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GROUNDWATER POTENTIAL, BLOOD INDIAN RESERVE, ALBERTA

(Report and 4 figures)

J. S. Scott

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By

J.S. Scott

DEPARTMENT OF

MINES AND TECHNICAL SURVEYS

CANADA

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GROUNDWATER POTENTIAL, BLOOD INDIAN RESERVE, ALBERTA

INTRODUCTION

Location

The Blood Indian Reserve occupies an area of approximately 500 square miles in southern Alberta between the city of Lethbridge and the town of Cardston and is contained within map-area 82H (National Topographic System). Boundaries of the Reserve are marked by Belly River on the west, Oldman River on the northeast, St. Mary River on the east and on the south by a line between St. Mary and Belly Rivers at the latitude of Cardston (49°12'30"N lat.).

An additional 9 square miles known as Blood Indian Reserve Timber Limit is located within Waterton Lakes National Park (N.T.S. map-area 82 H/4, E 1/2).

Climate

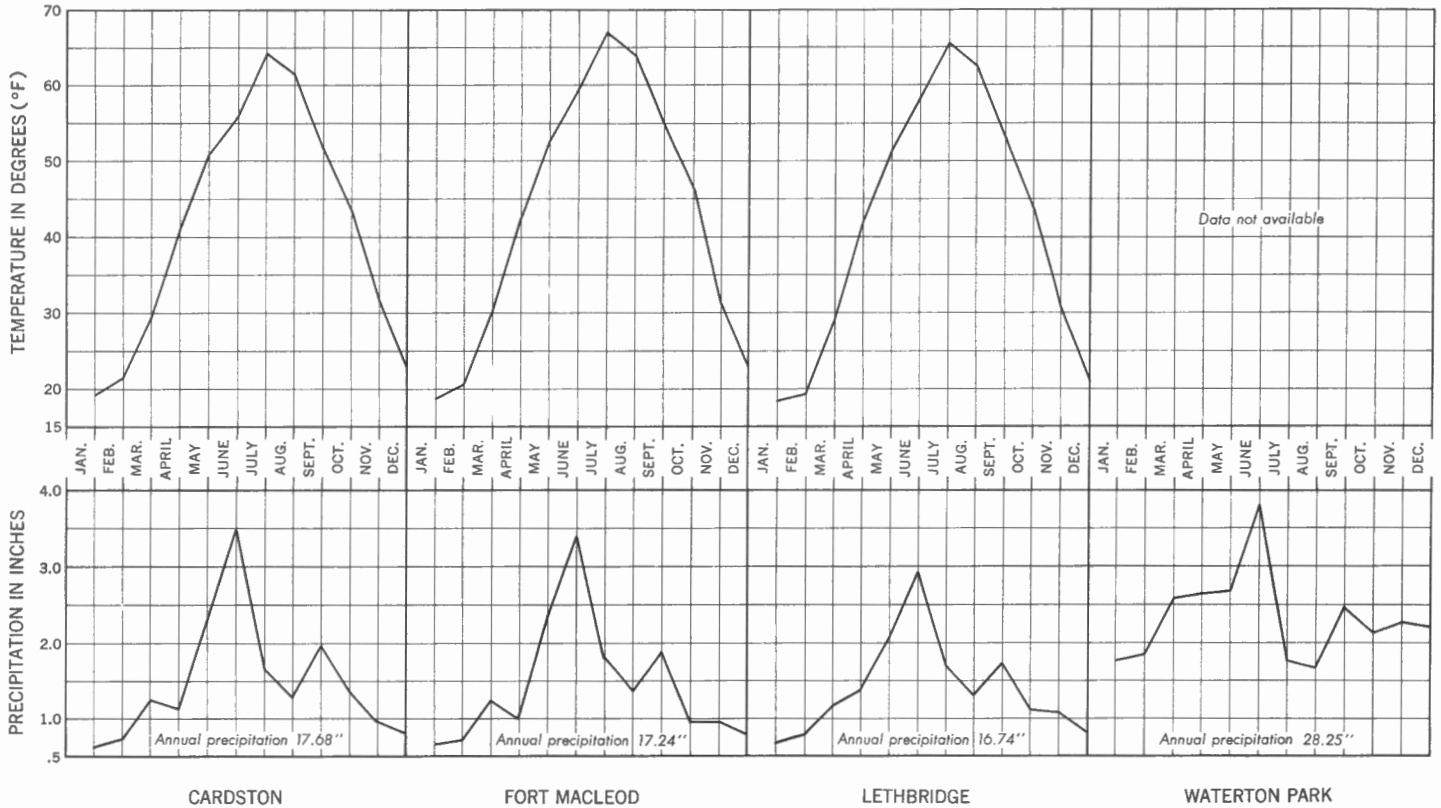
The main part of the Reserve occurs within the southwestern part of the Prairie Grassland climatic region as defined by Kendrew and Currie (1955).

As moisture-laden air masses derived from the Pacific Ocean are shielded from the area by the western mountain ranges the Reserve lacks available sources for abundant precipitation. The mean annual total precipitation over a large part of the climatic region is less than 15 inches (Dept. of Transport, 1959b); in the Blood Indian Reserve area, however, the normal annual precipitation is about 17 inches (Dept. of Transport, 1959a), as shown on Figure 1.

Precipitation shows wide variations from year to year with differences between extreme annual amounts commonly exceeding the mean annual total.

The range of temperature normals for the warmest and coldest months in the Blood Reserve area is 45°F (see Fig. 1). Daily temperatures, however, range from a low of -50°F in winter to more than 100°F during summer.

Most of the annual precipitation occurs during the warmest part of the year (Fig. 1). Consequently consumptive use and transpiration of moisture by vegetation, direct evaporation, and run-off allow only a very small percentage of the moisture to be available as groundwater recharge. It is possible that groundwater recharge may occur only during years of above normal precipitation and when soil moisture capacity has been satiated.



Data based on the period 1921-1950 from information obtained from Circular 3208, Meteorological Branch, Department of Transport

GSC

Figure 1. Temperature and precipitation normals, Blood Indian Reserve area

Purpose and Scope of Work

A groundwater study of Blood Indian Reserve was made at the request of the Indian Affairs Branch, Department of Citizenship and Immigration, to form a part of the economic development survey and study of the Reserve.

The writer spent the last half of August, 1962, in the field examining occurrences of springs, wells, and bedrock outcrops. Many of the wells had been abandoned and logs of those in use were not available from local well drillers; thus no quantitative assessment of groundwater potential based on well performance could be made either for the main part of the Reserve or the Timber Limit.

This report is, therefore, a qualitative assessment of groundwater potential based on field observations, interpretation of bore-hole logs from seismic and petroleum exploration, and published geological data.

Acknowledgments

A compilation of seismic shot-hole data, from which drift thickness contours and location of potential aquifers in surficial materials were interpreted, was kindly supplied by Dr. A.B. Irwin, Supervisor of Mineral Resources, Indian Affairs Branch, Calgary, Alberta.

Determination of regional bedrock structure was greatly facilitated by interpreted logs of petroleum exploration bore-holes supplied by Western Plains Office, Geological Survey of Canada, Calgary, Alberta.

Able field assistance was given by R.E. Borstmayer.

GEOLOGY

Rocks exposed on Blood Indian Reserve comprise mainly shale and sandstone, which range in age from Upper Cretaceous to Paleocene.

These rocks have been folded into the structure known as the Alberta Syncline. The axis of the syncline trends northwest across the southern part of the Reserve and separates the area into two structural zones. North of the axis beds dip gently west and southwest with inclinations of approximately 120 feet per mile. South of the axis the rocks have been folded and thrust faulted into a series of northwest-trending ridges, which constitute the Disturbed Belt. Within the Disturbed Belt dips of 30 to 40 degrees to the northeast and southwest are common (Williams, 1949).

Prior to glaciation of the area during the Pleistocene Epoch valleys were eroded in the bedrock surface and deposits of sand and gravel were laid down in parts of these valleys.

During the Pleistocene Epoch advance of glaciers across the area resulted in the deposition of till. Proglacial lakes formed in front of the receding glaciers, and much of the Reserve is now covered by fine sediments deposited in these lakes. In some places sand and gravel were deposited by streams that flowed into the proglacial lakes.

Table I

Table of Formations
(after Williams, 1949)

Era	Period or Epoch	Formation	Lithology
CENOZOIC	Recent and Pleistocene	(0'-200' +)	Till, lacustrine silt, clay, fluvial sand and gravel
CENOZOIC AND MESOZOIC	Paleocene and Upper Cretaceous	Willow Creek (1,000' +)	Shale, sandstone
MESOZOIC	Upper Cretaceous	St. Mary River (1,160' ±)	Shale, sandstone, oyster shell beds
		Blood Reserve (40'-100' +)	Sandstone
		Bearpaw (400'-600' +)	Soft clay shale, minor sandstone
		Belly River (2,200 +)	Sandstone, shale, minor coal

Bedrock Geology

Belly River Formation

Exposures of the Belly River Formation occur only in the Disturbed Belt in the southwestern part of the Reserve, where these older rocks have been brought to the surface by faulting.

The formation is approximately 2,200 feet thick and comprises light grey to greenish grey, fine-grained sandstone interbedded with shale and sandy shale. Minor beds of coal, limestone, and bentonite also occur within the formation.

Bearpaw Formation

The formation is exposed both in the Disturbed Belt and along the valleys of Oldman and St. Mary Rivers in the northeastern part of the Reserve. The rocks are dark brownish grey, soft, laminated shale containing thin layers of bentonite and fine-grained sandstone.

The thickness of the formation encountered in bore-holes north of the axis of Alberta Syncline is approximately 600 feet.

Blood Reserve Formation

The formation consists entirely of thick-bedded, massive, uniform, coarse- to medium-grained sandstone. The uniform lithology of the formation is in marked contrast with the variable lithology of the other formations underlying the Reserve.

Figure 2 shows the Blood Reserve Formation as occurring only on the eastern side of the Reserve because the outcrop width there is sufficiently large to be shown at the scale of the map. Other outcrops of the formation, not shown on Figure 2, also occur within the Disturbed Belt, between Bearpaw and St. Mary River Formations.

Russell (1932, p. 32B) measured 77 feet of the sandstone in the outcrop area in the northeastern part of the Reserve and found that the formation thins rapidly to the north, because only 40 feet of sandstone that could be identified as Blood Reserve were found in the valley of Oldman River.

St. Mary River Formation

The base of the St. Mary River Formation is marked by Ostrea (oyster) coquina beds and thin coal seams. The oyster beds, which are up to 25 feet thick in the southwestern part of the Reserve, are less than 2 feet thick in its northeastern part. These oyster beds, although of variable thickness, are probably continuous beneath the Reserve.

The remainder of the formation contains hard, massive, medium-grained, lenticular beds of sandstone interbedded with friable sandy shales.

The thickness of the formation is approximately 1,200 feet.

Willow Creek Formation

Rocks of the Willow Creek Formation comprise soft weathering, interbedded, grey, green and maroon shales and greenish grey fine-grained sandstone. Good exposures of the formation occur on Mokowan Ridge northeast of Stand Off.

The thickness of the formation is approximately 1,000 feet.

Surficial Geology

Preglacial Gravel

Deposits of preglacial gravel do not appear at surface but have been observed in stream cuts and encountered in seismic shot-holes.

Sand and gravel occurring at the base of the drift (Fig. 2) are probably of preglacial origin. The largest area of these deposits, determined from seismic shot-hole data, is along the west side of the Reserve north of Mokowan Ridge within the valley of preglacial Belly River as shown by Stalker (1961).

Other smaller areas of preglacial gravel are confined mainly to valleys that were tributary to preglacial Belly, St. Mary, and Oldman Rivers.

The thickness of the gravel is generally from 10 to 20 feet, although thicknesses of 40 feet were encountered in some shot-holes.

Till

Till underlies the entire Reserve except for areas of bedrock outcrop. Silt- and clay-sized particles are the dominant size fractions and have been compacted by processes of glaciation to form a hard dense material. Stones are present in relatively minor amount in the till.

Lenses and pockets of sand and gravel, which are common within till throughout western Canada, have been encountered in seismic shot-holes on the Reserve (Fig. 2).

The range in depth figures shown on Figure 2 indicate the maximum and minimum depths at which sand and gravel were encountered within the areas as mapped and do not signify the presence of continuous sand and gravel between the depths shown. The thickness of sand and gravel encountered in any bore-hole is generally from 5 to 20 feet.

As till constitutes the bulk of the glacial drift on the Reserve, the drift thickness contours shown on Figure 2 indicate the thickness distribution of till. The preglacial tributary valleys contain drift thicknesses in excess of 200 feet, whereas the upland surfaces are either drift free or are covered by 25 feet or less of drift.

Glacio-lacustrine Deposits

Approximately 50 per cent of the Reserve is covered by silt and clay deposited within proglacial lakes. These deposits are confined mainly to areas of low relief north of the Disturbed Belt.

Alluvium

Valleys of Belly, St. Mary, and Oldman Rivers contain deposits ranging in grain size from boulders to silt. The coarser materials are more abundant in the Reserve where steeper gradients of Belly and St. Mary Rivers occur.

Minor quantities of sand and gravel, derived from erosion of glacial deposits, have been deposited by streams tributary to the major rivers bordering the Reserve.

Surficial deposits of sand and gravel, of limited areal extent, occur in the Disturbed Belt. Some of these deposits are probably of Pleistocene age and were formed by streams flowing north into the proglacial lakes.

The thickness of alluvial deposits is generally 20 feet or less.

A more detailed description of the surficial geology of Blood Indian Reserve is given by Stalker (1963).

POTENTIAL SOURCES OF GROUNDWATER

Occurrence and Movement

The portion of precipitation that becomes groundwater moves through connected interstices of soils and rocks, which may be intergranular pore spaces or open fractures, in a direction governed by the hydraulic gradient. The rate of movement of water through the interstices (permeability) is controlled by the size of the openings. Intergranular permeability is generally higher for coarse-grained materials (sand and gravel) than for fine-grained materials (silt and clay), but no definite relationship between permeability and grain size is possible because of great variations in permeability of various admixtures of coarse- and fine-grained materials. Fractures also are extremely variable in size and extent, hence permeability, but they are generally more open near surface.

In order to be of practical value as a source of groundwater supply the water-bearing zone (aquifer) must yield water freely to wells. Fine-grained materials, although completely saturated, retain most of their water by capillary or molecular forces and thus are poor aquifers. Coarse-grained materials, on the other hand, yield a large percentage of their intergranular water and thus form good aquifers.

In most areas of western Canada a water-table map constructed on the basis of data obtained from shallow wells (depth less than 50 feet) and springs shows a distinct similarity in configuration of the water table to the topographic surface. It is possible, therefore, to predict that the water-table configuration of Blood Indian Reserve would be similar to the topographic surface at a depth of 15 to 20 feet below surface.

A water-table map, however, illustrates only the horizontal component of groundwater flow and thus would be similar to a surface drainage map.

The vertical component of groundwater flow is of greater significance because it determines the direction of recharge to aquifers at depth and consequently determines the most favourable locations for wells.

The direction of groundwater movement within an area can be most readily determined from observations of water levels in wells of various depths throughout an area. Areas of recharge or downward movement of groundwater are characterized by decreases in hydraulic head in the well with increasing depth i.e. the static water level in deeper wells will be lower than the static head in shallower wells assuming that water is permitted to enter only at the base of the well. Areas of discharge or upward movement of groundwater are characterized by an increase in hydraulic head with an increase in well depth. Flowing artesian wells are commonly located in areas of groundwater discharge. Wells located in the zone of lateral groundwater movement show no change in hydraulic head with depth.

In an area where water well data are not available, such as Blood Indian Reserve, an approximation of the groundwater flow pattern may be obtained by analogy with other areas of similar topography, climate, and geology.

Meyboom (1962), in a study of groundwater movement in the headwater region of Qu'Appelle River, Saskatchewan, has described a groundwater flow system, termed the prairie profile, that is applicable to conditions in western Canada. The prairie profile, by definition (Meyboom, ibid.) "...consists of a central topographic high bounded at either side by an area of lower elevation. Geologically the area is made up of two layers of different permeability, the upper layer having the lower permeability. Through the profile is a steady flow of groundwater from the area of recharge to the area of discharge. The ratio of permeabilities is such that groundwater flow is essentially downward through the material of low permeability and lateral and upward through the underlying more permeable layer."

It may be seen from Figure 2 that Blood Indian Reserve possesses the essential topographic elements of the typical prairie profile. The major watershed between Belly and St. Mary Rivers is located along the central topographic high and the Reserve is bounded on both the east and the west by areas of lower elevation.

Mean annual precipitation in the Blood Indian Reserve area is 17.22 inches, which is only slightly higher than the 16.50 inches reported for the Qu'Appelle River area. Other climatic factors of the two areas have sufficient similarity to warrant validity of the analogy.

The Qu'Appelle area is underlain by till that rests upon nearly horizontal marine shale of the Upper Cretaceous Bearpaw Formation. The till and shale form the upper layer of the prairie profile. The lower part of the Bearpaw Formation and the upper part of the underlying Belly River Formation contain sandy layers that form the lower layer of the prairie profile, which has the higher permeability.

Section B-B' on Figure 2 shows the relationship of geological formations underlying Blood Indian Reserve. The layer of glacial drift, consisting mainly of till, and the underlying beds of Willow Creek Formation and the upper part of St. Mary River Formation correspond with the upper layer of the prairie profile. Sandstone layers at the base of St. Mary River Formation and the entire thickness of Blood Reserve Formation correspond with the more permeable lower layer of the prairie profile.

The direction of groundwater movement in Blood Indian Reserve is downward in the recharge area, a zone centred about the major watersheds, then through a lateral transition zone composed of the sandstone layers of lower St. Mary River and Blood Reserve Formations and upward in the discharge areas overlain by Belly and St. Mary Rivers.

The presence of near-surface groundwater flow on the Reserve is indicated by the presence of springs (Fig. 2) and perennial surface streams that originate from spring flow, such as Prairie Blood Coulee and Layton Creek.

In the Stand Off area an artesian source of water is obtained in the Belly River flats at a depth of 50 feet, which indicates a zone of groundwater discharge. Considerably more well data would be required, however, to verify the pattern of groundwater flow.

Bedrock Sources

The sandstone layers within the lower part of St. Mary River Formation and the entire thickness of Blood Reserve Formation are thought to be the best potential bedrock aquifers underlying the Reserve.

No water wells on the Reserve are known by the writer to have penetrated these sandstone layers; however, water has been encountered in these rocks in areas adjacent to the Reserve.

Yarwood (1931) has described the stratigraphy encountered in the Spring Coulee Well (Sec. 15, T. 4, R. 23W4M) approximately 14 miles northeast of Cardston. The basal 305 feet of the St. Mary River Formation as penetrated by the well consists of grey-green sandy shales and beds of grey sandstone. One of the sandstone beds, according to Yarwood (ibid.) serves as a source of water supply for local residents. The lower 20 feet of the Fox Hills (Blood Reserve) Formation encountered in the same well also contained water.

The Blood Reserve Formation is of particular interest as a potential aquifer. Sanderson (1931, p. 1252) in describing the Fox Hills (Blood Reserve) Formation in southern Alberta stated: "A remarkable feature of the formation in Alberta is the remarkable uniformity of grain size and degree of rounding of the particles."

In a discussion of the paper by Sanderson (1931), Irwin (1931, p. 1262) commented: "In its remarkable lateral extent the Fox Hills (Blood Reserve) is similar to the Dakota sandstone but is more similar in its lithology and mode of deposition to the Eagle (Milk River) sandstone."

The Milk River Sandstone forms an artesian aquifer in the area centred about Foremost, Alberta, which is approximately 70 miles east of Blood Indian Reserve. The geology and hydrology of the Milk River Sandstone in southern Alberta have been well documented by Meyboom (1960).

The yield of wells that tap the Milk River Sandstone, as reported by Meyboom (op. cit., p. 37), is generally less than 5 gallons per minute, which is a reflection of the low permeability of the aquifer. The lithologic similarity of the Blood Reserve Formation to the Milk River Sandstone would indicate the possibility that the Blood Reserve Formation would also be an aquifer of low yield.

The location of sandstone of the Blood Reserve Formation and sandstone beds in the lower part of the St. Mary River Formation within the postulated groundwater flow system in a position favourable for artesian flow, the fact that these rocks contain water in a nearby area and the similarity of these rocks to a known artesian aquifer are sufficient indication to warrant exploration of these formations for groundwater. The location of three proposed test holes is shown on Section B-B', Figure 2. Borings at these locations would provide sufficient preliminary data to assess the potential of the sandstones as aquifers and would provide a guide for further exploration.

Surficial-Material Sources

Sand and gravel layers have the greatest potential as aquifers within deposits of surficial materials. The location of the deposit, however, within the flow system is a prime factor in determining the value of the layer as an aquifer. Aquifers within zones of downward movement of groundwater (recharge areas) are least desirable because the effect of withdrawal of water from the aquifer by a well is added to the natural loss in hydraulic head by downward flow. Withdrawal of water from aquifers in zones of lateral or upward movement also causes a decline in hydraulic head in the aquifer but the decline is partly offset by components of natural flow.

Sand and Gravel at Base of Drift

The best potential aquifers in surficial materials are deposits of sand and gravel that occur at the base of the drift as indicated by the association of most of the areas of flowing wells (Fig. 2), encountered during seismic drilling, with these deposits.

An extensive area of sand and gravel east of Belly River and 12 miles north of Stand Off constitutes the most favourable area for groundwater supply on the Reserve. These deposits occur within the preglacial valley of Belly River and are within the zone of upward groundwater flow.

Gravel deposits at the base of the drift at the north end of the Reserve are also probably within the zone of upward flow and thus have a high potential as aquifers.

Other localities of sand and gravel at the base of the drift, as shown on Figure 2, are of limited areal extent and are, consequently, of lesser value as potential aquifers.

The depth to the sand and gravel can be readily determined from the drift thickness contours shown on Figure 2.

Sand and Gravel within Drift

The limited areal extent of sand and gravel within the drift precludes the development of such deposits as a major source of groundwater supply. Figure 2 shows the location and range in depth of sand and gravel within drift as encountered in seismic shot-holes. It is probable that deposits of this kind are more extensive than shown on Figure 2 but it is not possible to predict the occurrence of these deposits.

Surface Deposits of Sand and Gravel

The valleys of Belly and St. Mary Rivers contain sand and gravel from which supplies of groundwater could be readily developed. The proximity of these deposits to an abundant source of surface water may tend to reduce the desirability of developing a groundwater supply from this source. A properly constructed well or infiltration gallery within sand and gravel deposits adjacent to a river, however, eliminates the problem of ice damage to pipe line intakes inserted in the river and also reduces the hazard of contamination to which surface water supplies are prone.

Springs were observed issuing from the base of surface deposits of sand and gravel along Bullhorn Coulee at the south end of the Reserve indicating the deposits are, in part, saturated and could be developed to yield small quantities of groundwater.

YIELD OF AQUIFERS

It is not possible to state definitely the probable yield of potential aquifers on the Reserve without quantitative data from wells.

In other areas of western Canada, in which conditions of climate and geology are similar to those of the Reserve, it has been found from pump tests that water discharged from the aquifer is being withdrawn from storage; i.e. the amount of withdrawal by pumping is in excess of the amount replenished to the aquifer by natural recharge. Under such conditions continued withdrawal from the aquifer will ultimately deplete the aquifer. The time required for depletion is a function of pumping rate and the size and hydrologic characteristics of the aquifer.

Many domestic wells in western Canada that have been developed either in surficial materials or in bedrock commonly yield 10 gallons per minute or less. Wells of this capacity are entirely adequate for domestic consumption and the watering of several hundred head of stock.

It is probable that wells producing water from potential aquifers on the Reserve would be capable of yielding 10 gallons per minute and thus be suitable sources for domestic use or for stock watering. Wells of higher yield might be developed from gravels within the valley of preglacial Belly River, but it is unlikely that any of the potential aquifers are capable of supplying the large quantities of water required for industrial or irrigation purposes.

QUALITY OF WATER

Samples of water obtained from springs, wells, and streams collected during the field work were analysed in the field with an Industrial Instruments Inc. Conductivity Bridge (Model RC-16B2) and a Hach Chemical Kit (Model 43-AP).

The sources from which water samples were obtained, as shown on Figure 2, are thought to be representative of the various sources of water available on the Reserve, but do not represent an exhaustive sampling of any particular source. Field analysis of water quality is not intended to substitute for more extensive laboratory analysis, but the parameters measured in the field serve as a useful guide to the relative quality of water from the various sources.

The parameters measured in the field were specific conductance, hardness, iron, pH, and chlorite; the results of the analyses are shown graphically in Figure 3.

The specific conductance of water is a measure of the ability of the water sample to conduct an electric current, which is governed by the concentration of ions within the water. Conductivity is, therefore, an indication of the concentration of total dissolved solids. No absolute relationship exists between conductance and dissolved solids but the following equation given by Hem (1959) indicates the empirical relationship:

Specific Conductance (micromhos at 25°C) x A = Dissolved Solids (parts per million).

The factor A has generally, according to Hem (op. cit.), a value between 0.55 and 0.75 unless the water has an unusual composition.

No attempt has been made to convert the specific conductance values shown on Figure 3 into parts per million dissolved solids because the conductance values themselves are sufficient to indicate differences in relative quality.

As shown on Figure 3 the maximum values of specific conductance are greater in waters from wells and springs than in surface waters which is in agreement with the general trend of increase in total dissolved solids with the depth from which the water is obtained. The property of hardness of water is generally associated with the effects in the use of soap or with deposits resulting from heating of water. Reaction with soap of some chemical elements dissolved in water, particularly calcium and magnesium, produces insoluble compounds that form the familiar soap scum. Heating of

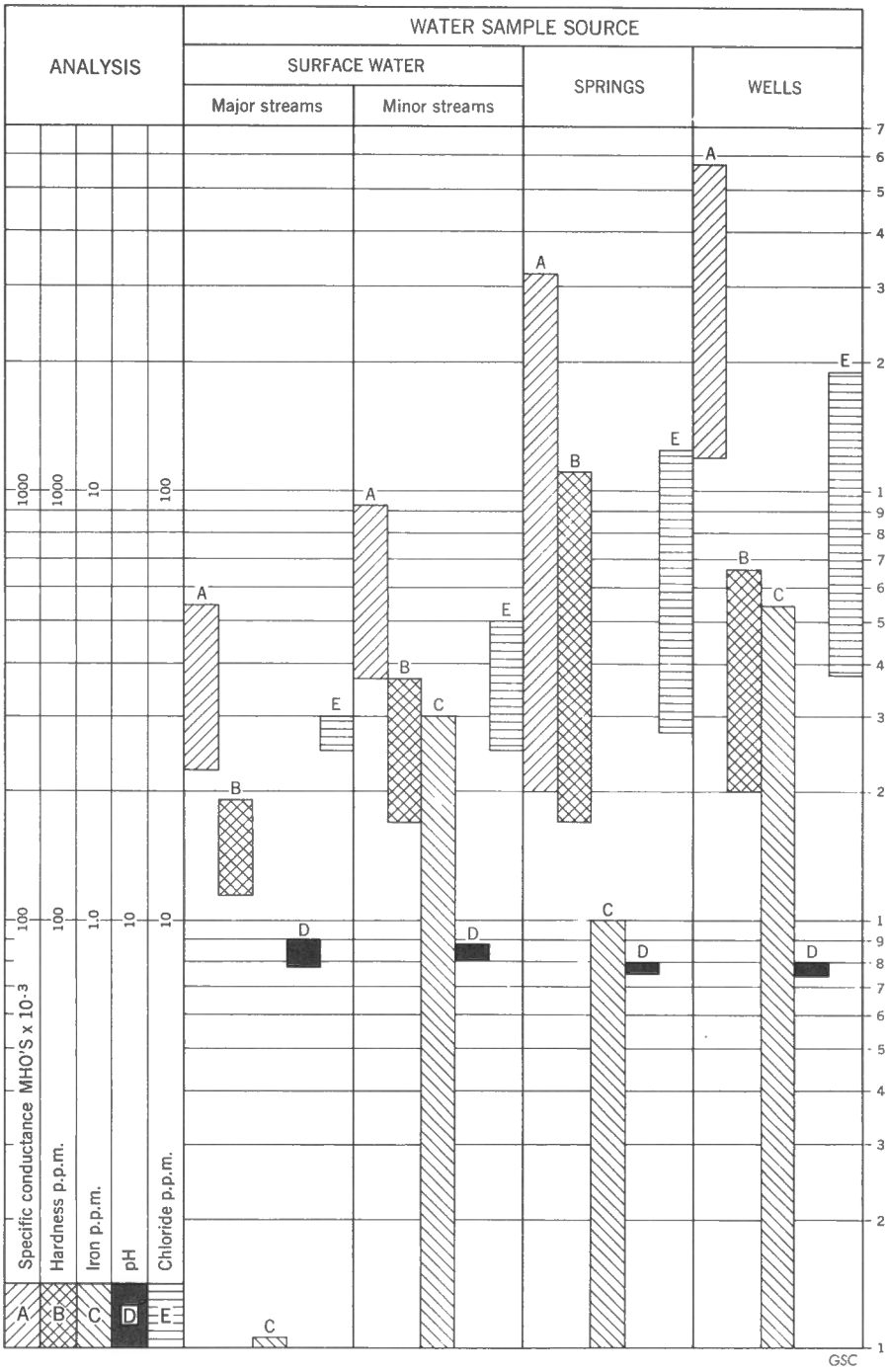


Figure 3. Quality of water, Blood Indian Reserve

water reduces the solubility of calcium carbonate, which is one of the main compounds that forms an encrustation on cooking utensils or boiler tubes.

Samples of spring water contained the highest concentration of elements contributing to hardness; lower concentrations occurred in samples from wells, minor streams, and major streams.

The presence of iron in water may produce an objectionable taste to the water as well as leaving undesirable stains on laundry or cooking utensils. Waters from major streams contain only a trace of iron whereas waters from the other sources sampled contained appreciable quantities. It may be that a part of the high concentration of iron in well water came from oxidation of the steel well-casing and thus may not indicate the true concentration of iron in the well water.

The pH of water is a measure of the acidity or alkalinity of the water. Pure water has a pH of 7.0. Waters having a pH value below 7.0 are acid whereas those having values above 7.0 are alkaline. Samples of water from all sources had pH values greater than 7.0.

The chloride content of the waters sampled follows the trend of specific conductance with the highest chloride concentrations being found in well water samples.

The relative quality of water from any source is determined by the use to be made of the water. It is presumed that water would be used on Blood Indian Reserve primarily for domestic and stock consumption.

Hem (1959) has given limits of mineral components in water that form a standard for drinking-water as established by U.S. Public Health Service. The standard is based on a more extensive number of components than those analysed from the Reserve; however, a comparison of the field analysis data with part of the standard, as given in Table II, provides a basis for a preliminary evaluation of quality of water from the various sources on Blood Indian Reserve.

It is apparent from Table II that major streams are the only source of water supply having a quality, based upon the parameters analysed, within the drinking-water standards set by U.S. Public Health Service. Water from wells is the most highly mineralized and is, consequently, of the lowest quality.

Most animals are able to use water of considerably lower quality than would be considered satisfactory for humans. Hem (op. cit., p. 241) reported that range cattle in the western United States are able to use water containing 5,000 ppm dissolved solids and that beef cattle have become accustomed to using water containing up to 10,000 ppm dissolved solids. Water supply from wells, therefore, although of poor quality for human consumption may be entirely satisfactory for stock watering.

Supplies of water from any source to be used for human consumption should be analysed by a Federal or Provincial Department of Health to determine the water quality from the standpoint of bacterial content.

Table II

Comparison of Quality of Water from Blood Indian Reserve with Drinking-water Standards of U.S. Public Health Service

Component (ppm)	U.S. Public Health Service Drinking-water Standards	Blood Indian Reserve			
		Major Streams	Minor Streams	Springs	Wells
Total dissolved solids[1]	500 (good) 1,000 (fair)	140 to 360	245 to 600	130 to 2,100	780 to 3,800
Hardness	200 (good)	115 to 190	170 to 375	170 to 1,100	200 to 660
Iron plus manganese[2]	0.3	0 to 0.11	0.1 to 3.0	0.1 to 1.0	0.1 to 5.5
Chloride	250	25 to 30	25 to 50	27 to 125	37 to 190

[1]Values of total dissolved solids for samples from the Reserve were assumed to be 65 per cent of specific conductance values.

[2]Values shown for the Reserve are for iron only.

BLOOD INDIAN RESERVE TIMBER LIMIT

The location of the Timber Limit within the Foothills Belt places the area within a zone of considerably higher precipitation than the main part of the Reserve. Although no climatic data for the Timber Limit are available the similarity in vegetation on the Timber Limit to that at Waterton Park, approximately 10 miles west of the Timber Limit, where normal annual precipitation of 28.25 inches has been recorded (Fig. 1), would indicate a similar amount of precipitation on the Timber Limit.

Altitudes within the Timber Limit range from 4,450 feet in the valley of Belly River to over 5,500 feet in the hill ranges, producing a local relief of over 1,000 feet (Fig. 3). The high relief contributes to rapid run-off of precipitation from the upland surfaces.

Potential Sources of Groundwater

The Timber Limit occurs within the Disturbed Belt and is underlain by faulted and folded rocks of the southwest-dipping Upper Cretaceous Wapiabi and Belly River Formations (Douglas, 1952).

The Wapiabi Formation comprises 750 feet of dark grey, sandy, silty and fissile shale with thin sandstone beds. These rocks grade upward into thin-bedded sandstone and silty shale, which form a transition with the overlying Belly River Formation.

A massive sandstone member, ranging in thickness from 70 to 125 feet occurs at the base of the Belly River Formation and is, in turn, overlain by shale, sandstone, and coal beds. The total thickness of the Belly River Formation, including the transition beds, is 2,250 feet (Douglas, 1952).

Aquifers probably exist within these rocks, particularly within sandstones of the Belly River Formation, but the demand for groundwater within the Timber Limit would probably be confined to the valley of Belly River where aquifers in surficial materials could be more readily tapped.

Surficial deposits within the Timber Limit, as mapped by Stalker (1958), (see Fig. 2) comprise moraine (till) deposited on the upland surface by both Cordilleran (mountain) and Laurentide (continental) glaciers. Extensive deposits of alluvium, ranging in grain size from boulders to clay, have been deposited in the valley of Belly River both by the river itself and by its tributaries.

One of the most promising areas for groundwater development is within the alluvial fan at the mouth of north Belly River (Fig. 2). The presence of springs at the toe of the fan is evidence of groundwater movement through the alluvial materials.

Supplies of groundwater adequate for domestic use probably could be obtained anywhere within the alluvial materials at a depth of 25 feet or less.

DEVELOPMENT OF GROUNDWATER RESOURCES

Development of groundwater resources requires, in addition to the location of potential aquifers, a preliminary test-drilling program to determine the yield and quality of water within the aquifers. If the preliminary testing program indicates a satisfactory supply of water can be obtained from an aquifer it is then necessary to construct a well with a design based upon the geological and hydrologic characteristics of the aquifer.

In order to obtain the best results from the test drilling and subsequent well installation the work should be done by a competent well drilling contractor. Information on competent water well drillers in the Blood Reserve area may be obtained from:

Alberta Water Well Drilling Association,
P.O. Box 505,
Edmonton, Alberta.

No assurance can be given that all holes drilled during the testing program will encounter adequate supplies of water from the potential aquifers; thus the expenditure of funds for dry holes must be anticipated. All drilling, however, will provide valuable information for future groundwater exploration, provided a record of the drilling has been retained in which an accurate location of the hole and a log of the hole are shown.

A preliminary drilling program to test the aquifer potential of the Blood Reserve Formation could be effected by bore-holes at the locations as shown on Figure 2. Additional bore-holes would be required, however, to test the groundwater potential of the formation in other parts of the Reserve.

Improvement to other sources of water supply on the Reserve, such as concrete enclosures over springs and the fencing of stock ponds, should be undertaken in addition to a program of groundwater development.

The Prairie Rural Housing Committee has published two booklets entitled:

"Farm Water Systems and Sewerage"
and
"Treatment of Farm Water Supplies"

that are available from the Extension Department, University of Alberta, Edmonton, Alberta. Both booklets contain a number of excellent diagrams and descriptions of methods for improving rural water supplies, which could be used to advantage on Blood Indian Reserve.

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