HYDROGEOLOGIC PROFILE ALBERTA-SASKATCHEWAN BOUNDARY

Prepared for the
PRAIRIE PROVINCES WATER BOARD

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PRAIRIE PROVINCES WATER BOARD
CANADA ALBERTA SASKATCHEWAN MANITOBA

FOREWORD

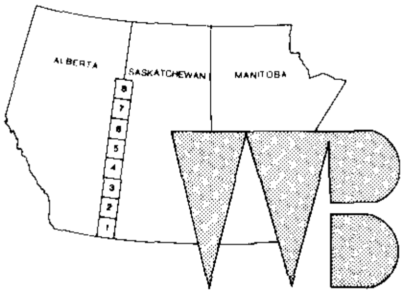
On December 1983, the Prairie Provinces Water Board contracted with Geoscience Consulting Ltd. to construct a hydrogeologic profile along the Alberta-Saskatchewan boundary.

The Consultant, in March 1984, completed the project and submitted to the Board the summary report including map sheets as specified in the contract.

Two kinds of map sheets were prepared. One includes detail data points and theoretical 20-year yield (Q20); the other provides only general information and does not include detail data points. The former is primarily for the use of well drillers or professional hydrogeologists. The latter is for the use of people requiring a more generalized knowledge of the groundwater potential. This report contains the generalized version. The more detailed map sheets will be available, on request, by contacting the Prairie Provinces Water Board or any of the members of the PPWB Committee on Groundwater.

This report originally was prepared by Mr. Tokarsky and has been revised to incorporate comments from the PPWB Committee on Groundwater and has been edited by the PPWB Secretariat.

TABLE OF CONTENTS



INTRODUCTION 1

A hydrogeologic profile to be used in groundwater management has been constructed from 49° 00'N to 57° 00'N. Lat along the Alberta-Saskatchewan boundary. Eight profiles were prepared on 1:250,000 horizontal scale and 1:5,000 vertical scale, with each profile covering one degree of latitude. The profiles extend northerly from the U.S. boundary almost to the edge of the Canadian Shield. Included on the profiles are relevant geology and principal aquifers, bedrock topography, effective base of groundwater exploration, and data control. A map showing bedrock topography and data control points accompanies each profile. Data control points within 19 kilometres of the boundary have been considered, with additional data at greater distances being obtained from existing hydrogeological and bedrock topography maps. A separate map showing subcropping bedrock formations and projected long-term yields of existing wells and a short descriptive text are included for each profile.

Maps and profiles are presented herein for the following areas:

Profile No. 1: Sheets 72E (Foremost, Alta.) and 72F (Cypress, Sask.)
2: Sheets 72K (Prelate, Sask.) and 72L (Medicine Hat, Alta.)
3: Sheets 72M (Oyen, Alta.) and 72N (Kindersley, Sask.)
4: Sheets 73C (Battleford, Sask.) and 73D (Wainwright, Alta.)
5: Sheets 73E (Vermilion, Alta.) and 73F (St. Walburg, Sask.)
6: Sheets 73K (Waterhen River, Sask.) and 73L (Sand River, Alta.)
7: Sheets 73M (Winefred Lake, Alta.) and 73N (Buffalo Narrows, Sask.)
8: Sheets 74C (La Loche, Sask.) and 74D (Waterways, Alta.)

ACKNOWLEDGEMENTS

The profiles and accompanying maps have been constructed using existing data and reports. No new testholes were drilled. The following individuals and organizations have been very helpful in providing information and assistance in the preparation of this report:

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The maps and figures in this report were prepared by Ken Born and Gordon Smith. The typing was done by Glenda Mason. They have measurably improved the quality of the final text and the Board's Secretariat acknowledges their dedication to this task.

The assistance of these individuals and others is gratefully acknowledged.

PREVIOUS WORK

The Saskatchewan Research Council has prepared a series of geology and groundwater maps on a 1:250,000 NTS grid basis. Six of these, dating from 1967 to 1980, abut the Alberta-Saskatchewan boundary from 49° 00' to 55° 00' N. Lat. These maps show bedrock topography, bedrock formations beneath the drift cover, and data control points along with bedrock elevation at these points. Major buried valleys have been identified and named. Four geological profiles accompany each map. Marginal notes identify the major aquifers. Details such as electric log traces and testhole lithologies are shown on the cross-sections.

The Alberta Research Council has prepared both a hydrogeological map series and a bedrock topography map series. The area adjacent to the boundary for the full length of the profile is covered by the hydrogeology map series, but the bedrock topography maps only extend northerly to 55° 00' N. Lat. The latter maps differ from the Saskatchewan series in that underlying bedrock formations are not shown, and data control points are either not shown or the bedrock surface elevation at each point is not indicated. Insert maps indicate valley thalwegs and drift thickness. Point locations of thick gravel or sand intervals overlying bedrock are usually shown.

Alberta's hydrogeological maps show expected well yields, main aquifer lithology, groundwater level contours, groundwater flow directions, areas of flowing wells, field features such as spring locations and flow rate, and selected well locations. Insert maps show meteorology, geology and hydrochemistry and give some idea of data density. Hydrogeological profiles show geological formations, lithology, well yield, groundwater chemistry, flow directions, and data control.

The basic difference between the Alberta and Saskatchewan map series is that more effort was put into the Saskatchewan maps to obtain "clean" geologic data by extensive test drilling. Other datum control points were carefully selected to ensure that only reliable data were used in the map preparation. Saskatchewan Research Council testholes and measured outcrops provided the basic geologic framework. Geophysical logs, mainly electric logs, of oil exploratory wells and structure testholes provided other reliable data. Only selected, carefully checked water well drillers' logs were used since many drillers' logs were contradictory or considered to be unreliable. The Saskatchewan maps provide a good geological foundation on which future hydrogeological work can be based. The advantage of showing datum control points, bedrock elevations and detailed lithology is that the maps can be added to as additional information becomes available, and interpretive information, such as contour lines on top of the bedrock or subcrop edges of formations, can be changed or modified as necessary. Chances of errors through the use of poor quality data are minimized. Datum control points however are usually quite widely spaced resulting in correlations over long distances and usually a considerably simplified interpretation of the actual situation.

The emphasis in Alberta has been on the production of interpr hydrogeologic maps rather than on those showing basic data. Fewer testh were drilled. However, not only were geological data obtained, but testh were also cased when suitable aquifers were encountered, and a water well completed, sampled, and pump-tested. Thus aquifer parameters such as hydra conductivity, transmissivity, changes in head, and water chemistry were dete mined. The cost per hole was, therefore, higher than for lithologic testh only, and fewer testholes were drilled per map sheet than in Saskatchewan. Th maps are highly interpretive and, since only selected data control points ar shown, it is difficult to check or add to the work. Basic data points ar however, plotted on 1:50,000 scale maps that are updated periodically and ar stored at the Alberta Research Council, Groundwater Division offices in Edmon ton. Revisions of the 1:250,000 scale hydrogeologic maps require considerabl time and effort because of the difference in scale from the basic data maps and because of the need to replot most of the older data points on 1:250,0 scale. Revisions of the bedrock topography maps are also time consuming, sinc data control points are not indicated and must be re-checked.

DATA CONTROL AND METHOD OF PRESENTATION

The method of presentation used follows closely that used by th Saskatchewan Research Council. Data control points are shown and actua values, such as bedrock surface elevation, are indicated for each point. Data control and selected e-log traces are shown on the profiles. Some data contro points have been omitted on the maps and profiles where data are especially dense.

This report suffers somewhat from the fact that no actual field work such as test drilling and outcrop examination, was carried out. Existing dat only were used and evaluated in the office. Testholes drilled by variou government departments such as the Saskatchewan Research Council, Albert Environment and Alberta Research Council, and reports produced by these organi zations, provide the basic framework for the study. Electric logs are avail able for most of these testholes. Electric logs of oil exploratory wells an structure testholes and some waterwells were also obtained. Of these, accom panying lithologic descriptions are available only for the water wells, an picks of the top of bedrock must be made using the e-log characteristics. Difficult or questionable picks, such as at locations where sand and gravel beds overlie sandy beds in the bedrock, or where clayey till or clay overlies shale, were not used in the compilation.

Only selected water well drillers' logs were used, and it was found that most of the older logs, prior to about 1970, were relatively poor and could not be used.

The Saskatchewan Research Council, in its test drilling program has favored descriptions of poorly consolidated bedrock materials without reference to any type of lithification. Bedrock materials are described for example as clay, silt, sand, etc. (generally non-calcareous) rather than claystone, mudstone or shale, siltstone, sandstone, etc., although they may be slightly lithified. Some degree of lithification is usually evident in outcrops and use of the terms for lithified materials is favored because it provides a ready distinction between drift and bedrock materials. Alternatively, the addition of the word "bedrock", an age connotation such as Cretaceous, or a formation designation could be used (eg. bedrock clay, Cretaceous clay, Ribstone Creek sand). Even with the most careful logging, some uncertainties arise, and mistakes may be made. The advantage of having generally reliable water well drillers' logs is that a great amount of information over a large area can be made available fairly quickly and without extensive and costly test drilling. Questionable or critical areas must still however be checked.

In most cases, even with the addition of new data, there was little need to change the existing mapping, or only minor modifications were necessary. In some cases, however, buried valley trends were modified or extended, or the valleys were found to be deeper and to contain thicker, more promising aquifers than previously estimated. An example of the latter is the Wildhorse Valley in map sheet 72E. The greatest change in the locations of major buried valleys was made on map sheet 73E where new data showed that parts of the very deep and narrow Lloydminster and Rex Valleys were in different locations than shown previously. Unfortunately, in this instance, the data control used in preparing the original map was not shown, and could not be checked. The new valley locations were confirmed by Alberta Environment testhole data, oil exploratory well e-logs, and a report by Pelz, 1978.

Other changes in bedrock topography mapping can be seen by comparison with previous maps. Additional changes are anticipated as new data become available. New buried valleys containing important aquifers are certain to be discovered, especially in the areas of little data, such as the southern two double map sheets and the northern two double map sheets. The Wiau Valley for example has been traced, in map sheet 73M, eastwards only as far as tp.72, rge.4W4, and its location in Saskatchewan has yet to be discovered. Data for map sheets 73M and 73N and 74C and 74D and the northernmost parts of 73K and 73L are fragmentary at best, and bedrock topography contours for these sheets could not be prepared with confidence except in some local areas.

GEOLOGY AND HYDROGEOLOGY

Aquifers are found in both drift and bedrock sediments. Drift refers to loosely consolidated sediments (till, clay, silt, sand, gravel), mainly of Quaternary age. Because of the difficulty of exact age dating and identification, the term may include some materials of late Tertiary age. Although potable water is usually found only in sediments in the upper part of these profiles, the cross-sections have been extended downwards into the Paleozoic in the southern five profiles, and the Precambrian in the northern three profiles. This has been done for the sake of hydrogeologic completeness, because the deeper aquifers, although containing saline water, and often oil and gas pools, can be used both as sources of water for water injection purposes in oil fields, and as zones of water disposal or of waste disposal. Most of the oil exploratory wells in the southern part of the mapped area have not penetrated deeper than the uppermost Paleozoic strata. Therefore, the geological cross-sections are reasonably complete in terms of available geologic data down to and including that depth.

A line indicating the "base of groundwater exploration" is shown on the Saskatchewan groundwater resource maps. Groundwater below this base is considered to be too mineralized, or saline, for domestic and stock-watering purposes. The limit of mineralization is not stated on each map, but others, a limit of 4000 ppm (mg/L) of total dissolved solids is used. In the Alberta hydrogeological map series, total dissolved solids contours are shown on the profiles where there are available data, as well as an elevation below which mainly chloride (saline) waters are present. These may be used to define the lower limit of groundwater exploration. Often, because of limited data, it is difficult to define an exact "base of groundwater exploration" so it is not surprising that there are some inconsistencies in the Saskatchewan maps. The Ribstone Creek sandstone in the Kindersley map sheet (72N), for example, is below the base of groundwater exploration, while in the adjoining sheet to the south (Prelate, 72K) it is above that line. On the northern part of the next sheet to the south (Cypress, 72F), the sandstone is again below the base of groundwater exploration. In addition, the Milk River Formation is shown on this latter map sheet to be well below the base of groundwater exploration (the top of this formation lies some 140 metres below the base of the Ribstone Creek sandstone), while a short distance (13 to 14 km) to the west, in Tp. 1, Rge. 2W4, several stockwatering wells have been drilled to this formation. Because of lack of data, it is uncertain whether the Milk River Formation would provide water of suitable chemistry for stock-watering in tps. 1 and 2, but this must be considered as a possibility.

Different bedrock formation names have been used for equivalent units on the different map sheets. A correlation between these is presented here as Table 1. The greatest variation is found in what is now termed the Judith River Formation in Saskatchewan (after McLean, 1971), which includes the Ribstone Creek sandstone as a tongue of that formation within the marine shales of the Lea Park Formation. An older terminology was used only in the Battleford map sheet (73C), where the Oldman Formation is equated with the main body of the Judith River Formation. The term "Ribstone Creek" however, was also used on that map sheet, where it was termed a "member" rather than a "tongue". A lower sandstone termed the Victoria member was also shown on this map sheet. Both these sandstone units, along with the intervening and overlying marine shales of the Vanesti member and the Grizzly Bear member, were assigned to the Foremost Formation. McLean (1971) favored the dropping of the name "Victoria", and would have this sandstone unit considered as an unnamed tongue of the Judith River. The name "Vanesti" and "Grizzly Bear" would be retained, and these would be tongues of the Lea Park Formation. McLean's terminology has been followed on all the Saskatchewan Research Council maps except the Battleford sheet, which preceded McLean's report. Neither the Vanesti tongue nor any unnamed tongues of the Judith River Formation are shown on these maps, except for the Battleford sheet.

The name "Judith River Formation" has not been used on any of the Alberta maps, where the old terminologies of Oldman and Foremost Formations were retained on sheets 72E & L, and the name "Belly River Formation", which includes the Ribstone Creek sandstone and the intervening marine shale, was used in sheets 72M, 73D & E. The underlying Vanesti shale and Victoria sandstone, if present, would also be included in the Belly River Formation.

In the present report, the name "Judith River Formation" is used, with the Ribstone Creek and locally the Victoria sandstone units forming tongues of that formation. The underlying marine shale is the Lea Park Formation, which includes the Grizzly Bear and Vanesti tongues. The name "Victoria" is retained for one of McLean's unnamed sandstone units because it appears to be both persistent and correlateable in the north part of sheets 73C & D. Its eastern edge coincides with that shown by Currie and Zacharko (1976) on sheet 73E, where it lies a short distance west of the Saskatchewan boundary.

The drift cover contains important aquifers, but has not been subdivided into units on most of the existing map sheets. Undifferentiated drift has been mapped on all sheets, although sand and gravel units are also shown on the existing profiles for sheets 72L and 73L in Alberta. On the existing Saskatchewan maps, undifferentiated drift only is shown on sheets 72F and 73F, although testhole lithologies show that thick sands are present on sheet 73F in the Lloydminster and Rex valleys. On sheets 72K and 73K, the Empress Group has been identified as a separate unit on the cross-sections, but not on the maps. On sheet 73C the Empress Formation is shown to be present at one location in the Battleford Valley, and the text states that it may be continuous in this valley, but with scattered occurrences on bedrock surface interfluves. Sand and silt, identified as Tertiary-Quaternary, are shown locally on sheets 72N and 73K. In both cases, this material occurs at relatively high elevations on the bedrock surface, and it appears to be distinct from that of the Empress Formation. Although identified only in one localized area on sheet 73K and in

Table 1 CORRELATION OF GEOLOGIC UNITS, ALBERTA - SASKATCHEWAN BOUNDARY, 49°00' to 57°00' N. Lat.

Unit of geologic time	Nomenclature, this report	Nomenclature previous hydrogeological maps, Saskatchewan	Nomenclature, previous hydrogeological maps, Alberta	Distribution of units by map sheet. Formation beyond depth of profiles not shown.
Quaternary	*Undifferentiated drift*	*Undifferentiated drift* "preglacial gravel" 73C Empress Group 72K, 73K Tertiary - Quaternary 72N, 73K	*Unconsolidated deposits*	*All map sheets*
Tertiary	*Cypress Hills Fm.*	*Cypress Hills Fm.*	*Cypress Hills Fm.*	
	Ravenscrag Fm.	*Ravenscrag Fm.*	*Ravenscrag Fm.*	
Cretaceous	*Undiff.* Frenchman Fm., Battle Fm., Whitemud Fm., Eastend Fm.	*Undiff.* Frenchman Fm., Battle Fm., Whitemud Fm., Eastend Fm.	*Frenchman Fm.* *(Battle & Whitemud Fms. not shown)* *Eastend Fm.*	72 E & F
	Bearpaw Fm.: Thelma mbr., Belanger mbr., Oxarart mbr., Unnamed sands, Matador mbr. (72K)	*Bearpaw Fm.*: Thelma mbr., Belanger mbr., Oxarart mbr., Unnamed sands, Matador mbr. (72K)	*Bearpaw Fm.* *- various sandstone mbrs. not identified except farther to the west*	72K & L; 72M & N, 73C & D
	Judith River Fm.: Grizzly Bear tongue, Ribstone Creek tongue, Vanesti tongue, Victoria tongue *Lea Park Fm.* *Eagle shoulder*	*Judith River Fm.*: Grizzly Bear tongue, Ribstone Creek tongue, Vanesti tongue, Victoria tongue *Oldman Fm.* *Foremost Fm.*: Grizzly Bear mbr., Ribstone Creek mbr., Vanesti mbr., Victoria mbr. *Lea Park Fm.* (73C) Claggett (Pakowki) Fm. (72F) Lea Park Fm. *Milk River Fm.* Eagle (Milk River) shoulder	*72 E & L*: *Oldman Fm.*, *Foremost Fm.*, *Pakowki Fm.*, *Milk River Fm.* *72M, 73D & E*: *Belly River Fm.*, *Lea Park Fm.*	73E & F
	Colorado Group	*Upper Colorado Group* *Lower Colorado Group*	*Alberta Grp. (72E)* *Colorado Grp. (72L to 73E)* *73L*: Upper Colorado Grp., Second White Specks Zone, LaBiche Fm., Viking Fm., Joli Fou Fm. (73M)	73K & L; 73M & N
	Mannville Grp.: Sunburst mbr.-72E; Deville Fm. - 72L&M	*Mannville Grp.*: *Upper Mannville*, *Lower Mannville*	*Mannville Grp.* Grand Rapids Fm., Clearwater Grp., McMurray Fm. (73M & 74D)	74C & D
Jurassic	*Undiff. Jurassic - 72E & F*	—	— —	
Mississippian	*Undiff. Mississippian - 72E, F, & M*	—	— —	
Devonian	*Undiff. Dev.* *Elk Point Grp.* *Beaverhill Lake Grp.*	*Undiff. Paleozoic (73K)* *Undiff. Devonian*	*Undiff. Devonian 73L & M, 74D*	
Cambrian	*Basal Sandstone - 73K & L*	—	—	
Precambrian	*Undiff. Precambrian*	*Undiff. Precambrian (74C)*	—	

three localized areas on sheet 72N, it is stated for 73K that "these sediments undoubtedly occur in other parts of the map area" (Christiansen & Whitaker, 1974).

Andriashek and Fenton (in preparation) have subdivided the Quaternary sequence into various units for sheet 73L, and include maps in their report which define the extent of some of the sands and gravels which are present in this area. A more detailed discussion on their units is presented in the discussion on sheets 73K and L.

In this report, drift units are not differentiated, but it is recognized that there are extensive deposits of sands and gravels within buried valleys and, in places, on highland areas between buried valleys. The work of Andriashek and Fenton, in preparation, shows that these units are correlateable over large areas. The definition of their extent, however, requires extensive testhole control.

WELL YIELDS

Projected long-term well yields have been shown on Alberta's hydrogeological map series on both maps and cross-sections. The values shown are highly interpretative and are projected into areas where there is little well or test control. Occasionally, the presence of important aquifers is either not recognized or shown, or their productivity is over-rated or under-rated. An unsuspected buried valley aquifer such as the as-yet untested sands and gravels of the Wildhorse Valley in 72E is an example of an omission of what will likely prove to be a productive aquifer. Good data control and as detailed a picture as possible of the geological framework and aquifer extent, even without pump testing, are important in making predictions of long-term well yields.

Regarding pump testing to determine the aquifer parameters, productivity, and water chemistry, two basic types of test data have been considered in the Alberta Hydrogeological map series and in this report. They are, firstly, data based on pumping tests of short and long duration, and, secondly, data based on drillers' tests in which only limited data are reported and from which an "apparent" value of aquifer transmissivity and an apparent 20-year well yield may be calculated.

Controlled pumping tests of long duration with the use of observation wells provide the best values of aquifer parameters since boundary conditions and leakage can be identified. Such tests are costly and usually are not available. Short pumping tests without observation wells can also provide useful information. There are many methods of pumping test analysis, dependent on aquifer characteristics. The Jacob "straight-line" method of analysis (Cooper and Jacob, 1946) can be used under certain limiting conditions in the case of unsteady-state flow in confined aquifers. It has the advantage of simplicity and is widely used. Transmissivity is obtained by plotting drawdown versus time on semi-logarithmic paper, and by use of the formula:

$$T = \frac{2.30Q}{4\pi\Delta s}$$

where T = aquifer transmissivity (m^2/day)
Q = discharge rate (m^3/day)
Δs = slope per log cycle (metres)

A re-arranged form of the equation (Farvolden, 1961) may then be used to calculate the theoretical 20-year well yield:

$$Q_{20} = \frac{TH \times 0.7}{1.465}$$

where, Q_{20} = theoretical 20-year yield (m^3/day)
T = transmissivity (m^2/day)
H = available head (metres)
0.7 = safety factor

Farvolden, 1961, showed that a value of transmissivity termed "apparent transmissivity" could be calculated by use of the Jacob equation, from most drillers' tests of wells if the following information was reported, namely the pumping rate, the time period of pumping, the pre-pumping water level, and the water level at end of test.

Ozoray, 1977, devised a nomogram by which apparent transmissivity could be determined quickly without the need of a graphical plot.

Using apparent transmissivity, an apparent value of 20-year well yield may be calculated. In this case, because the value obtained is an approximation only, the safety factor of 0.7 is not usually applied. Farvolden, 1961, cautioned that the validity of this method of determining transmissivity "is open to serious doubt because a number of factors that may have significant influence on the results are not considered". Apparent transmissivity values were used however because little other quantitative data were available. He further states that "the results of bailing tests tend to confirm the values obtained for apparent transmissivity". Apparent transmissivity and apparent 20-year yield were used extensively in the preparation of Alberta's hydrogeological map series, and have been used in this study also. The yield values obtained must be considered to be extremely tenuous, especially when high values are obtained at low rates of pumping. It is also noted that the values obtained by this method for highly productive aquifers are often too low, for the reason that a great proportion of the drawdown can be due to well losses rather than to water level drawdown in the aquifer.

The type of well completion and the degree of well development must also be taken into account when evaluating well productivity. Completion methods in domestic wells, especially in loosely consolidated formations such as sand and gravel, are often inadequate to obtain representative values of aquifer transmissivity and yield, and uncharacteristically low values are often obtained. In spite of all these shortcomings, short pumping tests and drillers' tests do provide an indication of the distribution of high yield areas, and are useful in the determination of areas where more detailed testing might be warranted.

Geology and yield maps are presented here for only six of the eight double map sheets, since there are almost no data for the northernmost two sheets. Results are discussed by individual map sheet. Multiple aquifer zones are often present in any one particular formation. No effort was made in the yield compilation to distinguish different aquifer zones, except to exclude tests on bored and shallow wells.

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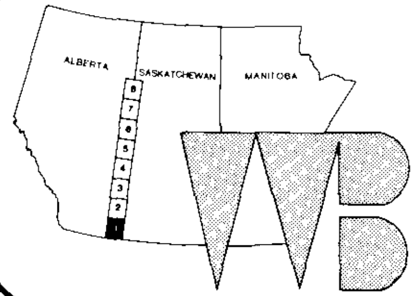

MAPS 72E & 72F

72E Foremost, Alberta

72F Cypress, Saskatchewan

2

Bedrock topography of these map sheets was mapped by Whitaker in 1976 and Westgate in 1968. Drift cover is generally thin, and there are only local occurrences of important drift aquifers. Whitaker, 1976, mentions sand and gravel lying between till and the bedrock surface near Maple Creek, Saskatchewan (in tp. 11, rge. 26W3) which yields up to 5.3 L/s of good quality water. Inter-till aquifers are also present near Maple Creek, where drift thicknesses of over 50 metres have been found. A spring located some 11 km. to the southeast of the town is also used for the town water supply. This spring is reported to have an average rate of flow of about 10.6 L/s, and probably originates from sands and gravels within the drift.

Buried gravels resting on the bedrock surface are also present near the town of Irvine, Alberta, where the depth to bedrock can be as much as 60 metres. Water quality is marginal, being high in sodium and sulfate. A well located in 16-36-11-3W4 was pump tested, and a long-term yield of about 15 L/s was calculated.

Whitaker, 1976, did not apply names to any of the several small buried valleys on the Saskatchewan side of the boundary. Westgate, 1968, has named the Jaydot Valley, which he shows as crossing the boundary into Saskatchewan in the north part of tp. 3. The southeasterly trending Wild Horse Valley has been identified in Alberta and crosses into the U.S.A. in the southwestern part of tp. 1, rge. 1W4. Three coal testholes in tp. 3, rge. 3W4 and tp. 4, rge. 4W4, drilled within the latter valley bottomed at depths from 36.6 to 48.8 metres without intersecting bedrock, indicating that the valley is considerably deeper than previously mapped. All 3 testholes found significant thicknesses

of sand or gravel, and it is expected that good well yields should be avail[...]
in this area.

Westgate, 1968, identified a northward-trending unnamed val[...] located within 2 km. of the Saskatchewan boundary in tps. 9 to 11, rge. 1W[...] which crosses into Saskatchewan at the southeastern corner of tp. 12, rge. 1W[...] There is insufficient available testhole data to determine the nature of th[...] channel fill and the presence of possible aquifers but it is noted that th[...] town of Irvine draws water from this aquifer.

All the valleys referred to above, which were mentioned by Westgate, 1968, were considered by him to be of preglacial age. The valleys are stated to be fairly wide, and the valley walls are gently enclined.

Glacial valleys are also present. These are all meltwater channels, which Westgate states are never more than 3.2 km. wide, with steep to vertical side walls. Battle Creek, Middle Creek, and Medicine Lodge Creek and Coulee, among others, are located for at least part of their course, within meltwater channels. Nielsen, 1969, assigned groundwater yield values of less than 0.1 to 0.4 L/s to the glaciofluvial gravels, sands and silts within meltwater channels. Westgate in 1968, also mapped several large and small eskers, made up of sand and gravel, in the southeast corner of Alberta. Their significance in terms of groundwater possibilities is uncertain.

There are numerous bedrock aquifers within the area, the youngest of which are confined to the Cypress Hills. Peripheral contact springs drain all of these aquifers. Sand, siltstone and coal beds form the main aquifers, with gravels also being common in the Cypress Hills Formation. The Cypress Hills, Ravenscrag and Frenchman Formations are all confined to the higher parts of the Cypress Hills. Water quality in the numerous springs issuing from these formations is good.

The basal sandstone unit of the Eastend Formation is tapped by wells at Elkwater, Alberta, where long-term well yields of up to 8 L/s of good quality water are possible. This unit however can thin abruptly in a laterally direction and yields are not consistently high.

Sandstone units in the upper part of the Bearpaw Formation, have been named by Furnival, 1950, from youngest to oldest, the Thelma, Belanger, and Oxarart members. From Furnival's descriptions of these formations along Thelma Creek, Alberta, and from his correlations between outcrop sections, it is apparent that there is only a small interval of some 20 to 22 metres between the Thelma and Oxarart members, and that the Belanger member with an average thickness from 4.5 to 7.5 metres is within this interval. The Oxarart member attains the greatest thickness, but has been shown to thin drastically to the east (Furnival, 1950), and to the north (Whitaker, 1976, and this report). The Thelma member was shown to pinch out to the east (Furnival, 1950) and to the north (Whitaker, 1976). Whitaker's estimate appears to be wrong. In examination of oilwell and structure testhole e-logs shows that the top of the Thelma member parallels the base of the Eastend Formation rather well (i.e. a consistent thickness of shale strata separates these two horizons), and it has been shown that the Thelma member to persist from south to north. The Belanger member is present locally on the line of the cross-section. Borneuf, 1976, does not show the presence of these sandstones on his line of cross-section (although they are present in that area), except in one isolated location, where he shows a large spring with an outflow of about 55 L/s issuing from one of these Bearpaw sandstones. A water well at Elkwater, Alberta is believed to have been drilled through the Thelma and Belanger members, but terminated before reaching the Oxarart member. This well is completed in what is believed to be the Belanger member, and was pump tested at a rate of 1.1 L/s. The water was of good quality.

The Judith River Formation is the equivalent of the Oldman and Foremost Formations of Alberta (Borneuf, 1976, Irish, 1968). This formation extends across the entire area, and contains sandstone and coal aquifers. The formation is present at relatively shallow depth along the line of cross-section only in tps. 1, 2, 11 & 12. Borneuf, 1976, indicates that well yields from this formation are usually relatively low (from 0.08 to 0.4 L/s). Locally higher yields however appear to be possible, where sandstone aquifers are better developed. A well in NW28-11-1W4. near Walsh, Alberta, has a calculated long-term yield of about 1.2 L/s. Few chemical analyses are available. An incomplete analysis for the well in NW28-11-1W4 shows that sodium at 480 to 633 mg/L, chloride at 326 to 351 mg/L and fluoride at 2.1 to 2.55 mg/L are relatively high. A deeper well at 6-23-10-2W4 has total dissolved solids of 1 281 to 1 496 mg/L, sodium of 515 to 521 mg/L, and chloride of 317 to 335 mg/L.

The Milk River Formation (correlative with the Eagle Formation of Montana) contains important aquifers in Alberta, where thick sandstone beds are present in the Virgelle member (middle member) of that formation. The Virgelle member grades from sandstone to shale out along a northwest trending line which passes through tp. 1 rge 1 W4. The name "Milk River Formation" is not used northeast of the point where the sandstone disappears. The shale-siltstone sequence of the equivalent of the Milk River Formation is included in the Lea Park Formation. The "Eagle Shoulder" (McLean, 1971) marks the top of the Milk River equivalent. The Milk River Formation as defined above, is present only in the extreme south end of the line of cross-section which accompanies this report. The top of the First White Speckled shale marker horizon marks the base of the Milk River Formation and of the Lea Park Formation, and the top of the Colorado Group. The first indicator of White Speckled shale is a very distinctive lithological marker, but is difficult to recognize consistently on oil well e-logs and has not been shown on the cross-section lines.

No water wells have been drilled to the Milk River Formation along the line of cross-section. Several flowing wells in tp. 1, rge. 2W4 however have been drilled to depths of 365 to 457 metres to tap this formation. Two of the four wells for which records could be obtained had reported flow rates of about 0.8 L/s. Chemical analyses for two wells show that total dissolved solids range from 2 292 to 2 520 mg/L, and chloride from 866 to 1038 mg/L. It is surmised that the wells were drilled to provide water for stock use in an area where water production from the Judith River Formation is relatively low, or because flowing wells do not need pumps or power to provide stock water. Gas is often associated with the water from this aquifer.

Formations below the Milk River Formation are expected to yield water which is too saline even for stock use. Most of the better aquifers, such as the Medicine Hat sandstone, Viking sandstone and others, are target horizons for oil and gas drilling. Gas is so abundent in the Medicine Hat sandstone that it is generally termed the Medicine Hat gas sand.

The base of groundwater exploration on the accompanying map sheets is the base of the Judith River Formation, although the Milk River Formation can provide a target locally in tps. 1 and 2 for somewhat saline water for stock use. Farther to the north, this formation is too deep to be economically useable, and in addition, it grades from sandstone to shale northward, where the "Eagle shoulder" marks the top of the equivalent of this formation.

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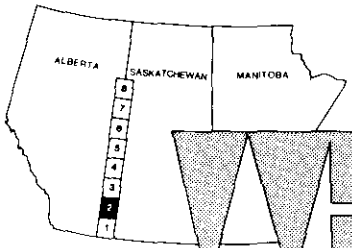

MAPS 72K & 72L

72K Prelate, Saskatchewan

72L Medicine Hat, Alberta

3

This is a sparsely settled area, and there is little water well and testhole control, except for an area near Empress, Alberta, where the Saskatchewan Research Council drilled numerous testholes on the Saskatchewan side of the boundary, and an area near Hilda, Alberta, where Alberta Environment carried out a test program in a search for groundwater (Bland, 1975).

Drift cover along the line of cross-section is relatively thick, being generally in excess of 50 metres (Carlson, 1970). Two major buried valleys, the Calgary Valley and the Lethbridge Valley (Carlson, 1970) join together about 24 km. west of the Alberta-Saskatchewan boundary to form a single valley which passes eastward into Saskatchewan at tps. 22 and 23. This valley has been termed the Tyner Valley in Saskatchewan (David & Whitaker, 1973). The Empress Formation of sediments forms the lower part of the valley fill (Whitaker and Christiansen, 1972). This consists of interbedded sands, silts and gravels, and is an important aquifer in this area (see Figure 1).

Other linear depressional trends have been identified on the bedrock surface on these map sheets (Carlson, 1970, David & Whitaker, 1973), but their exact delineation is difficult due to a shortage of test hole control. A northeasterly-trending unnamed valley crosses the boundary north of Hilda, Alberta. An upper inter till gravel unit has been identified as the most promising aquifer near this community, from which a yield of 2.3 to 3.8 L/s can be expected (Bland, 1975). A basal sand unit is present within the valley fill.

The village of Empress, Alberta obtains water from an interval of gravel which is expected to have a hydraulic connection with the nearby Red Deer River. This gravel unit is underlain by till and is therefore younger than the Empress Group gravels. Correlation with testholes cited by Whitaker and Christiansen, 1972, suggests that it should be assigned to their Saskatoon Group of sediments.

Aeolian and glacio-fluvial surficial sands are present locally close to the boundary across the northern part of these map sheets.

Relatively thin erosional remnants of the Bearpaw Formation are present in places along the boundary. The Matador sandstone member is a potential aquifer.

The Judith River Formation and the underlying Ribstone Creek tongue are present along the entire length of the line of cross-section, except where they are cut through by the Tyner Valley. These are the equivalents of the Oldman and Foremost Formations as mapped by Stevenson and Borneuf, 1977, who have also included the Grizzly Bear tongue (marine shale) of the Lea Park Formation, in their Foremost Formation. They have indicated that long-term well yields from the Judith River Formation (their Oldman Formation) and the Ribstone Creek tongue (the basal sandstone unit of their Foremost Formation) are likely to be in the order of 0.4 to 2.0 L/s. David & Whitaker, 1973, indicate a yield capability of up to 0.5 L/s from the very-fine to fine-grained silty sandstones of these formations, with a wide range of chemical quality.

The base of the main body of the Judith River Formation forms the base of groundwater exploration.

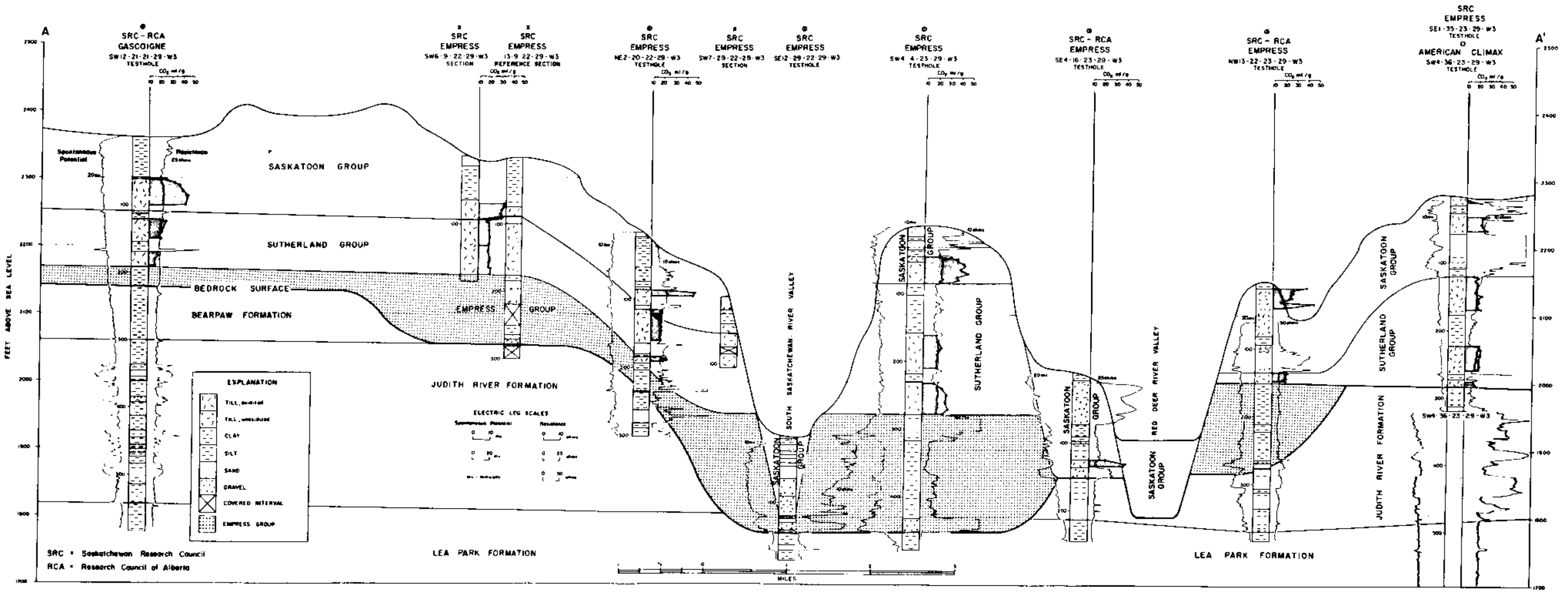

Figure 1. DETAIL OF NORTH END OF CROSS-SECTION 72K & L THROUGH POINTS 20 to 29. (AFTER WHITAKER AND CHRISTIANSEN, 1972)

REFERENCES 72K & L

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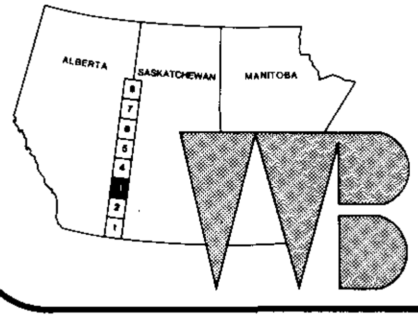

MAPS 72M & 72N

72M Oyen, Alberta

72N Kindersley, Saskatchewan

4

This is a sparsely settled area in which drill hole control is relatively scarce. Drift thickness along the line of profile generally exceeds 20 metres, and is greater over buried valleys. Carlson, 1970 has mapped a southeasterly-trending valley that he named the Sibbald Valley. It crosses the boundary at tp. 27, and is tributary to the southerly-trending Eyre Valley in Saskatchewan (Christiansen, 1965, Christiansen et al, 1980). The drift thickness along the Sibbald Valley at the boundary is mapped as exceeding 75 metres.

Carlson, 1970, shows a second less well-pronounced unnamed easterly-trending valley with a drift thickness of over 30 metres. It crosses the boundary in the north part of tp. 31. Neither Christiansen, 1965 nor Christiansen et al, 1980, show the presence of this valley in Saskatchewan, but reliable drillhole data are sparse in this area. This valley could be tributary to the Eyre Valley a few kilometres into Saskatchewan.

Kunkle, 1962, outlined areas underlain by relatively shallow sands and gravels which he considered to have good groundwater possibilities. These usually coincide with areas of thicker drift cover.

The bedrock beneath the drift is the lower part of the Bearpaw Formation, except beneath the Sibbald Valley where it has been removed and valley fill sediments have been deposited on the Judith River Formation. The Bearpaw Formation contains unnamed sand units which form potential aquifers. The predominant materials in the Bearpaw Formation are marine shales, silty shales and argillaceous siltstones. When these are overlain by clayey glacial tills, as is often the case, it can be difficult to determine the exact level of the bedrock surface. Relatively low well yields of up to about 0.5 L/s have been indicated for sandstone units of the Bearpaw Formation by Christiansen, 1965.

Where buried valley aquifers and other drift aquifers are lacking, or poorly developed, water can be obtained from the Judith River Formation, which extends along the entire area close to the boundary. This formation is equivalent to the Belly River Formation of Borneuf, 1979, who shows its general range of well yields to be from 0.08 to 0.4 L/s, with localized yields approaching two litres per second where sandstone aquifers are better developed. Christiansen et al, 1980, have indicated that the Judith River Formation thickens to the east toward the area of Coleville, Smiley and Kindersley, Saskatchewan where individual well yields up to 4.5 L/s have been reported. They also cite considerable local variation in yield due to lenticularity of the aquifer beds.

The Ribstone Creek tongue of the Judith River Formation is locally present in the upper part of the Lea Park Formation, but is considered to be too deep to be economically reached by water wells, as well as having an unsuitable water quality at this depth. The effective base for groundwater exploration after Christiansen et al, 1980, is considered to be the top of the Grizzly Bear tongue of the Lea Park Formation.

REFERENCES 72M & N

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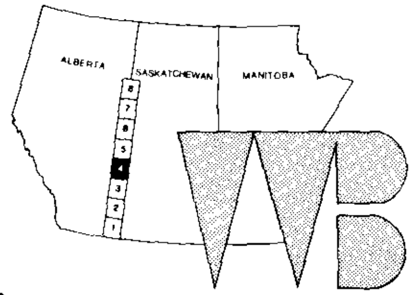

MAPS 73C & 73D

73C, North Battleford, Saskatchewan 5

73D, Wainwright, Alberta

A major buried valley called the Battleford Valley in Saskatchewan, and the Wainwright Valley in Alberta (Christiansen, 1965, Carlson and Topp, 1971) crosses the Alberta-Saskatchewan boundary at tps. 42 & 43. This valley had previously been called the Red Deer Channel in Alberta (Farvolden, 1963). An unnamed tributary to this valley crosses the boundary at tp. 39. These valleys are probably preglacial in age, and contain important sand and gravel aquifers. The basal gravels in the Battleford Valley were called preglacial by Christiansen, 1965 and, using later terminology, would be assigned to the Empress Formation.

The major aquifers for high capacity potable water wells in this area are found within the drift in the major buried valleys and in glaciofluvial sands and gravels. Christiansen, 1967, has stated that aquifers in the Battleford Valley are believed to be capable of yielding millions of gallons of water per day (over 100 L/s). Hackbarth, 1975, shows possible single-well yields in excess of 7.5 L/s over parts of the Wainwright Valley, and Topp, 1974, cites an aquifer test of sands and gravels in the Wainwright Valley in sec. 20-43-6W4, from which a "safe sustained yield" in excess of 38 L/s was calculated.

Glaciofluvial sands and gravels in sec. 12-39-1W4 near St. Lawrence Lake form an aquifer which is utilized by the town of Provost, Alberta, some 16 km. distant, and for which a continuous pumping capacity of between 10 and 12 L/s has been calculated (Beckie, 1966, Tokarsky, 1977).

Other surficial aquifers also occur in the area, but are generally of limited extent, and have a fairly low yield capability. An extensive area of aeolian and glaciofluvial sand however is found overlying and close to the area of the Battleford Valley, and high well capacities can be obtained locally in this vicinity. Water wells drilled near Dillberry Lake (sec. 36-41-1W4) for example have obtained long-term well yields of up to 20 L/s.

The most important bedrock formations in terms of water supply are the Judith River Formation to the south of the Wainwright-Battleford Valley, and the Ribstone Creek tongue to the north of this valley. The Victoria tongue is also utilized in the northern portion of the area, and sandstones of the Bearpaw Formation are used locally in the high land in the southern part of the area.

Christiansen, 1967, has stated that aquifers of the Judith River Formation may yield up to four litres per second in 14-7-36-25W3. Hackbarth, 1975, shows the general range of well yield close to the boundary to be generally 0.4 to 8 L/s. Drillers' records for this area show that three or four litre per second is more likely to be the upper long-term production limit for the formation. Water quality is generally acceptable.

Sandstones of the Ribstone Creek tongue have yielded saline water at the town of Provost, Alberta, (SW17-39-2W4) from a depth of 176 metres, and at Dillberry Lake in NE36-41-1W4. Water quality in this formation to the north of the Wainwright - Battleford Valley is generally acceptable. Well yields however are usually less than 1 L/s.

Sandstones of the Victoria tongue are utilized locally in the northern portion of the area where the Ribstone Creek tongue is thin, poorly developed or absent due to erosion. Yield and quality are expected to be much the same as for the Ribstone Creek tongue. The Victoria tongue changes from sandstone to shale and disappears to the north of this map sheet.

Thin sandstone beds generally capable only of very low production (less than 0.4 L/s) are present in the Bearpaw Formation in the high land at the south end of the area. The bedrock in this area is glacially contorted (Carlson & Topp, 1971), and formation picks in this area are difficult to make.

Most water wells have been drilled through this formation to tap the more productive aquifers in the underlying Judith River Formation.

The base of groundwater exploration is the Victoria tongue north of the Wainwright Valley. South of the Wainwright Valley, it is the Ribstone Creek tongue for part of the area and the Judith River Formation for the remainder.

REFERENCES 73C & D

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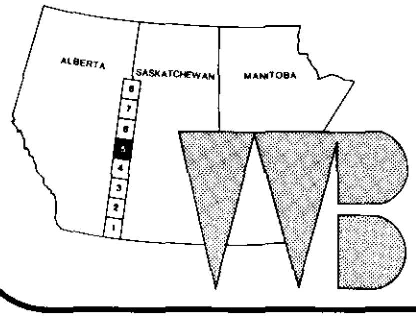

MAPS 73E & 73F

73E Vermilion, Alberta

72F St. Walburg, Saskatchewan

6

Drift cover over the area close to the boundary and south of tp. 55 is relatively thin except along buried valleys. In the areas where drift cover is thin and the Ribstone Creek sandstone tongue is not present, (tps. 52, 53 & 54), the main lithologies are glacial till resting on the marine shales of the Lea Park Formation, and it can be very difficult to obtain groundwater supplies. From tp. 55 north the land rises abruptly, and drift cover is relatively thick. This area is largely unsettled, but water supplies can be obtained from sand and gravel lenses within the glacial till.

Two major buried valleys cross the boundary from a short distance north of the City of Lloydminster. These are the Rex Valley and the Lloydminster Valley, both steep-walled, deep and narrow. Christiansen and Whitaker, 1973, have stated that the Rex Valley is probably preglacial, modified by glacial erosion, while the Lloydminster Valley was formed during the first glacial advance or during an early deglaciation.

Pelz, 1978, made a major modification to the bedrock topography mapping of Carlson and Currie, 1973, and shows that the main segment of the Lloydminster Valley in Alberta trends almost directly north-south immediately west of the Alberta-Saskatchewan boundary. This trend has been extended to join the Rex Valley in approximately sec. 1-52-1W4. The Lloydminster Valley appears to have captured the waters of the Rex Valley, probably in early glacial or interglacial time, and diverted the Rex Valley drainage southeastwards into the Tyner Valley system.

Two thick sand aquifers have been identified within the Lloydminster Valley. The town of Lashburn, Saskatchewan has a well completed in the lower sand which rests on bedrock. The aquifer at this location appears to have the capability of yielding several tens of litres of water per second. One chemical analysis of the water shows a total dissolved solids content of 1 761 mg/L, sodium of 525 mg/L, chloride of 288 mg/L, sulfate of 224 mg/L. An industrial water supply well in NW-7-49-26W3, is also completed in this lower aquifer and has water of similar quality. This well is licensed for a maximum diversion rate of 9.7 L/s. Another industrial well in SW-12-51-1W4 is completed in this lower aquifer (gravel at this location) at a depth of 180 metres. This well is rated as being capable of yielding about 20 L/s of water of similar quality to that obtained from the Ribstone Creek aquifer at nearby locations. Pelz, 1978, states that the basal gravels may cover an area up to 1.2 km. wide, with the crest-to-crest distance of the containment valley being up to 3.2 km. wide.

No municipal or industrial wells are known to be completed within the Rex Valley, but thick intervals of sand and gravel are also present in this valley, and high well yields can be expected.

Other linear depressions on the bedrock surface occur. Many of these contain basal sands and gravels that can be highly or moderately productive. Some of the sands and gravels form benches or terraces associated with the Lloydminster and Rex Valleys. Wells at the village of Marshall, Saskatchewan tap aquifers which may fall into this category. Yields of a few tens of litres per second may be possible from these wells. Industrial wells on the north side of the city of Lloydminster tap gravel aquifers at locations where the Ribstone Creek sandstone has been eroded. Gravels resting on bedrock at the south end of Sandybeach Lake at depths of over 30 metres are hydraulically connected with the lake. The city of Lloydminster has been withdrawing water at rates of up to 50 L/s from these gravels since 1960 (LeBreton, 1963a), which has resulted in a drastic lowering of water level in the lake. Marwayne and Streamstown in Alberta, both utilize buried gravel aquifers. The gravels at Marwayne are deeper and considerably more productive than at Streamstown.

The Ribstone Creek tongue of the Judith River Formation is the only important bedrock aquifer close to the boundary. Well yields from this formation are variable. Yields of two to eight litres per second are common, but can locally drop to below one litre per second. This is the main aquifer in the southern part of this mapsheet. Communities such as Blackfoot, Kitscoty and Paradise Valley in Alberta obtain their water supply from this aquifer, and there are numerous large-scale industrial users.

The base of groundwater exploration in this area is the Ribstone Creek tongue where it is present, or the base of the drift where the Ribstone Creek tongue is not present.

REFERENCES 73E & F

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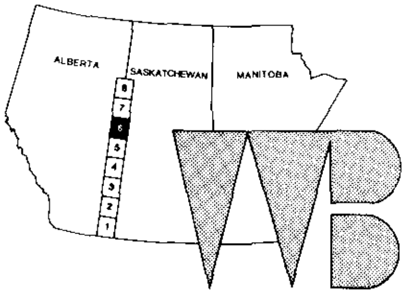


MAPS 73K & 73L

73K Waterhen River, Saskatchewan 7

72L Sand River, Alberta

Drift cover on these map sheets attains a fairly great thickness even in areas between buried valleys and sand and gravel aquifers within the drift are common. Marine shales of the Lea Park Formation and Colorado Group form the underlying bedrock. The base of groundwater exploration for this area is the base of that drift sequence.

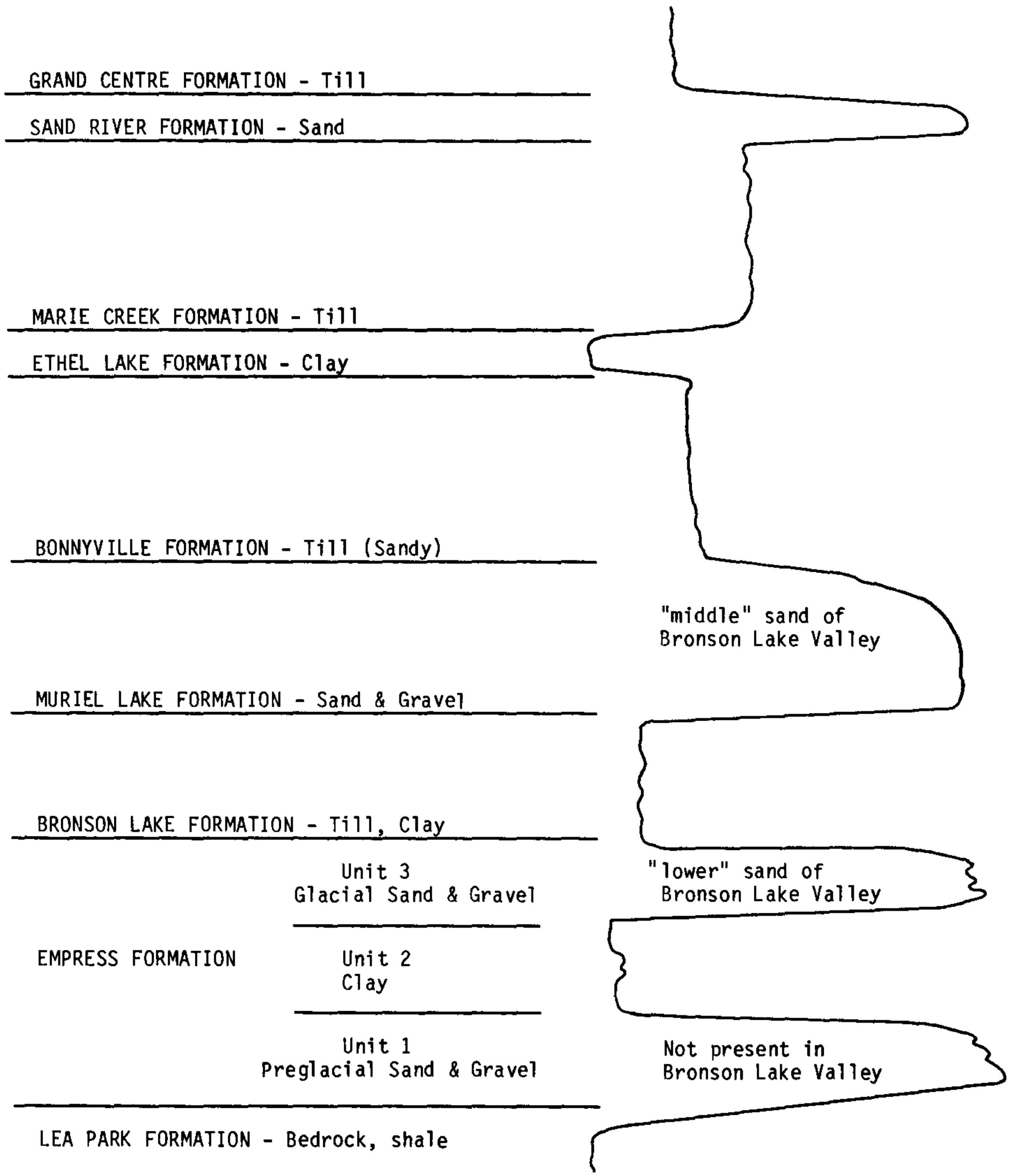
Bedrock topography has been mapped by Yoon & Vander Pluym, 1974, Christiansen and Whitaker, 1974, Maathuis & Schreiner, 1982, Gold et al, 1983, and Gold, in preparation. Whitaker and Pearson, 1972, concluded that the major buried valley beneath Cold Lake is part of the Hatfield Valley, the major preglacial river valley in Saskatchewan. Maathuis and Schreiner, 1982, suggested that the data are inconclusive and that the channel shown in the area may be a branch or tributary of the main valley. They therefore refer to this valley as the "Hatfield Valley", using quotation marks to point out the uncertainty of the correlation. In Alberta, this valley is known as the Helina Valley (Gold et al, 1983). Other valleys that cross the boundary are the Bronson Lake Valley (Maathuis & Schreiner, 1982, Gold et al, 1983), and the Vermilion and Big Meadow Valleys (Gold et al, 1983). Andriashek and Fenton (in press) consider the Helina and Vermilion valleys to be preglacial in age, while the Big Meadow and Bronson Lake Valleys are considered to be glacial.

The alluvial basal valley fill deposits in the "Hatfield Valley", have been referred to as the Empress Group by Maathuis and Schreiner, 1984, who termed it the "Hatfield Valley" aquifer system. In Alberta, Andriashek and Fenton (in preparation) have divided the Empress Group, to which they give formational status, into three units, which from oldest to youngest are termed units 1, 2 and 3. Unit 3 includes sand and gravel of glacial age and is the most extensive of the three units. They show this unit to be present in all the main buried valleys in map sheet 73L. Unit 1 is preglacial and they show it to be present only in the preglacial Helina and Vermilion Valleys, although reworked Unit 1 deposits can occur in some of the later valleys. Maathuis & Schreiner, 1983, have identified an unnamed west-east trending basal sand and gravel unit in the vicinity of tp. 60, which appears to have hydraulic connection to the Empress Group.

Andriashek and Fenton (in preparation) have named the drift formations in the Sand River map sheet. Their nomenclature and electrical resistivity response of the formations are shown on Figure 2. The Muriel Lake Formation (which they had tentatively named the Durlingville Formation in a previous, unpublished version of their report, and which name has found its way into some recent literature on this area), makes up another major aquifer above the Empress Group. Andriashek and Fenton show it to be present in all the major valleys. It has a broader extent than the Empress Group and forms the lowermost sand and gravel unit along tributary valleys and in interfleuve areas. This formation appears to be correlatable with the unnamed basal sand and gravel unit of Maathuis and Schreiner, 1982. Andriashek and Fenton tentatively equate it with some of the middle stratified members of the Sutherland Group in Saskatchewan.

Water source wells for use in secondary oil recovery operations have been completed in both the Empress Group sediments and in the Muriel Lake Formation. These aquifers have been termed the Lower Aquifer and Middle Aquifer, respectively by Mateyk, 1982, and the lower sand unit and middle sand unit respectively by Tokarsky and Rippon, 1978. Mateyk, 1982, has reviewed industrial needs from these two aquifer systems in relation to groundwater availability. He has calculated the total groundwater availability (as calculated from the rate of natural flow-through) from the Lower Aquifer (Empress Formation - unit 3) in the Bronson Lake Valley near Fort Kent, Alberta, to be in the order of 2 560 m^3/day (29.6 L/s) which is in excess of the total industrial demands at this location. He has assumed a hydraulic conductivity of 45 m/day for the aquifer at this location. Hydraulic conductivity of the Middle Aquifer (Muriel Lake Formation) was calculated to be 20.8 m/day, with a calculated groundwater availability of 2 770 m^3/day (32 L/s) from this aquifer at this location.

Figure 2 QUATERNARY STRATIGRAPHY AND APPROXIMATE RESISTIVITY LOG RESPONSE, SAND RIVER MAP AREA (AFTER ANDRIASHEK & FENTON, IN PREPARATION)



Christiansen and Whitaker, 1974, have stated that wells in the Empress aquifer should be capable of yielding up to about 50 L/s of water, and have cited reasonably good water quality from two wells in this aquifer at Goodsoil, Saskatchewan, in 62-22W3, where calcium bicarbonate water with a total ion concentration of 1 040 to 1 060 mg/L is obtained.

The Middle Aquifer in the Helina Valley in tp. 65, rge. 2W4 is thick and extremely productive. Mateyk, 1982, has calculated a total groundwater availability from this aquifer at this location to be 22 300 m^3/day (258 L/s) using a hydraulic conductivity of 67 m/day.

The above values show that both the Lower and Middle Aquifers are quite productive and that well yields of several tens of litres per second are possible without causing serious depletion of the aquifers. Chau and Gold, 1983, using a mathematical modelling technique, obtained results considerably lower than those of Mateyk, 1982. Their conclusions are that feasible pumping rates from the Lower and Middle Aquifers in the Bronson Lake Valley near Fort Kent are in the order of 1 272 m^3/day (14.7 L/s) and 657.6 m^3/day (7.6 L/s) respectively. All calculations must be considered to be preliminary and subject to revision as additional data on aquifer characteristics and on water level fluctuations in the aquifers become available. All companies using significant quantities of groundwater are required to monitor water use and water levels and to submit an annual report on the results to the Alberta Department of Environment.

"Upper sand" aquifers are also present in the drift, in the form of interglacial glaciolacustrine or glaciofluvial sands and gravels of the Ethel Lake and Sand River formations, and in other intertill sand and gravel lenses. Most domestic groundwater supplies are obtained from these aquifers because of their relatively shallow depth. Well yields are variable, but are generally low. Deeper, relatively productive sand and gravel aquifers however are present almost everywhere over this area, even in interfleuve areas.

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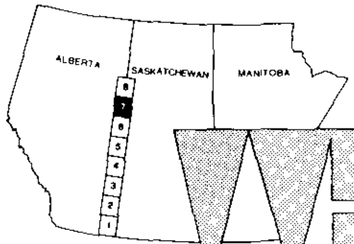

MAPS 73M & 73N

73M Winefred Lake, Alberta

73N Buffalo Narrows, Saskatchewan

8

This is an area of thick drift cover, culminating in thicknesses of over 300 metres in the buried Wiau Valley (as named by Gold, pers. comm.). The cross-section shows that the bedrock surface has relatively low relief with thick drift cover over the entire map sheet. Relative to the bedrock surface, the Wiau Valley is shallow, having only cut down from 30 to 40 metres. The basal sand deposits in the Wiau Valley are thick, in the order of 60 to 80 metres, and extend out of the valley proper to cover much of the map area. Ozoray, 1974, considered that it was probable that the basal sands (and gravels) were of preglacial age. Sand units are located higher in the stratigraphic section, some of them very thick and permeable.

The area close to the boundary is completely unsettled and no water wells have been drilled here. The Wiau Valley has been traced eastwards only as far as shown on the map, but extends to the west and northwest into, and beyond, the Red Earth Creek area of Alberta where it is known as the Misaw Buried Valley (Ceroici, 1979) or the Misaw Glacial Channel (Wright, 1984). Water exploratory wells have been drilled recently into the Wiau Valley sediments in the area of townships 72 and 73, ranges 5 and 6W4, (Ipiatic area), where large quantities of water of fair quality are available. The aquifers are usually very thick units of generally fine grained, but highly productive sand. Ozoray, 1974, mentions a testwell drilled farther to the north in 14-31-76-7W4 that penetrated 107 metres of drift overlying bedrock. The drift in this area was also composed mainly of fine grained, well sorted and rounded sand, silt and occasional pea gravel. A moderate long-term well yield of 4.3 L/s was calculated from a relatively shallow well completion with a screened interval in the well of 1.8 metres. It had a calculated average transmissivity of $2.6 \times 10^{-4} m^2/s$, and good water quality.

It is believed that all bedrock aquifers, including the sandstones of the Grand Rapids Formation, will yield saline water in this area, as indicated by Ozoray, 1974. The base of groundwater exploration in this area therefore is taken to be the base of the drift.

Because of lack of subsurface control closer to the Alberta-Saskatchewan boundary, the profile in the southern part of the map sheets has been drawn to the west as far as Range 4W4 Mer.

The approximate top of the Precambrian surface is as shown by contours prepared by Pugh, 1973.

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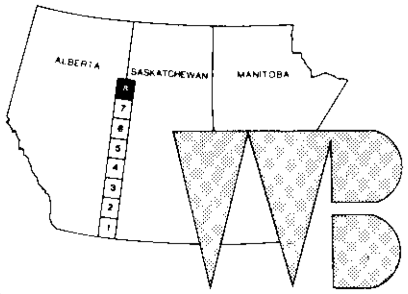

MAPS 74C & 74D

74C La Loche, Saskatchewan

74D Fort McMurray, Alberta

9

The area close to the Alberta-Saskatchewan boundary is completely unsettled, and only a few oil exploratory testholes have been drilled. The profile has been drawn through a few testholes in Saskatchewan in which formation zones were selected by Paterson et al, 1978.

Both Paterson et al, 1978, and Ozoray, 1974, have prepared bedrock topography maps, based on very limited control in this area. The contours shown on map are taken from these authors. They were adjusted near the boundary to obtain a better fit and to allow for the limited amount of additional control points which have been located.

Paterson et al, 1978, indicate a major west-east trending buried valley to be present at the south end of Lac La Loche. It has cut down through the Upper Mannville unit (equivalent to the combined Grand Rapids and Clearwater Formations of Alberta) to expose the Lower Mannville (equivalent to the McMurray Formation of Alberta) in the subcrop. The subsurface control for the valley is uncertain. It was not indicated by Paterson et al, and the drift lithology in the valley is not known. Ozoray, 1974 does not show his points of control, so that it is not possible to check his mapping.

Outcrops described by Paterson et al, 1978, indicate a considerable sand in the drift cover, and reasonably good well yields should be possible. Water quality is also expected to be of reasonably good quality. Ozoray, 1974, shows that good quality water, with total dissolved solids of less than 1 000 mg/L may be obtainable from sandstones of the Grand Rapids Formation between Garson Lake and the Clearwater River. Springs from the McMurray Formation along the Clearwater River (Ozoray field notes) have a relatively high chloride content, and total dissolved solids usually exceed 3 000 mg/L. The base of groundwater exploration therefore is taken to be the base of the Grand Rapids Formation. The Devonian carbonates are known to contain saline water.

REFERENCES 74C & D

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