.	34	"	"	"	Bored	80	1,900	- 78	1,822	78	1,822	Glacial drift	Hard		D, S	Small supply; became contaminated; filled in.

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.