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CANADA

DEPARTMENT OF MINES

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TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 317

GROUND-WATER RESOURCES OF TOWNSHIPS 35 to 38; RANGES 1 to 4; WEST OF 5th MERIDIAN, ALBERTA

(Markerville Area)

By

A. Mac S. Stalker

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1953

NOTE:

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

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INTRODUCTION

The survey of the ground-water resources of the Red Deer region, Alberta, was resumed during the field season of 1946, and much information on these resources was obtained by a compilation of records of water wells.

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

Publication of Results

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

How to Use the Report

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

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

GLOSSARY OF TERMS USED

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(1) Wells in which the water is under sufficient pressure to flow above the surface of the ground.

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

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

BEDROCK FORMATIONS OF EAST-CENTRAL ALBERTA

The formations that outcrop in east-central Alberta are of Tertiary and Upper Cretaceous age, and consist entirely of relatively soft shales and sandstones, with some bands of hard sandstone and layers of ironstone nodules. The succession, character, and estimated thickness of the formations are shown in the following table:

Age	Formation	Character	Thickness Feet
Tertiary	Paskapoo	Light grey sandstone, in part carbonaceous; shale; small amounts of siliceous limestone and volcanic dust; coal seams.	800 ±
Upper Cretaceous	Edmonton	Grey to white, bentonitic sands and sandstones, with grey and greenish shales; coal seams prominent in some areas, as at Drumheller.	1,000 to 1,150
	Bearpaw	Dark shales, green sands with smooth, black chert pebbles; partly non-marine, with white bentonic sands, carbonaceous shales, or thin coal seams similar to those in Pale Beds; shales at certain horizons contain lobster-claw nodules and marine fossils; at other horizons selenite crystals are abundant.	300 to 600
	Pale and Variegated Beds	Light grey sands with bentonite; soft, dark grey and light grey shales with selenite and ironstone; carbonaceous shales and coal seams; abundant selenite crystals in certain layers.	600 ±
	Birch Lake (?)	Grey sand and sandstone in upper part; middle part of shales and sandy shales, thinly laminated; lower part with grey and yellow weathering sands; oyster bed commonly at base.	100 ±
	Grizzly Bear	Mostly dark grey shale of marine origin, with a few minor sand horizons; selenite crystals and nodules up to 6 or 8 inches in diameter.	100 -
	Ribstone Creek	Grey sands and sandstones at the top and bottom with intermediate sands and shales; mostly non-marine, but middle shale in some areas is marine.	325 -

WATER ANALYSES

Introduction

The following discussion of water analyses is included to assist those who wish to know the effect of various mineral constituents in well water, which give the water in some wells certain peculiar qualities.

Discussion of Chemical Determinations

The dissolved mineral constituents vary with the material encountered by the water in its migration to the reservoir bed. The mineral salts present are referred to as the total dissolved solids, and they represent the residue when the water is completely evaporated. This is expressed quantitatively as "parts per million", which refers to the proportion by weight in 1,000,000 parts of water. A salt when dissolved in water separates into two chemical units called "radicals", and these are expressed as such in the chemical analyses. In the one group is included the metallic elements of calcium (Ca), magnesium (Mg), and sodium (Na), and in the other group are the sulphate (SO_4), chloride (Cl), and carbonate (CO_3) radicals.

Mineral Constituents Present

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

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

Sodium (Na) is derived from a number of important rock-forming minerals, so that sodium sulphate and carbonate are very common in ground waters. Sodium sulphate (Na_2SO_4) combines with water to form "Glauber's salts", which if present in amounts over 1,200 parts per million makes the water unfit for domestic use or for irrigation. Sodium carbonate (Na_2CO_3) or "black alkali" waters are mostly soft, the degree of softness depending upon the ratio of sodium carbonate to the calcium and magnesium salts. Waters containing sodium carbonate in excess of 200 parts per million are unsuitable for irrigation.

Chlorine (Cl) is, with a few exceptions, expressed as sodium chloride (NaCl), which is common table salt. When found in water in excess of 400 parts per million it renders the water unfit for domestic use.

Iron, when present in more than 0.1 parts per million, will settle out of the water as a red precipitate on exposure to the air. Water that contains not more than 0.5 parts per million is considered the usual upper limit for potable water, but this amount is often exceeded. A water that contains considerable iron will stain porcelain, enamel ware, and clothing that is washed in it, but the iron can be almost completely removed by aeration and filtration of the water.

Hardness. Hardness is of two kinds, temporary and permanent. Temporary hardness is caused by calcium and magnesium bicarbonates, which are soluble in water but are precipitated as insoluble normal carbonates by boiling, as shown by the scale that forms in teakettles. Permanent hardness is caused by the presence of calcium and magnesium sulphates, and is not removed by boiling. Waters grade from very soft to very hard, and can be classified according to the following system[1].

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[1] The "Examination of Waters and Water Supplies"; Thresh and Beale, Fourth Ed. 1933, p. 21.

A water under 50 degrees (that is, parts per million) of hardness may be said to be very soft.

A water with 50 to 100 degrees of hardness may be said to be moderately soft.

A water with 100 to 150 degrees of hardness may be said to be moderately hard.

A water with more than 200 and less than 300 degrees of hardness may be said to be hard.

A water with more than 300 degrees of hardness may be said to be very hard.

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

In soft water the calcium carbonate has been replaced by sodium carbonate, due to natural reagents present in the sands and clays. Bentonite and glauconite are two such reagents known to be present. Montmorillonite, one of the clay-forming minerals, has the same property of softening water, owing to the absorbed sodium that is available for chemical reaction.[2]

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[2] Piper, A.M.: "Ground Water in Southern Pennsylvannia", Penn. Geol. Surv., 4th series.

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

TOWNSHIPS 35 TO 38, RANGES 1 TO 4, WEST 5TH MERIDIAN, ALBERTA (Markerville Area)

Introduction

The investigation of ground-water resources in Alberta was continued during the summer of 1950 by the writer, ably assisted by K. F. Pallett. The surficial material was also mapped, and the relation of both it and the underlying bedrock to the ground-water supply studied.

Physical Features

Red Deer River flows through the southern townships of the area and three rivers are tributary to it in this section of its course. The Little Red Deer enters from the south, Medicine River enters from the north, and Raven River joins it from the west.

As Red Deer River rises in the Rocky Mountains, it has a fair volume of water all year, but is particularly high when the snow melts in the mountains in June and July. It flows through the area in an old valley 100 feet deep, and has a gradient greater than 10 feet to a mile. It enters the area in a wide, braided channel, with large gravel deposits and a wide flood plain, and much of its water seeps through the gravel. In the east of the area the current is slower, the valley narrower, and the river has lost much of the heavy load derived from the mountains. Little Red Deer River has a gradient of 15 or 20 feet to a mile and maintains a fairly even volume of water all summer. Its valley is steep-walled, and increases rapidly in depth from a few feet to 110 feet near where it joins the Red Deer. The meandering Medicine River rises locally. It floods in spring, but practically disappears during the summer. This river differs markedly from the others, as it has only the low gradient of about 1½ feet to a mile, and during most of the year is slow flowing. Its valley appears old, and the land slopes towards the river for many miles on either side. Raven River is a small, meandering stream that occupies only a small part of a valley several miles wide and 100 or 200 feet deep. Its large valley and the considerable amounts of alluvium present indicate that a large river, perhaps the Clearwater, once flowed in this valley.

Among the other valleys of importance, one, floored with thick alluvium, is occupied by Dickson Creek. Another large one, occupied by Tindaston Creek in the lower reaches, extends north to Cygnet and Sylvan Lakes. Many other valleys not now used by streams are present, mainly in the southwest. Most of these, formed during the retreat of the last ice or in interglacial time, trend southeastward. Gravel is generally present near such valleys.

The topography of the area may be divided conveniently into three parts. The first is the hilly, rolling area of the northeast with its many small valleys and with bedrock shallow. Most of this area lies at an elevation between 3,150 and 3,250 feet above sea-level. The second division includes the area along Medicine River and in the southeast. The surface of this division is smoother than that of the first, as it has undergone stream erosion, followed by deposition of fairly flat-lying ground moraine, and later by sediments laid down in glacial lakes. This area lies mostly between 3,000 and 3,150 feet above sea-level, the highest parts being most remote from Medicine and Red Deer Rivers. The third division comprises the land lying west and southwest of Medicine Valley. Its northern part is characteristically rolling, with hills 10 to 25 feet high, whereas the southern part is typically an area of parallel, broad, southeast-trending valleys and rough sand dunes. It lies mostly between 3,200 and 3,300 feet elevation but rises to 3,700 feet in the southwest. The surficial material is thickest in this division.

The largest lake wholly in the area is Cygnet Lake, but an end of Sylvan Lake juts in from the north. No other large lakes are present, and the area, except in the west where swamps are common, is mostly well drained.

Geology

The entire area is mantled by various thicknesses of drift or alluvium. The bedrock immediately under the drift is Paskapoo formation, and the underlying Edmonton formation is too deep, probably everywhere more than 500 feet, to affect either topography or water supply. The dip of the Paskapoo bed is small and its direction here unknown. Bedrock is exposed along much of Red Deer Valley, in the valley of the Little Red Deer, and, particularly in the northeast, in many road ditches and cuts.

Paskapoo Formation. This formation was first named by Tyrrell from exposures of the lower part of the formation along Blindman River near its confluence with the Red Deer. It is composed essentially of sandstone and shale deposited in fresh water, and includes some thin coal seams and carbonaceous beds. The basal beds are massive, cross-bedded sandstone that weathers buff-yellow, and 150 to 200 feet above the base of the formation are a series of lenses of siliceous limestone containing fossil gastropods and pelecypods. The upper beds are uneven layers of sandstone, commonly uncemented, and shale, that thicken and thin repeatedly. In this area the sand is commonly coarse, reflecting the nearness of the western mountains, and weathers buff-yellow or reddish brown. In several localities the formation seems to contain a greater proportion of shale than is general, and coal seams are of minor importance. Siliceous limestone beds are important only in the west, where they are nearer the surface.

Surficial Geology. During Pleistocene, or Glacial, time great accumulations of ice formed at various centres in northern Canada. This ice moved out in all directions from these centres and covered large regions with what has been called the continental ice-sheet. As the ice advanced, it picked up great quantities of loose rock debris that was left when the ice finally melted. This material is unconsolidated, and is commonly called glacial drift.

The present area was entirely covered by one or more continental ice-sheets during Pleistocene time, and the final retreat of the ice left the bedrock buried to various depths by glacial drift. Most of the drift consists of boulders and pebbles of various compositions and sizes embedded in a matrix of clay or sandy clay to form a more or less impervious mass known as boulder clay or till. Irregularly intermingled with this till, and also lying above it, are beds, pockets, and lenses of sand and gravel that form the water-bearing members or acquifers.

The till of the area is light brown, reddish brown, or grey. It generally contains much clay and is practically impervious to water but locally may contain considerable sand, especially in the northeast where bedrock is shallow. The few stones present are mostly quartzite or sandstone pebbles, originally brought from the west by rivers and later redistributed by the ice. Large boulders are rare. Igneous and metamorphic stones brought by ice from the northeast, although present, are not common. Traces of older till are present in the valley of Red Deer River, and also in old, filled valleys, where they have been protected from subsequent glacial erosion. This older till is of darker colour than the younger, and is more compact and sticky.

Gravel is common in the southwest and along some rivers. It consists mostly of material originally brought from the west by streams, much of which was transported again by water and ice in interglacial and post-glacial times. It is generally coarse, and has all degrees of sorting and bedding.

The surficial material in the area has an average thickness of probably 15 to 20 feet. It is thinnest in the northeast, where it averages about 5 feet in thickness, and thickest in the west and southwest, where in several old river channels it may be more than 100 feet thick.

Ground Moraine. This type of glacial drift is chiefly till or boulder clay laid down beneath the ice-sheet. In this area it consists of the till described above and, particularly in the west, contains a few lenses and pockets of water-lain sand and gravel. It commonly has a gently to strongly rolling surface. Ground moraine, chiefly in large patches in the northeast and in the west, covers about 260 square miles of the area.

End Moraine. Part of the material carried by the ice-sheet was dropped at its front or margin during pauses in the general retreat of the melting glacier. It consists of till, silt, sand, and gravel gathered during the advance of the ice-sheet. Much of the clay, silt, and fine sand was carried away by melt-water from the glacier, and the material forming end moraine is commonly coarser than that of ground moraine. Much of it consists mainly of gravel, sand, and coarse till, characteristically arranged in hummocks and undrained or poorly drained hollows.

Only a few linear ridges of end moraine and some patches in a valley in township 35, range 1, occur in this area. Some of the northwestern part of the area mapped as ground moraine is hummocky and contains undrained hollows. It is perhaps low end moraine.

Glacial-lake beds. During the melting back of the ice-sheet many lakes were formed where the normal drainage was temporarily blocked by lobes of ice or masses of glacial debris. The sand, silt, and clay washed into these lakes was exposed upon the draining or lowering of these lakes. Similar, although commonly coarser, material was laid down by streams draining these lakes or running out of the melting ice, and by recent streams. About 200 square miles of the area, mostly in the valley of Medicine River, are covered by such beds, which are commonly underlain by ground moraine.

Alluvium. Rivers and streams commonly have bordering regions in which, during times of flood or through shifting of the river channels, gravel, sand, silt, and clay are deposited. Such material is present not only along the present rivers, but in the abandoned valleys of rivers that have since disappeared. Much of the older alluvium has been reworked by ice, and may contain pockets of till or be overlain by layers of ground moraine.

Alluvium is particularly widespread in this area and covers 80 to 85 square miles. To the west the land is mountainous and the streams have a high gradient. In the Markerville area the gradient decreases, causing the streams to drop much of their load.

Sand Dunes. In some localities the lake and alluvial sand or silt has been reworked by wind action, and commonly formed into sand dunes. These dunes are mostly longitudinal ridges, 10 to 40 feet high, which trend northwestward. Altogether such deposits cover about 40 square miles.

Water Supply

With the exception of a few small districts to be mentioned later, sufficient water for ordinary farm and town use can be obtained anywhere in the area. The quality is generally good, and chemical analyses of representative samples are given later.

The average depth of drilled wells in the area is about 105 feet, being greatest towards the centre of the area and shallowest in the north. The water is generally under pressure and, although its rise in the wells is extremely variable, it generally rises one-third to two-thirds of the distance to the surface. Springs occur along some valleys, and several flowing wells are present, particularly in the northwest.

The average yearly precipitation in the area ranges from about 17 to 22 inches, being greatest in the southwest and least in the northwest and southeast. One-quarter to one-third of the precipitation is in the form of snow. The eastern half of the area is generally well drained, but has many trees and a moderate run-off. The west is commonly poorly drained and heavily wooded, and, consequently, the run-off is slow and proportionately small. The alluvium, sand dunes, and to a lesser extent the ground moraine, will hold water and allow seepage into the bed-rock, whereas the lake clay is nearly impervious to water. Humidity is low, the summers are warm, and evaporation is often high. However, in most of the area, the water available to soak into the ground is many times more than enough to supply all present needs and all foreseeable future ones, and any difficulty that is had in obtaining sufficient water is due to lack of porous aquifer beds rather than to a lack of water to enter them.

Several dependable sources of surface water are present. The chief of these is, of course, the swiftly flowing Red Deer River, but Little Red Deer, Medicine, and Raven Rivers are also sources. A number of other streams in the southwest can also supply some water. Sylvan and Cygnet Lakes contain good, fresh water, which is now being used for cattle. Small, fresh-water ponds are also present, particularly in the southwest.

The alluvium, dune sand, lake sand or silt, and the glacial-outwash gravel are the important water-bearing surface materials, and they generally yield satisfactory supplies. Some wells are sunk in the rolling ground moraine in the western half of the area, but their water supply is rarely satisfactory. Of the 150 non-bedrock wells about 75 draw from glacial drift, 65 from alluvium, and the others chiefly from dune sand. These wells are largely in the southwest of the area. The supply in many of these shallow wells, into surface material, decreased in the dry years of 1949 and 1950, and they largely are being replaced by deeper, commonly drilled wells, into bedrock. The shallow wells are largely in recently settled areas, or where streams and sloughs offer supplementary supplies for watering stock, or in villages where large supplies are unnecessary. Water found in the drift is mostly hard, as it contains much calcium, and it may also contain noticeable iron. Water from the alluvium is mostly hard or moderately hard, but is soft in several wells.

Of the 795 wells and springs recorded, about 642 draw from bedrock aquifers, in all cases from the Paskapoo formation. About 140 of these 642 are springs, or dug or bored wells, the rest drilled wells. In two of the sixteen townships all the wells recorded tap bedrock aquifers.

The Paskapoo formation generally contains abundant water, mostly in lenses of porous sand that yields water rapidly and that are more common in some horizons of the formation than in others. None of these lenses can be traced far, but in most places they overlap and form aquifer zones. Each of these zones has water with distinguishing characteristics, and some of them are traceable for fair distances. In a few places, however, sand lenses seem to be absent, and the formation is almost entirely clay and shale.

The water contained in the Paskapoo formation of the area varies greatly in quality, but commonly contains much calcium carbonate, indeed some of the water is too hard for ordinary washing. Of those wells into Paskapoo beds recorded, about 223 yield hard water, 154 moderately hard, and about 266 soft. The water of about one-third of the wells contains enough iron to taste or to cause stains. In a few instances much iron is present, although rarely so much as to prevent use of the water.

As the soft water of the area contains much soda, aluminum, or magnesium, casing is inadvisable in wells yielding this type of water.

In the well record sheets at the end of the report, and in the descriptions of the various townships, the terms poor, insufficient, fair, sufficient, good, very good, and excellent, are used to describe the water supply. Poor or insufficient is used if enough water for ordinary farm needs, perhaps 500 gallons a day, cannot be obtained from the well. Fair supply is used if there is enough water for such needs, and generally more than 1,000 gallons a day, but only obtained by slow pumping or by pumping small amounts several times a day. Sufficient supply indicates that enough water is available, but that little information could be obtained regarding the amount used. Good supply is used if the well does not go dry under ordinary farm demands, and if enough water for each day's farm needs with some to spare can be obtained at one pumping. Such wells can yield 2,000 gallons a day and commonly as much as 5,000 gallons. Very good supply means that no trouble has ever been had in obtaining sufficient water, and that between 7,000 and 15,000 gallons a day should be available. Excellent supply is used if the amount of water available is exceptionally good.

Township 35, Range 1. Red Deer River, which flows eastward in a valley about 80 feet deep, forms the northern boundary of this township, and Little Red Deer River crosses the east centre. Several small creeks are tributary to these rivers. The surface is flat to broadly rolling, and is generally a bedrock surface slightly modified by overburden. It rises from an elevation of about 2,975 feet at Red Deer River to more than 3,200 feet in the southeast, but mostly it lies between 3,020 and 3,120 feet.

Ground moraine covers the bedrock everywhere in the township but is rarely exposed as it is commonly overlain by a thin mantle of glacial-lake sand or, in the southwest, by wind-deposited sand. Also on the east margin of the township a north-trending valley contains hummocks of end moraine and some sand hills. Though the surficial material, which is thickest in sand-dune areas and thinnest near Little Red Deer River, has an average thickness of only about 15 feet, actual outcrops of bedrock are recorded only from Little Red Deer Valley.

Some of the surface material, chiefly the sand, can supply small amounts of hard water, but only 5 of the wells recorded obtain their water, a sufficient supply in each case, from this material. As the surface material is thin, attempts to obtain much water from it are generally inadvisable, and most wells tap bedrock aquifers, which are more satisfactory.

Wells into bedrock are 75 to 233 feet deep, with an average depth of 115 to 120 feet, and obtain water from aquifers between 2,840 and 3,070 feet above sea-level. The upper aquifers are used in the high districts lying in the south, and the deeper ones in the low land near Red Deer River. About half the wells, mostly those more than 130 feet deep, yield soft water, whereas those less than 130 feet deep yield hard water that generally contains noticeable to much iron. The amount of water is ample, and most drilled wells could supply 5,000 gallons a day. Although in a few wells the water has no pressure, it generally rises to within 20 feet of the surface. It will rise to more than 3,100 feet above sea-level in the southeast, to about 3,000 feet in the northwest, and to about 2,900 feet in the northeast.

In general, sufficient water for ordinary farm use can be obtained anywhere at moderate depth in the bedrock, and large amounts are commonly available.

<u>Township 35, Range 2</u>. Red Deer River crosses the northwest corner of the township in a valley about 100 feet deep, and the Little Red Deer flows northeastward through the centre in a valley that increases in depth from a few feet in the south to about 80 feet in the north. Except for those valleys, the surface has little relief and is nearly flat to gently rolling. The highest districts, about 3,120 feet above sea-level, are in the southwest, and the lowest, at 3,070 feet, in the northeast, but most of the townships is about 3,120 feet above sea-level.

Alluvial plains about half a mile wide border both sides of the river channels. These are composed of gravel with minor amounts of silt and sand. Sand dunes, up to 15 feet high, form a rough surface to 6 square miles of the southeast. This area is thinly inhabited, mostly wooded, and contains many sloughs. Ground moraine covers most of the remaining area, but in the northeast it is overlain by lake clay and silt, and northwest of Red Deer River by lake sand, silt, and clay. Northwest of Red Deer River the average thickness of surface material is probably about 40 feet and between Red Deer and Little Red Deer Rivers about 20 feet. It is thickest in the sand-dune areas of the southeast.

Of the wells examined, 8 draw small amounts of hard water from glacial drift, chiefly ground moraine, and 7 from alluvium, chiefly the river gravel. The latter yields a fair supply of water, mostly hard, that varies considerably from season to season. Generally, however, wells into the surface material are not satisfactory. Bedrock is a more dependable source of water, and 35 of the wells recorded draw from it.

Most of the bedrock wells are drilled, and are 60 to 220 feet deep, with an average depth of about 115 feet. Those that yield the most water tap aquifers between 2,890 and 3,065 feet above sea-level, but mostly between 2,985 and 3,065 feet. Practically all yield soft or moderately hard water, and generally the lower the aquifer the softer the water it contains. The few wells with hard water have an insufficient supply gathered mostly from surface seepage, and this water contains noticeable to much iron. Although several of the drilled wells can yield much water, the supply in general is only fair, and that from aquifers at elevations between 2,900 and 2,980 feet and those above 3,030 feet is apt to be small. The supply of water southeast of Little Red Deer River is commonly good, between Red Deer and

Little Red Deer Rivers poor to fair, and northwest of the Red Deer generally poor. The bedrock water nearly everywhere is under enough pressure to rise in the wells half the distance to the surface; to about 3,150 feet above sea-level in the southwest and to 3,000 feet in the northeast.

In general in this township, drilled wells into bedrock are advisable, and most of these will obtain adequate amounts of soft water at moderate depth. If more water or softer water is required it is generally available at greater depth.

Township 35, Range 3. Red Deer River, which flows eastward through the centre of the township in a valley about 100 feet deep, drops from about 3,200 feet to 3,100 feet above sea-level in crossing the township. Raven River enters it in section 28. The old meanders, channels, cut-offs, and flood plains of the Red Deer and the valleys of other old streams, which mostly trend northwestward, characterize the areas south and west of Red Deer River and cause a rough and irregular surface, whereas north of Red Deer River the surface is undulating to rolling. The surface has a drop from about 3,250 feet above sea-level in the west to about 3,160 in the southeast, and to less than 3,100 feet in the northeast.

Ground moraine covers the entire area north of Red Deer and Raven Rivers, but in the extreme northeast corner it is overlain by glacial-lake sand. South of Red Deer River ground moraine covers several square miles, but most of the surface material is river alluvium, consisting of gravel, sand, silt, and clay, intermingled with patches of till and outwash gravel. Wind has duned much of the sand. This alternation of alluvium and till continues west of the Red Deer, and altogether covers nearly half the township.

As the surficial material is generally thicker than in any of the other townships, little information on the depth to bedrock is available. It is exposed in the south of sections 2 and 3, and along Red Deer River, but elsewhere it is deeply buried, especially where old valleys have been filled. Alluvium, including gravels of preglacial, interglacial, and post-glacial age is present, along with gravel gathered up by ice and later deposited as outwash. Till is common, and patches of old till, overlain by younger till and alluvium, may be seen in valleys. The alluvium in Raven Valley and around Dickson seems to be especially thick, but the lessening gradient of the swift-flowing streams from the mountains has aided deposition of alluvium everywhere.

As much sand and gravel is present and as the area has only recently been settled, most wells are dug and are shallow. In all 33 dug wells and several springs are recorded, most of which have sufficient, but commonly hard, water. A few have a large amount of water, but the supply in several is insufficient. They average 20 feet in depth, and mostly tap aquifers in alluvial gravel, except near Dickson where aquifers in either alluvium or lake sand are used. During the past dry summers (1949 and 1950) the water supply of most of these wells decreased, and many are being replaced by deeper, drilled or bored wells. Most dug wells near Dickson yield ample water, much of which, unfortunately, contains so much iron as to prevent its use.

Of all wells recorded 23 tap bedrock aquifers, 21 draw from alluvium, and 7 from glacial drift. The 17 drilled wells recorded, 16 of which enter bedrock, all yield ample water. The drilled wells are from 45 to 175 feet deep, with an average depth of 90 feet, and tap aquifers anywhere between 2,990 and 3,170 feet above sea-level. The water is soft in those wells deeper than 90 feet, but hard in those less than 80 feet deep, 8 of the 9 soft-water wells being drilled into bedrock. The hard water generally contains noticeable iron, and in some places much of it. The water in the drilled wells has generally enough pressure to rise about half way to the surface.

In general, although shallow, dug wells, especially those in alluvium, may yield sufficient water, larger and more dependable supplies of better water are available at greater depth, particularly from moderately deep wells drilled into bedrock.

Township 35, Range 4. From an elevation of 3,700 feet above sea-level in the west, the surface of this township falls rapidly northward and eastward to en elevation of 3,500 feet in the northwest, 3,200 feet at Red Deer River in the southeast, and to a low of about 3,150 feet at Raven River in the northeast corner. The township, which is largely wooded with pine, spruce, poplar, and birch, has many rapid, clear streams, and is crossed by several generally broad, dry valleys with a southeast trend. The surface is characteristically rough, rolling, and hilly.

The average thickness of the surficial mantle is perhaps 20 or 30 feet, but as few wells go right through it, the depth of bedrock is generally unknown. In this region swiftly flowing streams from the west have deposited much gravel in preglacial, interglacial, and post-glacial times. Some of the earlier of these gravels was picked up by the ice and redistributed as outwash gravel or mixed with till. As a consequence of these processes, gravel may be found both overlying and underlying till and is probably present between older and younger till sheets. It shows every variation in size of pebbles and degree of sorting.

Eighteen square miles of ground moraine are shown on the map, but much of it is underlain by gravel. About 14 square miles are shown as alluvial gravel, sand, and silt, which, however, contains pockets of till. Wind has reworked the alluvial sand and silt to form an area of sand dunes, some as high as 30 feet, covering 4 square miles, Most of this area, also, is underlain by gravel. Thus, most of the township has at least one gravel bed above bedrock, and these gravel layers are generally 6 to 14 feet thick.

As few drilled bedrock wells are present, little is known of their value. The 6 recorded are 55 to 155 feet deep, with an average depth of 110 feet, and tap aquifers between 3,100 and 3,480 feet above sea-level. The 2 wells that tap the lower aquifers yield soft water, but the others hard. The supply in all 6 is good. Drilled bedrock wells should obtain ample water anywhere at rather shallow depths.

There are 21 dug wells and several springs in the township. The dug wells average 20 feet in depth and all yield hard or moderately hard water. In about half, the water contains noticeable to much iron. The supply is generally good but is insufficient in a few cases. During the dry summers of 1949 and 1950 the supply decreased noticeably, and deepening the wells would be beneficial in most cases. As local relief is high, the water-table is very irregular. It stands at about 3,550 feet above sea-level in wells in the southwest, at 3,400 feet in the northeast, at 3,200 feet in the southeast, and at 3,150 feet in the northeast. The rise in the wells is generally small and commonly negligible, but the water rises half way to the surface in rare instances.

Of the 21 non-bedrock wells and springs, 18 obtain water from gravel. Although use of bedrock aquifers should increase, gravel will continue to supply much of the water used. As many streams are available for cattle, and the gravel and sand areas are poor farmland, the demand for underground water may never be great in this township.

Township 36, Range 1. Red Deer River flows eastward along the southern boundary of the township, but just beyond the eastern boundary it swings north. Medicine River flows across the southwestern corner of the township in a shallow, broad valley, and its tributary, Tindastou Creek, occupies a large valley crossing the northwest corner. The surface of the township, which is mostly flat to undulating, drops from about 3,100 feet above sea-level in the northeast and 3,000 feet in the northwest to 2,940 feet near Medicine River in the southwest, and slightly lower in the southeast.

A thin mantle of glacial-lake clay, silt, and sand covers most of the township, but patches of the underlying ground moraine project through it in many places, and in the southeast the lake beds have been entirely eroded away. The meander belts of Red Deer and Medicine Rivers cover about 4 square miles in the southwest. The following is a generalized section through the surface material near Medicine River. A thin layer of gravel overlies bedrock, overlain by some sand that is in turn overlain by a thick bed of silt and clay. Farther from the river the basal gravel is missing and still farther the sand also is absent. In the eastern part of the township lake clay lies directly on till.

The average thickness of the surface material is about 15 feet. It is greatest in the alluvial gravel and silt near the junction of Medicine and Red Deer Rivers, and in the thick lake bed along Medicine Valley, and is least in the southeast and north.

The 6 non-bedrock wells recorded are near Medicine River in the southwest, and either draw their water from alluvium or from gravel and sand below the lake clay. They yield hard water in only poor to fair amount, and supplementary sources of water, such as the river or springs, are necessary for stock. The thinness and impermeability of the lake clay and till render any attempt to obtain water in them useless.

Most of the wells, including all soft water ones, enter bedrock, but the shallow, dug ones rarely have sufficient water, whereas the yield of all the drilled ones, which are 65 to 195 feet deep with an average depth of about 110 feet, is sufficient or good. In sections 10, 11, 13, 14, 15, 22, 23, 24, 25, 26, 27, 34, 35, 36, or in the northeast where the surface is highest, aquifers between 2,940 and 3,000 feet above sea-level are used, whereas elsewhere aquifers between 2,850 and 2,920 feet are tapped. About equal numbers of wells yield soft, moderately hard, or hard water, and the same aquifer may supply soft water in one area and hard in another. The hard and moderately hard waters generally contain noticeable to much iron. The water in most of the drilled wells has enough pressure to rise two-thirds to three-quarters of the distance to the surface, that is, to nearly 3,100 feet elevation in the northeast and to nearly 3,000 feet in the northwest, to less than 2,940 feet in the southwest, and to less than 2,900 feet in the southeast.

In general, drilled wells are best, and ample water may be obtained at rather shallow depths anywhere in the bedrock.

Township 36, Range 2. Red Deer and Little Red Deer Rivers occupy valleys about 80 feet deep. Medicine River flows in a broad, shallow valley. The surface of the township, most of which is flat to gently rolling, rises from about 2,950 feet above sea-level near Medicine and Red Deer Rivers to more than 3,000 feet in the northeast, to 2,980 in the north centre, to 3,150 in the northwest and west, and to about 3,110 feet in the southwest. Lake beds overlie nearly the entire township, forming a black soil and giving a characteristically flat surface. Mostly they consist of clay, but sand and silt predominate in the southeast. However, large patches of the underlying ground moraine appear where the lake sediments have been removed or were never deposited. As the lake beds are commonly thin, and in places only a few inches thick or even missing, the surface generally reflects the undulating to rolling topography of the underlying ground moraine. Where both ground moraine and lake deposits are thin, as in the northwest, broad, gentle, bedrock swells control the topography. Alluvial gravel occurs near Red Deer River and alluvial silt and sand near Medicine River. In the northeast part of the township wind has formed northwest-trending, longitudinal sand dunes, mostly 10 to 20 feet high. The surficial material is generally 10 to 20 feet thick, but in areas of sand dunes and alluvium it is thicker and may be as much as 80 feet thick in the southwest, where an old valley has seemingly been filled with alluvium.

Three-quarters of the wells draw water from bedrock, and two-thirds are drilled. The non-bedrock wells are largely confined to the alluvium area of the southwest, near the alluvium and sand-dune districts in the northeast, and in the north where several obtain water from near the contact of overburden and bedrock. They yield hard or moderately hard water, which in places contains noticeable iron. The supply is rarely more than just sufficient and is commonly poor, and in several of these wells decreased in the dry years of 1949 and 1950.

The drilled bedrock wells are from 55 to 190 feet deep, but mostly between 80 and 120 feet with an average depth of about 110 feet. They tap aquifers between 2,850 and 3,050 feet above sea-level, the lower aquifers being used in the east and the higher in the southwest and northwest. About three-quarters of these wells yield soft or moderately hard water, and iron is noticeable in the water from about only one-fifth. Although the amount of water is generally good, in three areas sufficient water is difficult to obtain. The first area, in sections 24 and 25, obtains adequate water but with none to spare at about 2,870 feet. The second area is in the north of section 21 and in the south of sections 28 and 29, where only fair supplies are obtained from aquifers at about 2,920 feet. Deeper drilling should improve the supply in this area. The third area, which is more complex, is in sections 8, 9, 10, 16, 17, and 18, with the poorest supply in the east of section 8 and in section 16. The cause of the scarcity of water in three areas is uncertain, but may be in part that there is a greater proportion of clay and shale in the bedrock there than normal. In the third area, however, another factor may be the principal cause. Apparently an old valley, perhaps a former course of Raven River, crossed the southwest part of the township. This valley has been filled with alluvium and till, locally as much as 150 feet deep, and into it much of the water in the bedrock nearby may be draining. This reduces the likelihood of good supplies of water being obtained from the bedrock but means that the lower part of this valley may be a potential source of large supplies of water. In these areas of difficult water supply, the likelihood that deep drilling may be necessary should be borne in mind, and the well should be located as far to the north as possible.

The water in bedrock aquifers is generally under enough pressure to raise it one-half to four-fifths of the distance to the surface, and it rises above 3,100 feet elevation in the west centre, above 3,050 feet in the northwest and southwest, above 2,950 feet in the northeast, and to about 2,950 feet near Red Deer and Medicine Rivers.

In general the surface material is unsatisfactory as a source of water, whereas most wells into the Paskapoo formation, especially those drilled to depths of 100 feet or so, yield ample water. However, deep drilling is necessary in several areas if large supplies are required.

Township 36, Range 3. The surface of this township rises steadily from east to west from an elevation of about 3,110 feet to over 3,200 feet, and in places over 3,250 feet above sea-level. Lake waters have covered the extreme eastern edge of the township where the surface is more or less flat, but as the surface rises to the west and there is less modification by the glacial-lake waters, it becomes more irregular until near the western border there are broad, rolling hills 3 to 10 feet high. An old valley, which now contains no stream although it is as much as 50 feet deep, trends southward through the centre, and is marked by swamps, peat bogs, and some fine gravel.

Lake beds of clay and silt in the east and sand in the southeast cover about 7 square miles, and a few sand dunes, 20 or 30 feet high, are present in the extreme southwest corner. Rolling ground moraine is the surface material elsewhere. The surficial material has an average thickness of 15 to 20 feet, but in the south, where an old valley has apparently been filled, it is much thicker.

The supply of water in the ground moraine and lake clay is negligible, and in the northern third of the township only one well is recorded that derives water from ground moraine. Several wells draw water, which is mostly hard and may contain noticeable iron, from the lake sand near Dickson or from gravel in the valley in the centre of the township, but the supply is rarely good, and in more than half the wells is insufficient for local farm needs. The alluvium in the old, filled valley in the south may hold much water, and one soft-water well in the northeast of section 16 probably draws from it. Other wells in southwest section 15, southeast section 13, and northeast section 17 probably also draw water from this buried valley.

The drilled bedrock wells are from 60 to 275 feet deep, with an average depth of 115 feet, and tap aquifers between 2,865 and 3,150 feet above sea-level, but mostly between 2,980 and 3,110 feet. Wells in the higher districts in the west generally use the upper aquifers. Three-quarters of the wells yield soft water, the hard water coming mainly from aquifers above 3,090 feet, and one-quarter of the wells yield water with noticeable iron. The supply, almost without exception but especially in the lower aquifers, is good. However, in northeast section 33, bedrock water is scarce, and 6 wells, 130 to 350 feet deep, have been drilled without the hoped for results. The cause of this local shortage is unknown, but may be due to fewer sand lenses than usual in the bedrock. The water in bedrock aquifers generally has enough pressure to rise two-thirds to four-fifths of the distance to the surface, and it rises to elevations of 3,100 feet in the east, 3,200 feet in the extreme northwest, and above 3,150 feet elsewhere.

In general it is inadvisable to try to obtain water in the surface material but rather to go into bedrock, where ample water, mostly soft, can usually be obtained at moderate depth.

<u>Township 36, Range 4.</u> Raven River flows westward through the centre of the township, occupying only a small part of a large, old valley. Southeastward flowing Stauffer Creek joins it near the centre of the township. Other valleys, also with a southeast trend but now dry, are present. These produce an irregular surface in much of the township, and are commonly marked by swamps, peat bogs, and gravel. Outside the valleys the surface is mostly rolling, with broad, gentle hills 4 or 5 feet high in the northeast, and as much as 30 to 40 feet high in the south. From Raven River in the southeast, at about 3,150 feet above sea-level, the surface rises to about 3,250 feet in the northeast and 3,275 feet in the northwest.

Rolling ground moraine covers about 12 square miles of the southeast. The rest of the township is covered with alluvial gravel, sand, silt, clay, and glacial till, deposited by existing streams in flood plains, meander belts, and channels, by glacial streams from reworked glacial materials, by preglacial streams cutting their large valleys, and by ice mixing up the earlier deposits and adding new material. Wind, blowing across areas of alluvium, deposited sand over most of the area, and tended to flatten out irregularities in the surface. In section 2, however, it formed dunes 40 feet high, and in sections 18 and 19 northwest-striking, longitudinal dunes as much as 20 or 30 feet high have been formed. The thickness of the surficial material is generally unknown, but probably averages more than 30 feet.

As the regions of sand dunes, flood plains, and alluvium are poor farmland and are largely wooded with pine and spruce, most of the township is thinly populated, and information on water supply consequently scanty. About half the wells are dug and half drilled, and most enter bedrock. The proportion of drilled wells may be expected to increase, as they are easier to maintain and yield better water in more satisfactory amounts.

The few non-bedrock wells recorded are chiefly in dune sand or alluvium. They tend to silt up and yield poor to fair supplies of hard water, that is commonly of poor quality and may contain noticeable iron. Bedrock wells, and especially those drilled, are generally more satisfactory. At present they are used in only a small district, but all have ample water that is characteristically soft or moderately hard and that rarely contains noticeable iron. They are 50 to 165 feet deep, with an average depth of 110 feet, and tap aquifers between 3,010, and 3,240 feet above sea-level, but mostly between 3,040 and 3,200 feet. The upper aquifers are used in the higher areas in the north and northwest. The water is generally under enough pressure to rise one-half to three-quarters of the distance to the surface, that is, to about 3,150 feet elevation in the southeast, 3,200 feet in the northeast, and to above 3,250 feet in the northwest. Drilled wells anywhere in the township should be able to obtain ample water from the bedrock

Township 37, Range 1. The broad valley of Tindastou Creek runs southwest across the centre of the township, dropping from 3,050 feet above sea-level in the northeast to 3,000 feet in the southwest. The land rises to 3,100 or 3,150 feet in the southeast and to 3,230 feet in section 21 and in the northwest. In the south the surface is gently rolling but in the higher land to the north it is irregular and strongly rolling, and is characterized by broad, bedrock hills little modified by drift.

Lake beds, mostly clay that is commonly varved and stony, cover about 9 square miles in the southwest. They are, however, thin, and patches of the underlying ground moraine are exposed in many places. Ground moraine, rarely more than 10 feet and commonly not over a few inches thick covers the remainder of the township, including all the high land. The composition of the till varies in accordance with the nature of the underlying bedrock, it being sandy where bedrock is sandy and clayey where bedrock is clayey, and its colour is the reddish brown of the Paskapoo sandstone. The thinner the drift, the more it resembles the bedrock. Bedrock outcrops in many road ditches, but is generally covered by 3 to 10 feet of drift, more in areas of lake beds, and by the greatest thickness in the east.

The 2 wells that do not enter bedrock yield insufficient hard water and, as the drift is everywhere thin, practically no possibility exists of finding sufficient water in it.

Two-thirds of the wells are drilled, and these are 16 to 350 feet deep, with an average depth of 120 feet. The 350-foot well obtains its water at 200 feet. The wells tap aquifers between 2,840 and 3,140 feet above sea-level, but mostly in the zone 2,955 to 3,110 feet, and the higher aquifers are used mostly in the northwest. Practically all the drilled bedrock wells yield soft or moderately hard water, whereas the dug bedrock wells mostly yield moderately hard or hard water. Most water from aquifers above 3,010 feet is hard or moderately hard, that from lower ones is soft. Iron is rarely noticeable in the water. Almost all bedrock wells, whether drilled or dug, yield ample water, and if the supply in any well is poor it is generally the fault of the well rather than absence of aquifers. The rise of the water in the wells is variable, and ranges from practically none in the north to three-quarters of the distance to the surface in the south. It rises to about 3,000 feet above sea-level in the southwest, less than 3,050 near Tindastou Valley, to more than 3,100 feet in the southeast, and as high as 3,150 feet in parts of the northwest.

In general, bedrock is the only dependable source of water supply and yields ample water anywhere.

Township 37, Range 2. Medicine River flows southeastward, with low gradient, a narrow channel, and much meandering, in a broad, old valley running through the centre of the township. An old channel of this river is present several miles to the east of its present one, and the land between the two is low. Most of the township is an old lake bed and the surface is mostly flat to undulating. Long, northwest-trending, dunal ridges, mostly 10 feet high but in places as much as 30 feet high, occur near the river, and in the steeply rising, high land in the northeast, broad, bedrock hills modified by small, rolling drift hills 2 to 10 feet high are characteristic. Near the river the surface is 2,980 to 3,000 feet above sea-level, but rises to more than 3,050 feet in the southwest and to 3,250 feet in the northeast.

The area of about 4 square miles between the river's present and previous channels is covered by sand and fine gravel, such as is present near the modern river. Ground moraine, a few inches to 7 or 8 feet thick, covers the bedrock in the northeast. Glacial-lake sediments cover the remainder of the area. These are mostly clay and silt, commonly varved, that contain scattered stones that are fewer near the river and more away from it. The lake beds are generally thin, but are thicker southwest of the river than elsewhere. Scattered patches of the underlying groundmoraine appear here and there at the surface, especially east of the river. In places near the river, alluvium has been reworked by wind, and sand dunes cover an area of nearly 6 square miles. The combined thickness of ground moraine and lake clay is between 3 and 15 feet, and altogether the surface material probably averages about 15 to 20 feet in thickness.

Half of the wells recorded are dug and half drilled. Three-quarters of them tap bedrock aquifers, and half yield soft water. The water rarely contains noticeable amounts of iron. The non-bedrock wells are in sand-dune areas or in alluvium along Medicine River. They require much maintenance and most of them yield hard water. Of the 13 such wells noted, 6 had insufficient water, 5 just sufficient, and only 2 a large supply. The thinness of the ground moraine precludes obtaining water from it, and, as the lake beds have a high clay content, they too are useless for water supply.

The wells drilled into bedrock are 20 to 255 feet deep, with an average depth of 105 feet. They tap aquifers between 2,750 and 3,140 feet above sea-level, although few wells use those aquifers between 3,000 and 3,100 feet, or below 2,870 feet. Aquifers between 2,970 and 3,000 feet are used mostly by dug wells, largely in the south; those above 3,050 feet are used only in the northeast; and those lower than 2,900 feet are used in the west. Aquifers below 2,970 feet yield soft water, whereas half those higher yield hard water. Most bedrock wells have a fair to good yield of water. From the high land of the northeast water is drained by springs into gullies and lower neighbouring areas. Thus the water here has a negligible rise in the wells, to not much over 3,150 feet above sea-level. Elsewhere it rises to within 20 or 30 feet of the surface, and reaches 3,050 feet in the southwest and about 3,000 feet in other districts.

In general, bedrock aquifers everywhere yield sufficient water for ordinary farm use, but the unconsolidated material is not a reliable source of water.

Township 37, Range 3. Most of the township has an undulating surface that reflects a broad, rolling, bedrock topography. It rises from elevations of about 3,101 feet near Medicine River in the northeast and 3,050 feet in the southeast, to 3,100 feet in the northwest and 3,250 feet in the southwest. The only stream in the township flows eastward across the northern part along a small valley, and the southwest, in consequence, is poorly drained. There the surface is rolling, with small hills 3 to 10 feet high.

Brownish ground moraine is exposed over an area of 11 square miles of the southwest, but over most of the rest of the township it is covered by a mantle of glacial-lake clay, silt, and some sand. The lake sediments are thickest, with the most extensive varving in the northeast, but to the west, near the shore of the old lake they are thin and contain a moderate number of stones. Low sand dunes are the eastern parts of sections 24 and 25. The surface material is thin, especially in the northwest and north, with an average thickness of perhaps 15 feet. Because of its thinness, and the large amount of clay most of it contains, any attempt to obtain water from the surface material is inadvisable, except perhaps the sand-dune areas, where small amounts of water may be available.

All wells recorded tap bedrock aquifers, and about one-half yield soft water, one-quarter moderately hard, and one-quarter hard water. Iron is rarely present in noticeable amounts. The drilled wells are 60 to 400 feet deep, with an average depth of 115 to 120 feet. They tap aquifers between 2,700 and 3,230 feet above sea-level, but mostly between 2,900 and 3,110 feet, and especially in the zone 2,980 to 3,050 feet. Ninety per cent of the drilled wells, including practically all that tap aquifers below 3,050 feet, yield soft water, usually in fair to good supply. The upper aquifers are used mostly in the higher parts of the township in the southwest. In most of the township those wells with unsatisfactory yields of water tap aquifers higher than those supplying neighbouring wells, and their yields could be increased with a fair amount of deepening. However, most such wells are in the northeast and here the water supply problem is different and more difficult. Nevertheless, here also deepening the wells should help.

The water is generally under enough pressure to rise to within 20 or 30 feet of the surface, that is, to less than 3,000 feet above sea-level in the northeast, to about 3,100 feet in the northwest, and as high as 3,250 feet near the southwest.

In general, the only available water is in bedrock, but this is mostly soft and in fair to good supply.

Township 37, Range 4. Local relief is small in this township, with the lowest elevations, in the northeast, about 3,150 feet above sea-level, and the highest, in the northwest, about 3,300. The southern half of the township lies at an elevation of about 3,270 feet. Most of the surface is rolling, with broad, drift hills 3 to 10 feet high, but higher, dunal hills are present in the southwest, and the extreme northeast is comparatively flat. Drainage is generally poor, and swamps, many of which contain peat, are common. Several southeast-trending valleys cross the southwest part of the township, but these do not now contain streams.

Ground moraine covers most of the township. In a small area in the northeast, however, patches of thin, clayey lake beds overlie it, and in the southwest sand dunes, mostly in northwest-trending ridges, are present. Along the extinct stream valleys gravel occurs both below and above the till. The surficial material has an average thickness of less than 20 feet.

Most wells are either dug, or dug and later deepened by boring, but about one-third are drilled. About half the wells yield soft or moderately hard water, and iron is noticeable or in large amount in the water from one-third. Three wells, which appear to draw water from the zone at the contact between the drift and bedrock, have insufficient water, and most of the surface deposits, with the possible exception of the dune sand, offer little prospect of large supplies. The bedrock, which is generally shallow, is a better source of water, and practically all wells tap aquifers in it. They use aquifers between 3,070 and 3,270 feet above sea-level, but mostly in the zone between 3,100 and 3,270 feet. The lower aquifers are used in the low land in the northeast, where are most of the drilled wells, whereas the higher aquifers are used in the west. The drilled wells are 30 to 180 feet deep, with an average depth of about 80 feet, and mostly use the lower aquifers. These aquifers yield large amounts of water that is mostly soft or moderately hard. About three-quarters of the dug wells yield hard water. About half of them have ample water, and the others just enough or else insufficient water. These dug wells mostly tap aquifers over 3,200 feet above sea-level.

The water is under strong pressure, generally rising to within 10 or 15 feet of the surface, and several springs and flowing wells are present. In the northeast it rises to only 3,150 feet above sea-level, but elsewhere to more than 3,250 feet.

Township 38, Range 1. Cygnet Lake and the south end of Sylvan Lake lie in a broad valley crossing the east part of the township. Broad flats, which are at times or were in the past covered by water, border these lakes. Elsewhere the topography shows broad bedrock hills and ridges that are slightly modified by minor, gentle drift hills a few feet high. Cygnet Lake, which, although shallow, is used for watering cattle, is about 3,050 feet above sea-level, and Sylvan Lake is slightly higher. The northeast part of the township rises to an elevation about 3,130 feet and the west centre to 3,250 feet. The centre and northwest lie at an elevation of about 3,150 feet, and the southwest at 3,200 feet.

Lake water covers about 4 square miles of the township. Near the lakes, water has reworked ground moraine to form a flat or undulating surface covered with patches of sand, silt, and clay, of various thicknesses and commonly bedded. The rest of the township is covered by a thin mantle of ground moraine, composed of sandy till containing a few stones and with the reddish brown colour of the Paskapoo formation. Bedrock is, however, exposed at several points. The surface material probably averages less than 10 feet in thickness, although near the lakes its thickness is difficult to determine. Even there, however, it is unlikely to be great. On the hills and higher areas it is rarely more than a few feet thick. Largely because of this thinness, the surficial material is of little importance in water supply, except in the town of Sylvan Lake. The wells in that town need only yield very small amounts of water for domestic purposes and draw mostly from lake sediment. Outside the town only 2 wells are recorded that draw water from the surficial material, one a poor supply from lake sediment. In both wells the water is hard.

The drilled bedrock wells, which form 90 per cent of the wells recorded, are 30 to 205 feet deep, with an average depth of about 90 feet. They tap aquifers lying between 2,870 and 3,225 feet above sea-level. About half the wells yield moderately hard water, one-fifth hard, and the remainder soft water. Iron is noticeable in the water of about one-quarter. About 85 per cent of the wells recorded yield ample water. In a few the supply is just sufficient, and in 6 not sufficient for ordinary farm needs. In general, the lowest aquifers contain the most, and the softest, water.

The water rises to near the surface in low areas, but not so high in the wells in the high districts of the west and northeast. It is, however, everywhere under pressure, and rises to about 2,950 feet above sea-level near Cygnet Lake, to more than 3,100 feet in the northeast and northwest, to about 3,150 feet in the southwest, and above 3,200 feet in the west centre.

In general, most bedrock aquifers, which are the only reliable sources of water, yield soft or moderately hard water in good supply.

Township 38, Range 2. The shallow, meandering channel of Medicine River cuts southwards through the southwest corner of the township in a broad valley, which, however, is narrower here than farther south. From about 2,980 feet above sea-level near the river the land rises fairly steeply eastwards, to about 3,170 feet at Benalto, and to more than 3,200 feet 2 miles east of Evarts. East of these points the surface levels off and the northeastern two-thirds of the township lies between 3,200 and 3,250 feet.

The surface near the river is more or less smooth, but in those districts remote from the river, above 3,200 feet, it is rough, hilly, and swampy, and is much dissected by valleys. Bedrock, slightly modified by broad, gently rolling, morainal hills 3 to 8 feet high, shapes the topography of the higher districts.

Alluvium and lake sediment, mostly clay and silt but including some sand, covers Medicine Valley, and ground moraine covers the remaining area. Altogether, the surficial material probably does not average much more than 10 feet in thickness. It is thickest in the areas of alluvium and lake sediment but is only 5 to 10 feet thick on the slope rising eastwards from the river, 5 feet thick near Benalto, 2 to 15 feet thick in the central regions, and generally less than 5 feet thick on the slope towards Sylvan Lake.

As it is thin, the ground moraine does not yield much water, and even the alluvium and lake sediment can give only small, variable quantities of hard water from wells that would require much maintenance. Probably all the wells recorded tap bedrock aquifers, which are more satisfactory and dependable than those in surface material.

A few dug or bored wells are recorded, and these yield sufficient water for farm needs, but do not supply as much water as the deeper, drilled wells. Most wells are drilled, and are 30 to 160 feet deep, with an average depth of about 95 feet. They tap aquifers between 2,850 and 3,230 feet above sea-level. The lowest aquifers are used in the low areas of the southeast, those above 3,200 feet are used in sections 10, 11, and 15, and mostly those about 3,170 feet are used in the northeastern half of the township. The yield is good in all but one well. This well, in northeast section 25, taps an aquifer that is drained by lower ground in the east, and deepening is advisable. The wells are divided fairly evenly between those that contain soft, moderately hard, and hard water, with the lower aquifers supplying most of the soft water. The water of one-quarter of the wells contains noticeable iron. The water is under some pressure but, because many aquifers are drained by low-lying areas nearby, its rise in the wells is extremely variable and is generally less than in other townships. It rarely rises more than half way to the surface, but springs occur on both the slope towards Sylvan Lake and that towards Medicine River. The water does not rise to 3,000 feet in the southwest near Medicine River, but rises to 3,150 feet above sea-level in the southeast and northeast, and above 3,200 feet in most of the remainder of the area.

Township 38, Range 3. Medicine River flows southward across the northeast corner of the township. It occupies a shallow, meandering channel in a valley that, although several miles wide, is narrower here than farther south. From the river the land rises steeply eastwards from 2,980 feet at the river to more than 3,100 feet, and in places more than 3,150 feet, above sea-level in the northeast. Westward the land rises less abruptly to 3,140 feet in the northwest, 3,120 feet in the southwest, and more than 3,200 feet in sections 18 and 19. Generally the surface is undulating to gently rolling, and the main features of the relief are controlled by bedrock.

Alluvium is present beside the river, but elsewhere a thin mantle of ground moraine overlies bedrock. Much of this ground moraine is in turn overlain by patches of lake sediment mostly composed of clay or silt, commonly varved, which modify and smooth out its rolling surface. It is noteworthy that in parts of the southwest till overlies the lake beds.

The surficial material has an average thickness of probably little more than 15 feet. It is thickest in the north, near Medicine

River in the northeast, and in what is probably a filled river valley in sections 22 and 27. In the centre and south it ranges from a few inches to about 20 feet thick, but mostly around 10 feet.

Two drilled wells, in southwest section 27 and northwest section 22, seem to obtain their water from drift and alluvium in an old, buried river channel, and 2 other wells probably draw from ground moraine. These 4 wells yield ample, hard water. Although some water may be obtained from alluvium near Medicine River, or from silty and sandy lake beds, bedrock aquifers are better and, indeed, the thinness of the surficial material commonly leaves no alternative.

Practically all the wells are drilled, are 35 to 165 feet deep, with an average depth of 100 feet, and tap aquifers between 2,830 and 3,140 feet above sea-level, but mostly scattered through the zone 2,900 to 3,120 feet. The lowest aquifers are used in the low land of the southeast and, to a lesser extent, in the northeast. In general, section 1 uses aquifers below 2,900 feet, the western half of the township and section 36 use aquifers above 3,000 feet, and sections 18, 19, and parts of 7 and 20, use ones above 3,100 feet. A few wells yield moderately hard water, the others are about equally divided between those yielding soft and hard water, with most of the soft water being drawn from below 2,990 feet. The supply is generally good, and in the two instances where it is poor, either slight deepening is needed or the wells themselves may be poor. The water from half the wells contains noticeable to much iron.

The rise of water in the wells is extremely variable. In some wells it reaches the surface, whereas in others it scarcely rises at all. It rises to 3,000 feet above sea-level near Medicine River and in the southeast part of the township, to 3,100 feet in the northeast, to above 3,100 in the northwest and southwest, and to 3,150 feet in the west centre.

Township 38, Range 4. Several small, unimportant streams flow to the north and east. Drainage is generally poor in this township, however, and small ponds, sloughs, and swamps are numerous. Some of the swamps contain peat. The surface of the township, except for more or less flat regions in the northeast and southeast, is strongly rolling, with hills averaging about 10 feet in height and some high points 15 feet or occasionally over 20 feet high. The land rises steadily westward from about 3,100 feet above sea-level in places in the northeast and southeast and 3,150 in the east centre, to nearly 3,200 feet in the northwest and 3,300 feet in the southwest. Bedrock controls the steady, westward rise, but most relief features are formed by drift.

Ground moraine, which is in places almost a low end moraine, covers most of the township, but patchy lake clay covers about 4 square miles of the more level regions in the east. The surficial material probably has an average thickness of less than 20 feet.

Seven of the wells recorded yield hard or moderately hard water from ground moraine, which commonly seeps into the well from nearby swamps. Of these wells 2 have insufficient water, 2 just sufficient, and 3 ample water for ordinary farm needs. The water supply in shallow wells decreased during the dry summers of 1949 and 1950. Many of these wells have now been replaced by drilled wells, and others have been deepened by digging or by boring with augers. Generally wells in the drift are unsatisfactory and most wells in the township tap bedrock aquifers. About three-quarters of the wells, including some originally dug and later deepened, are drilled or put down by auger. Most bedrock wells yield sufficient water. The drilled and augered wells are 25 to 200 feet deep, with an average depth of about 80 feet, and tap aquifers between 2,970 and

3,250 feet above sea-level, but mostly between 3,060 and 3,250 feet. In sections 7, 8, 9, 17, 18, and parts of 4, 5, 6, 16, and 19, aquifers above 3,200 feet can be used, but in the extreme northeast, and in part of section 32 and parts of sections 1, 12, and 13, wells have to go below 3,100 feet above sea-level. In the southwestern half of the township aquifers above 3,150 feet can generally be used.

Practically all bedrock wells have ample water, and the only one with insufficient supply is a shallow, dug well from which little water could be expected. There are, however, a few wells with only a fair supply and this could be improved by deepening. One-quarter of the wells yield soft water, and the remainder are equally divided between those yielding hard and those yielding moderately hard water. The water from lower aquifers is no softer than that from higher ones, and the same aquifer may yield soft water in one place and hard in another. Iron is noticeable in the water from about half the wells. The water is under strong pressure. It always has some rise in the wells, and in about two-thirds of them rises to within 20 feet of the surface. Only 9 springs and flowing wells are recorded, but others are present. The water rises to less than 3,150 feet in the northeast and southeast, about 3,175 feet in the northwest, and to more than 3,250 feet above sea-level in the southwest.

ANALYSES OF WELL WATERS FROM Townships 35-38, ranges 1-4, West of 5th Meridian, Alberta

Sample Number	¼	Section	Township	Range	Meridian	Owner	Depth of well (feet)	Aquifer *	Total dissolved solids (parts per million)	Constituents as Analysed (parts per million): Calcium (Ca)	Magnesium (Mg)	Alkalis (Na,K)	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Bicarbonate (HCO_3)	Alkalinity (as $CaCO_3$)	Hardness as($CaCO_3$) (pts. per million): Ca hardness	Mg hardness	Total hardness
4448	NE	10	37	2	5	C. Stevenson	32	P	1234.0	214.8	47.0	15.1	67.5	69.0	197.1	533.0	441.0	535.9	193.4	729.3
4449	SW	1	37	2	5	E. Hehr	176	P	710.0	16.8	8.1	278.4	35.0	10.4	0.0	714.9	586.0	41.9	33.3	75.2
4450	NW	1	37	2	5	R. Youngstrom	42	P	824.0	14.0	7.6	333.2	89.3	17.3	70.9	697.8	626.0	34.9	31.3	66.2
4451	NE	35	37	2	5	D. L. Fitch	145	P	448.0	55.0	31.9	81.2	30.5	0.0	0.0	483.6	396.4	137.2	131.3	268.5
4452	SE	35	38	4	5	J. Dorsti	65	P	396.0	52.1	32.6	59.8	17.3	0.0	0.0	439.7	360.4	130.0	134.1	264.1
4453	SE	4	38	4	5	L. Sebek	28	P	724.0	29.9	8.3	262.4	74.1	0.0	0.0	701.5	575.0	74.6	34.2	108.8
4454	SW	25	38	4	5	W. E. Cole	18	P	378.0	84.0	34.3	12.6	9.9	0.0	3.5	429.4	361.0	209.6	141.1	350.7
4455	NE	25	38	4	5	W. J. Cordan	48	P	378.0	33.2	26.0	86.2	18.9	0.0	0.0	420.9	351.0	82.8	107.0	189.8
4456	SW	5	38	3	5	W. T. Burns	111	P	608.0	2.6	4.4	260.4	14.8	14.8	0.0	615.6	511.8	6.5	18.1	24.6
4457	NW	9	38	3	5	A. Stewart	60	P	576.0	1.4	3.9	244.3	33.7	0.0	0.0	552.2	509.6	3.5	16.0	19.5
4458	SW	26	37	3	5	A. Jarvis	299	P	2526.0	8.9	37.5	920.3	1329.7	0.0	0.0	583.2	616.0	22.2	154.3	176.5
4459	NW	17	38	2	5	R. Hambly	160	P	630.0	1.1	1.5	268.3	66.3	0.0	0.0	539.7	507.2	2.7	6.2	8.9

* Symbols used for aquifers P - Paskapoo formation

ANALYSES OF WELL WATERS FROM Townships 35-38, ranges 1-4, West of 5th Meridian, Alberta

Sample Number	¼	Section	Township	Range	Meridian	Owner	Depth of well (feet)	Aquifer *	Total dissolved solids (parts per million)	Constituents as Analysed (parts per million): Calcium (Ca)	Magnesium (Mg)	Alkalis (Na,K)	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Bicarbonate (HCO_3)	Alkalinity (as $CaCO_3$)	Hardness as ($CaCO_3$) (pts. per million): Ca hardness	Mg hardness	Total hardness
1557	NW	34	38	2	5	H. Lund	80	P	526.0	68.0	32.8	8.7	23.5	0.5	0.7	383.6	298.0	169.7	135.0	304.7
1558	NE	17	38	1	5	E. Grutter	80	P	474.0	83.0	30.6	35.5	16.1	15.0	63.7	427.0	350.0	207.1	125.9	333.0
1559	SW	18	35	4	5	C. Ingram	120	P	374.0	83.0	30.6	13.0	16.4	0.5	0.9	412.4	338.0	207.1	125.9	333.0
1560	SW	15	36	3	5	K. Christiansen	73	P	626.0	31.0	9.8	204.6	68.3	26.5	0.7	483.1	432.0	77.4	40.3	117.7
1561	NW	35	35	3	5	J. Adamsen	73	P	612.0	91.0	39.1	90.1	43.4	11.0	4.4	383.2	478.0	227.1	160.9	388.0
1562	SE	6	36	2	5	R.D. Jensen	68	P	2108	92.0	24.3	616.0	1109.8	6.5	0.9	522.0	428.0	229.5	100.2	329.7
1563	SW	8	35	2	5	M. Cheston	-	A	256.0	74.0	14.6	4.5	5.3	0.5	2.7	278.2	228.0	184.6	60.1	244.7
1588	NW	20	35	2	5	J.L. Smulders	116	P	532.0	21.0	10.3	215.1	61.3	0.5	0.0	485.6	482.0	52.4	42.4	94.8
1589	NE	22	35	1	5	J. Thomson	112	P	658.0	91.0	32.1	115.9	121.0	0.5	0.0	546.6	448.0	227.1	132.1	359.2

* Symbols used for aquifers P - Paskapoo formation A - Alluvium