CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 269

GROUND-WATER RESOURCES OF TOWNSHIPS 39 TO 42, RANGES 5 TO 8, WEST OF 4th. MERIDIAN, ALBERTA

Records collected by P. S. Warren and G. S. Hume; compiled by G. S. Hume

OTTAWA
1947

CANADA
DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY
WATER SUPPLY PAPER NO. 269

GROUND-WATER RESOURCES OF TOWNSHIPS 39 to 42, RANGES 5 to 8, WEST FOURTH MERIDIAN, ALBERTA

Records collected by P. S. Warren and G. S. Hume; compiled by G. S. Hume

OTTAWA
1947

CONTENTS

Illustrations

GROUND-WATER RESOURCES OF TOWNSHIPS 35 TO 38, RANGES 1 TO 4, WEST 4TH MERIDIAN, ALBERTA

INTRODUCTION

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

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

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

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

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

Publication of Results

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

How to Use the Report

Anyone desiring information 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 provided on bedrock formations, pages 4 to 11, 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 record tables, from the elevation of the surface at that point.

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

GLOSSARY OF TERMS USED

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

BEDROCK FORMATIONS IN EAST-CENTRAL ALBERTA

The formations that outcrop in east-central Alberta are mainly of Upper Cretaceous age, but Tertiary beds occur to the southwest in the Red Deer area. These higher strata are sandstones and shales with thin coaly and carbonaceous beds. Commercial coal beds occur in the Upper Cretaceous Edmonton formation, but other thin coal seams are present, particularly in the Ribstone Creek formation and in the Pale and Variegated Beds. Carbonaceous beds also occur in the Bearpaw formation and are widely scattered through other formations. The Edmonton formation contains some harder sandstones, but almost the whole Upper Cretaceous succession consists of softer sands and sandstones alternating with shales in which ironstone nodules are commonly present. The succession, character, and estimated thickness of the formations are shown in the following table:

Age	Formation	Character	Thickness Feet
Tertiary	Paskapoo	Sandstones and shales with thin coal seams and carbonaceous beds; basal sandstones, massive and crossbedded; some siliceous limestone 150 to 200 feet above the base of the formation.	A few hundred feet thick in Red Deer area. The thickness increases to the south and west.

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

Paskapoo Formation

The Paskapoo formation was first named by Tyrrell from exposures of the lower part of the formation occurring along Blindman

River near its confluence with the Red Deer. It is composed essentially of sandstones and shales of freshwater deposition, and includes some thin coal seams and carbonaceous beds. The basal beds are massive, crossbedded sandstones that weather buff-yellow, and are in striking contrast to the underlying, light-coloured, bentonitic clays of the Edmonton formation. About 150 to 200 feet above the base of the formation are beds of siliceous limestones containing gastropods and pelecypods, but these beds are lenticular rather than continuous, although a zone of them appears widely distributed at about the same stratigraphic level.

Edmonton Formation

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

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

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

Bearpaw Formation

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

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

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

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

Pale and Variegated Beds

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

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

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

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

Birch Lake Formation

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

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

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

Grizzly Bear Formation

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

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

Ribstone Creek Formation

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

These marine shales in turn are overlain by a sandy zone about 20 feet thick containing oysters in the basal part. This sandy zone is the upper sand member of the Ribstone Creek formation. It thickens to the east and west from the Grizzly Bear area, but is probably at no place much more than 50 feet thick.

The lower sand member of the Ribstone Creek formation also varies in thickness from a minimum of about 25 feet. On the banks of Vermilion Creek, north of Mannville, the basal sand is at least 60, and may be 75, feet thick. It is overlain by shaly sand and sandy shale beds, which replace the shale beds in the central part of the formation as exposed at the mouth of Grizzly Bear Coulée. In the Wainwright area, where the formation has been drilled in deep wells, the basal sand is 60 feet thick, with the central part composed of shale containing sand streaks. The upper sand member is about 20 feet thick in this area. The total thickness of the formation in the Wainwright area is 180 to 200 feet, but this increases to the west and in the Viking area exceeds 300 feet.

The Ribstone Creek formation is widely exposed in a northwest-trending belt in east-central Alberta. The southern boundary on the Alberta-Saskatchewan meridian is in the south part of township 44, south of Battle River, whereas the northern boundary is in township 51, a few miles north of Lloydminster. The southwest boundary of this northwest-trending belt passes through the mouth of Grizzly Bear Coulée in tp. 47, rge. 5, and beyond to the Tit Hills area in tp. 54, rge. 12, whereas the northeast boundary crosses North Saskatchewan River southwest of Elk Point and extends northwest to include an area only slightly north of St. Paul des Metis and Vilna to tp. 60, rge. 14. Within this belt water wells are common in the Ribstone Creek sands, which are almost without exception water-bearing in some part of the formation. The limits of the belt to the northeast determine the limits of water from this source, but to the southwest of the belt, as here outlined, water may be obtained in this formation by drilling through the younger beds that overlie it. The Ribstone Creek sands are a prolific source of water in many places, and hence the distribution of this formation is of considerable economic importance. Where the formation consists of upper and lower sands with a central shale zone only the sands are water-bearing, although thin sand members may occur in the shale. Where the formation is largely sand the distribution of water may be in any part of the formation, although the upper and lower sands are perhaps the better aquifers. To the east of Alberta along Battle River and Big Coulée in Saskatchewan the Ribstone Creek sands are marine. Marine conditions apparently become more prevalent to the southeast, and it is believed that in this direction the sands are gradually replaced by marine shales. Thus at some distance southeast of Battleford the Ribstone Creek formation loses its identity and its equivalents are shales in a marine succession.

Lea Park Formation

The Lea Park formation is largely a marine shale, and only in the upper 180 feet is there any water. In the Dina area south of Lloydminster the upper beds of the Lea Park consist of silty shales about 110 feet thick underlain by silty sands 70 feet thick. Below these sands are marine shales only, and these yield no fresh water either in east-central Alberta or west-central

Saskatchewan. The sand in the upper Lea Park formation is thus the lowest freshwater aquifer within a very large area. The extent of this sand in the Lea Park, particularly to the northeast, is not known, but as the strata in east-central Alberta have a southwest inclination, progressively lower beds occur at the surface to the northeast. Consequently, at a short distance beyond the northeast boundary of the Ribstone Creek formation, as previously outlined, the sand in the upper Lea Park reaches the surface, and represents the last bedrock aquifer in that direction. Farther northeast water must be obtained from glacial or surface deposits only. In Alberta this area without fresh water in the bedrock includes the country north of North Saskatchewan River in the vicinity of Frog Lake and a large area extending to and beyond Beaver River. In this area, however, more freshwater streams are present than farther south, and bush lands help to retain the surface waters. The area northeast of North Saskatchewan River in Saskatchewan is almost wholly within the Lea Park formation, where water can be found only in surface deposits.

TOWNSHIPS 39 TO 42, RANGES 5 TO 8, WEST FOURTH MERIDIAN, ALBERTA

Physical Features

The northeast part of this area is within the former Wainwright Buffalo Park Reserve, a gently rolling area of sand and sandy soil suitable only for grazing purposes. It lies north of the treeless area, and in part is park land with groves of poplar trees. Ribstone Creek crosses it from south to north. This is a freshwater stream, but flows only during the rainy periods of the year. Elsewhere numerous alkaline lakes lie in the depressions between rolling prairie land that has a relief of about 200 feet. Tit Hills, in the southwest part of tp. 39, rge. 7, is the most prominent feature within the area. These hills attain an elevation of about 2,550 feet, and rise 300 feet above Ribstone Creek Valley to the south. They thus appear to be prominent peaks in spite of their relatively low altitude. They are largely bare of vegetation, and the soil in their immediate vicinity is relatively poor.

GEOLOGY

Bad-land topography occurs within the Pale Beds to a very limited extent in the vicinity of Tit Hills. The tops of these hills may contain some Bearpaw strata, but mostly they are composed of Pale Beds of brown and dark shales and light-coloured bentonitic sands. Exposures of Pale Beds also occur in the vicinity of Bruce and Grant Lakes, but elsewhere exposures are relatively scarce. Bearpaw strata underlie the southwest part of the area. In sec. 5, tp. 39, rge. 8, part of the exposures in the valley of a small creek have the appearance of Pale Beds, with dark shales and white bentonitic sands, but outcrops both to the north and south are lithologically more like Bearpaw beds. It is probable, therefore, that the Pale Beds-Bearpaw contact is represented here by an interfingering of non-marine and marine strata. On the south of sec. 2, tp. 39, rge. 8, is an outcrop of strata lithologically similar to the Pale Beds. Near this outcrop, in a road-cut between townships 38 and 39 about the middle of the section, is an exposure of green sand with ironstone overlying dark shales. These beds are considered to be Bearpaw, and the contact of the Pale Beds and Bearpaw formation is at an elevation of about 2,385 feet. In the Tit Hills, only a few miles distant, Pale Beds are exposed above an elevation of 2,450 feet, and although the tops of Tit Hill contain no outcrops the rounded appearance is suggestive of easily eroded shales that may be Bearpaw. In the Northwest Company's well, on sec. 17, tp. 39, rge. 7, the base of the Variegated Beds is thought to have been reached at a depth of 780 feet. It is probable that 185 feet of Pale Beds are exposed in the Tit Hills area above the top of this well, so that the total thickness of Pale and Variegated Beds in this area is believed to be at least 965 feet.

Water Supply

In the area of sand and sand hills water accumulates in the sand and can be obtained in shallow wells. In tp. 42, rge. 8, several wells obtain water from a zone at an elevation of 2,230 to 2,240 feet, probably at the base of the drift, but many wells have been sunk into bedrock to find an adequate supply of water. In the vicinity of Tit Hills the Pale Beds appear to contain more shale than is usual elsewhere in this formation. For this reason, therefore, the formation has a less adequate supply of water, particularly in its upper part. Sands in the upper part of the Bearpaw are water-bearing in the southwest part of the area. It is possible that two or three deep wells in tp. 41, rge. 6, reached the Birch Lake sand at the base of the Variegated Beds, but this is very uncertain.

Township 39, Range 5. So far as known all the wells except one in this township obtain their water from glacial sands. One deep well reaches the underlying Pale Beds and was drilled to a depth of 555 feet. It encountered water at a depth of 235 feet, or an elevation of 2,021 feet, in what is probably the same group of sands that yields the water in several flowing wells elsewhere. The water in this well rises to an elevation of 2,246 feet, which is as high as that recorded for wells on secs. 23 and 26, tp. 38, rge. 4.

Township 39, Range 6. Several wells in this township are shallow and obtain their water from glacial sand and gravel deposits. One well, on SW. section 28, is reported to have encountered fine gravel at a depth of 196 feet or an elevation of 2,085 feet, but it is probable this is not glacial material as other wells that reach this level in this general area are in Pale Beds. Two wells on section 21 reach Pale Beds at an elevation slightly above 2,100 feet, but in one of these fine sand plugs off the water supply. Undoubtedly an adequate supply of water everywhere exists in the Pale Beds, although deep wells are necessary to obtain it.

Township 39, Range 7. In this township are many outcrops of Pale Beds, particularly in the vicinity of Tit Hills and on the steep bank of Grant and Bruce Lakes. Consequently, the glacial deposits are thin, but many shallow wells in them yield water. A well drilled for water to a depth of 200 feet on SE. section 2 reached a water sand in the Pale Beds at an elevation slightly above 2,100 feet. The Northwest Company's well drilled for oil and gas on NW. section 17 is reported to have encountered three freshwater horizons in the Pale and Variegated Beds at depths of 224, 440, and 600 feet, or at elevations of 2,043, 1,827, and 1,667 feet respectively. No further water was reported above the Lower Cretaceous formations, where the water contains a high content of salts. The base of the Pale and Variegated Beds in this well is presumably at a depth of 780 feet or an elevation of about 1,485 feet.

Township 39, Range 8. Most of the wells in this township are from 20 to 50 feet deep, and one is 65 feet deep. The elevation of the water-bearing bed shows marked regularity in many wells. It is assumed that all the wells are in glacial sands, but the regularity of a water-bearing sand at an elevation of about 2,400 feet suggests that the horizon might be a sand in the Bearpaw formation, as a green sand considered to be Bearpaw occurs in a road-cut on the township line south of sec. 2 at an elevation of 2,350 feet.

Township 40, Range 5. This township is largely an area of sand and sandy soil, and most wells are less than 20 feet deep. Only two are known to exceed 30 feet, the deeper of these being 75 feet but still, so far as known, in glacial materials. The relief of the surface is not great, and it is thought that the rainfall has accumulated in the base of the sand deposits resting on more impervious clays. No difficulty need, consequently, be experienced in obtaining water anywhere in this township.

Township 40, Range 6. In the southern and central part of this township are several outcrops of Pale Beds, and the drift is relatively thin. However, most of the wells in this southern and central part are very shallow and are in the drift. In the northern part several wells are 100 to 200 feet deep, and one is 257 feet deep. All obtain water in the Pale Beds. The most prominent water-bearing sand occurs at an elevation of about 2,155 feet in wells on sections 32, 33, and 34. The deepest sand reported is that in the well 257 feet deep on section 31 at an elevation of 2,057 feet. It is possible that this well was drilled below the water-bearing sand and that the elevation of the sand may be higher than reported. In this case the sand may be the same as that which occurs in a well 165 feet deep on SE. section 33 at 2,098 feet.

Township 40, Range 7. Most of the wells in this area probably derive their water from glacial sands at depths of less than 60 feet. These sands are irregularly distributed between elevations of 2,215 and 2,375 feet, and most of the wells strike water-bearing sands not far below the surface. This is interpreted to mean that such beds are numerous even though individual beds may not be of great lateral extent. At least two sand zones in the Pale and Variegated Beds are encountered in drilled wells. One of these occurs between elevations of 2,120 and 2,160 feet, and the other, reported in a well 460 feet deep on NW. section 7, occurs at an elevation of 1,963 feet. No water was reported at this level in the Northwest Company's well drilled 5 miles to the south, indicating that the water-bearing sand is probably not extensive.

Township 40, Range 8. In the south part of this township the Pale Beds are presumed to be overlain by a little Bearpaw, and a few wells, such as those in tp. 39, rge. 8, obtain water possibly in a Bearpaw sand at an elevation of about 2,400 feet. This sand is so widespread as to suggest that it may be in the Bearpaw formation rather than in glacial material. Several shallow wells in the township, however, are known to be in glacial materials. In a few wells more than 100 feet deep the underlying Pale Beds have been tested. In some wells water occurs in sands between elevations of 2,280 and 2,330 feet, and in one well, on SW. section 14, a water-bearing sand at an elevation of 2,077 feet is reported at a depth of 345 feet. In another well, on SW. section 17, no water was encountered to a depth of 360 feet, although the well at this depth had passed through the horizon of the water-bearing bed of the well on SW. section 14.

Township 41, Range 5. Surface water accumulates in the sand and sandy soil that covers much of this township, and can be obtained in relatively shallow wells. At a few places, as indicated in the records, wells have been dug or bored into glacial materials where water is found in sands at elevations of 2,180 to 2,200 feet. No wells, so far as known, reach bedrock in this area, although sands in the Variegated Beds and in Birch Lake and Ribstone Creek formations are water-bearing.

Township 41, Range 6. A few wells, less than 100 feet deep, obtain water in this area from sands in the glacial drift. Others reach the bedrock and obtain water in the Variegated Beds and Birch Lake sands. The Birch Lake sand has an elevation of 1,950 to 1,970 feet, whereas the Variegated Beds produce water from several sands. In the northern part of the township a sand in the Variegated Beds occurs in sections 31, 33, and 34 at an elevation between 2,060 and 2,080 feet. This may be the same sand that occurs in section 6 in the southwestern part of the township in a well 230 feet deep and at an elevation of 2,084 feet. If so, the sand may be quite widespread. Another sand occurs in the south part of the township at an elevation of 2,105 to 2,110 feet, and a higher one between elevations of 2,150 and 2,160 feet, with some still higher sands in individual wells.

Township 41, Range 7. In this area a few wells obtain water in sand in glacial drift at depths up to 60 feet. The main supply of water, however, comes from wells drilled into the underlying Pale Beds. The sands in the Pale Beds are, in this township, of limited lateral extent, and, consequently, only closely spaced wells are likely to encounter water in the same bed. For example, two wells 300 to 310 feet deep respectively, on section 16, and one well 273 feet deep on NE. section 17 obtain water at an elevation of about 2,045 feet. It is possible that the well 295 feet deep on NE. section 36 also taps this bed. Again, a water-bearing sand is found in two wells, on NE. section 20 at a depth of 196 feet and on NE. section 28 at a depth of 150 feet, where the water-bearing sand has an elevation of 2,185 to 2,190 feet. The remaining wells that obtain water from the Pale Beds are each in a separate sand. In this area, therefore, as has been previously indicated, the inference is that the Pale Beds are more shaly than farther east, with the sand bodies restricted in lateral extent.

Township 41, Range 8. The wells in this township that obtain water from the drift are in part quite shallow and in part 50 or more feet deep. The sands from which the water comes do not occur at any uniform level, but apparently are widely distributed at various elevations in the glacial materials and in certain localities are absent. In a few instances, therefore, search has been made for water by drilling wells into the underlying Pale Beds, and at least two water-bearing sands have been found. One of these, at an elevation of 2,275 feet, was encountered in a well on SE. section 4 at a depth of 150 feet, and in a well on NE. section 14 at a depth of 100 feet. The other sand occurs only in one well, 320 feet deep, on SE. section 12 at an elevation of about 2,030 feet.

Township 42, Ranges 5 and 6. The part of these townships not within the Buffalo Park Reserve is covered by sandy soil in which water can be obtained in very shallow wells. In a few places wells have been bored to sands in the glacial deposits, but no wells have been sunk to the underlying bedrock.

Township 42, Range 7. All the wells of which records have been collected in this township reach the Pale or Variegated Beds, and several sands have been found to be water-bearing. The highest of these, at an elevation of 2,220 to 2,225 feet, occurs in wells on NE. section 2 at a depth of 160 feet, and on NW. section 6 at a depth of 65 feet. This may be the same horizon as that encountered in NW. sec. 34, tp. 41, rge. 7, at a depth of 129 feet or an elevation of about 2,230 feet. Another, deeper sand zone occurs here at an elevation of about 2,090 feet in a well on SW. section 4 at a depth of 266 feet and in a well 285 feet deep on NW. section 12. A still deeper horizon, perhaps in the Variegated Beds, occurs at a depth of 333 feet or an altitude of about 2,025 feet in a well, 333 feet deep, on NW. section 4. Another sand, in the Pale Beds, occurs in two wells at an elevation of 2,165 feet on SW. section 14 at a depth of 245 feet and on NE. section 16 at a depth of 230 feet. Thus quite a number of sands in the bedrock in this area yield water, and at least one, namely that at an elevation of 2,220 to 2,225 feet, may be quite widespread.

Township 42, Range 8. Several wells in this township obtain water from sands in glacial materials at depths of 10 to 55 feet. It is probable that the maximum thickness of the drift is about 55 feet. In the drift a sand and gravel zone at elevations of 2,230 and 2,240 feet is quite widespread. It is possible this is an outwash deposit lying in front of a moraine at or close to the base of the drift. Deeper wells have found water-bearing sands in the Pale Beds. The sand that in tp. 42, rge. 7, lies at an elevation of 2,220 to 2,225 feet was encountered in a well 80 feet deep on SE. section 2, and in two other wells at an elevation of 2,216 feet. One of these, on SW. section 24, is 168 feet deep, and the other, on SE. section 32, is 100 feet deep. The water sand that in tp. 42, rge. 7, occurs at an average elevation of 2,090 feet was encountered in a well, 208 feet deep, on NW. section 28, in a well, 205 feet deep, on SW. section 32, and possibly in a well, 200 feet deep, on NE. section 31. Another, somewhat higher water sand occurs only in one well, on SE. section 14, at a depth of 145 feet or an elevation of 2,176 feet.

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.