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GROUNDWATER AVAILABILITY IN THE MORLEY INDIAN RESERVE, ALBERTA

– PRELIMINARY EVALUATION

by

O. Tokarsky

Research Council of Alberta
Groundwater Division

March 6, 1973.

PROVINCE OF ALBERTA

RESEARCH COUNCIL OF ALBERTA

11315 - 87TH AVENUE
EDMONTON 7, ALBERTA, CANADA.

OUR REF:

March 6, 1973.

Mr. Harold MacBride,
Department of Indian Affairs,
125 - 12 Avenue S.E.,
CALGARY, Alberta T2G 0Z9.

Dear Sir:

Attached please find a preliminary report on groundwater conditions on the Morley Indian Reserve. The report is based strictly on geological evidence and on the interpretation of drillers' logs. Ideally, some drilling and pump testing should be carried out at selected sites to check our interpretations. In this regard, I would like to request that we be informed as to when your next drilling contract will be let and where and when the holes will be drilled. I would like to make arrangements with the driller to collect drilling samples for us within selected areas and perhaps to allow us to conduct short pump tests. I believe that all concerned could benefit from this.

I would also like to thank Harold McBride, Felix Poucette and Dillon Rider for their aid in determining the proper location of water wells within the reserve.

Yours truly,

O. Tokarsky,
Hydrogeologist.

OT/dc

Copies to: Mr. Wayne Pasemko
Chief John Snow, Wesley Band
Chief Frank Koquits, Chiniquay Band
Chief Raymond Baptiste, Bearspaw Band

Morley Indian Reserve,
Morley, Alberta.

Addendum

Please notice that in areas of sandstone generally from 1 to 5 gallons per minute is available, and in areas of shale generally less than 1 gallon per minute. In areas that have not been colored on the map, the above values should generally apply.

Areas near the Bow River have also not been colored in except where there are nearby wells. This is because groundwater conditions near the river are even more variable than elsewhere. In general, where shale banks extend down to river level, you should expect poor wells or dry holes. Where sandstone outcrops along the river, conditions should be more favorable. The best possibilities, however, are in areas where till or gravel extends down to river level. In any case, water will not usually be encountered in any quantity until drilling depths reach elevations close to that of river level. For example, if we drill on a 200-foot high bank of the river, we should not expect to encounter any water before the 200-foot depth, and the final water level will also be at about this depth.

Please note also that the expected well yields that are assigned refer to "20-year safe yields" - in other words any well within a designated yield area should be capable of that yield for a 20-year period under continuous pumping (provided there is no interference from nearby wells). Therefore, even in the lowest yield areas of less than one gallon per minute, wells may be capable of producing 3, 4 or 5 gallons per minute or more for short periods of time, but cannot be expected to provide this yield over a long time period.

GROUNDWATER AVAILABILITY IN THE MORLEY INDIAN RESERVE, ALBERTA

- PRELIMINARY EVALUATION

INTRODUCTION

An attempt has been made to investigate groundwater conditions within the Morley Reserve using water well drillers' logs plus geological data. Some 200 logs were available but the locations of most of these were not given or were in doubt. The locations had to be accurately established because successful interpretation of groundwater conditions in any area depends to a great degree on the proper location of basic data, the reliability of the drillers' logs, the type and number of pump tests carried out, on proper well construction and development, and on other factors related to the regional geology. Evaluation of the availability of groundwater to wells is presented in this report. Other hydrogeological factors, particularly the chemical quality of groundwater in the reserve, have not been examined.

Thanks are extended to G. M. Gabert for editting the report.

GEOLOGY

Geological maps by Hume (1942) and Beach (1943) show the bedrock geology of the Morley Reserve. Tharin (1960) has mapped the surficial geology.

The reserve is located within the foothills of the Rocky Mountains. The bedrock strata are intricately folded and faulted in the area. East of Morley, closely spaced, high-angle thrust faulting is the common type of deformation. West of Morley, faulted, generally northerly plunging folds are present. The general strike of both geologic strata and structure over the area trends approximately 20 to 30° west of north. Bedrock ridges, therefore, are aligned mostly in this direction.

Strata of Upper Cretaceous age involved in the folding are:

Belly River Formation - alternating beds of sandstone and shale containing beds of conglomerate and coal. The sandstones are more resistant to erosion and commonly stand out as ridges.

Wapiabi Formation - marine shale and sandy shale with minor sandstone.

Cardium (Bighorn) Formation - interbedded sandstone and sandy shale - ridge forming.

Blackstone Formation - marine shale and sandy shale with minor sandstone.

The Upper Cretaceous Edmonton Formation and the Tertiary-Upper Cretaceous Paskapoo Formation are present at the extreme east end of the reserve but this area was not investigated because it is unsettled.

The surficial materials of importance to this present study are the coarse gravels and sandy or silty gravels of the Morley flats and the till that often underlies these deposits. This till is also present in the area of northeast-southwest trending drumlinoid ridges (e.g. between Chiniki Lake and Morley), and as valley fill between bedrock ridges. Sand and gravel lenses may be present within the till. There is also some evidence for buried valley deposits of sand and gravel beneath the till.

The accompanying map, without naming formations, includes the general lithology of the major aquifers to be expected within the reserve. The areas indicated as shale are underlain by the Blackstone or Wapiabi Formations. Those indicated as sandstone are underlain by Belly River or Cardium Formations.

HYDROGEOLOGY

Of the main aquifer lithologies within the reserve, gravels are considered to have the highest permeabilities and if sufficiently saturated (Fig. 1) will yield large amounts of water to wells. In order of decreasing permeabilities, other major aquifer lithologies within the reserve are sand, sandstone, and shale.

Gravel, being very permeable, also tends to be readily drained where exposed at the surface. Springs, as for example those east of Morley, are points from which active drainage is occurring. If the gravels are somewhat elevated in relation to the points of discharge, they may be completely drained, or at locations some distance from the point of discharge, may contain water with only a low head. This appears to be the case over much of the area of the Morley Flats (see Fig. 1). Where a low head of water does exist, the water occurrence may sometimes be missed by a driller, especially if rotary drilling is used. Therefore, if gravel is present in a well, it should be carefully tested for the presence of water. Other factors are also involved:

(a) cemented gravel has been reported in some wells, in which case it may be relatively impermeable;

(2) if the gravel is extremely dirty or clay-bearing, the permeability could be quite low;

(3) the gravel may represent a local pocket only and might quickly be dewatered;

(4) stony till (stony clay) is common on the reserve and has low permeability. If samples are not carefully studied this could be mis-logged as gravel.

(5) gravels may be underlain by other permeable material such as fractured sandstone which may itself be partially drained further downslope by gravity springs. The gravel then may be completely dry.

Sand has much the same characteristics as gravel, but if it is very fine-grained it may be difficult to complete a well in this material.

Sandstone within the area is generally very well indurated. Permeability is probably due almost entirely to open joints, fractures and bedding planes (hereafter called collectively "fractures") which must be rather extensively developed, as sustained production is usually possible. The amount, extent, and interconnection of the general fracture pattern will largely determine the yield to be expected.

Shale tends to be less permeable than sandstone, probably because of less extensive interconnected or open fracturing. Good wells will not generally be found in extensive shale areas.

In all cases, exceptions may occur due to various causes. Generally permeable materials may be drained or have had their permeability destroyed; sandstones may be unfractured and not yield any water to a well; shales may be extensively fractured and provide high water production. It may or may not be possible to predict just where these exceptions are likely to occur. High production from fractured shale may be possible for example where the shale is in proximity to other permeable materials or where extensive fracturing has taken place through present-day or ancient landslides, etc.

As most or all springs in the area are expected to be of the gravity type, it is probable that good wells should be obtainable in the upland areas above the sites of large springs (see Fig. 1), even at some distance away from the spring sites. In this regard, the Department of Indian Affairs is to be commended for the present manner of well construction at spring sites.

An evaluation of expected well yield within the area of the reserve, based on both existing well control and on geological inferences is shown on the accompanying map (Encl. 1). However, since drillers' logs are not always reliable and since pump tests are not always carried out or recorded, errors may arise on this account. Errors may have been introduced from mislocated wells. In addition, geological complexities and errors in interpreting geological features may cause further mistakes. In any case, it is extremely difficult in this area to predict subsurface conditions. In the area underlain by till and gravel for example, unexpected rises in the underlying bedrock may create a locally poor area for groundwater, or unexpected drops in the level of the bedrock surface near the Bow River may result in a good area for groundwater which might otherwise be expected to be drained. Similarly, in the bedrock areas, it is difficult to impossible to predict fracture pattern distribution. Nine holes drilled to a certain sandstone bed for example may encounter water, while the tenth will be dry. The <u>probability</u>, however, of obtaining water from this particular sandstone is still good. It has been found in a similar area in southern Alberta that wells located to intersect sandstone beds in the subsurface have a better chance of success than those drilled entirely within shale. This is shown on figure 2. The sandstone beds stand up as distinct ridges and the dip slope and amount of dip can

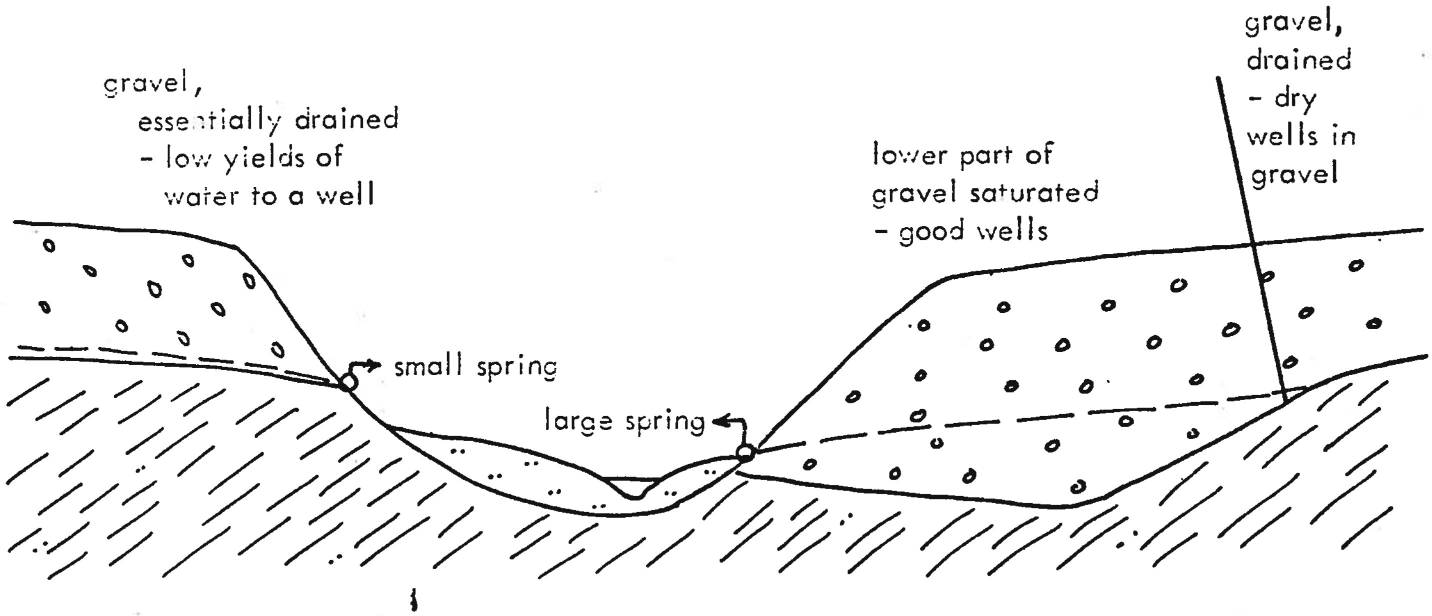

Figure 1. Schematic diagram - Nature of water saturation within a body of gravel

gravel

water level

silt

shale or other material of low permeability

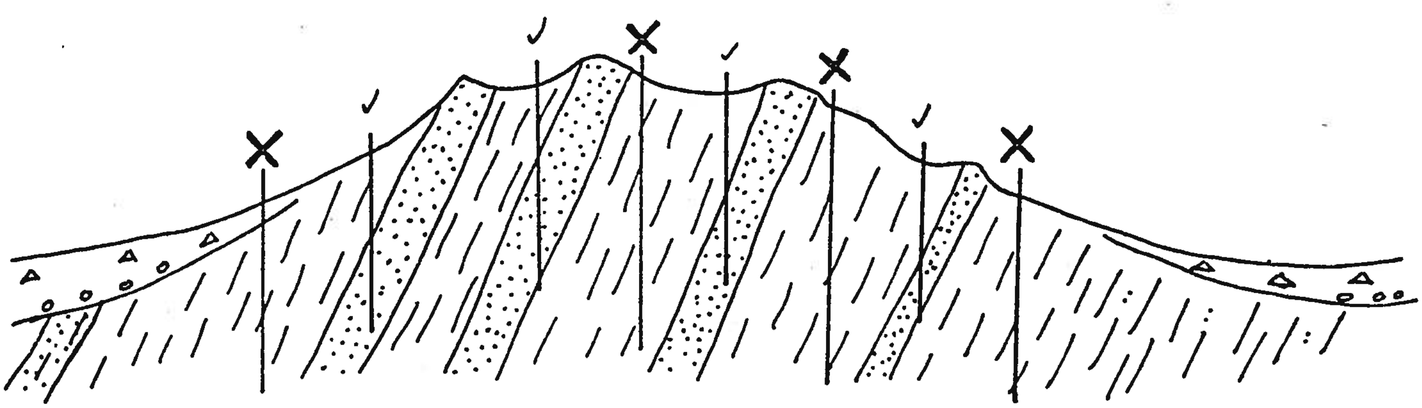

Figure 2. Schematic diagram - Well locations within an area of alternating sandstone and shale within the foothills

poor well or dry hole

good well

sandstone

shale

gravel

stony clay or till

usually be determined. The amount of dip will influence just where along the slope the well should be located.

Areas colored red or green on the map (Encl. 1) are expected to have few problems in obtaining water. Lesser amounts of water, but still generally enough for domestic use, should be obtainable in the orange-colored areas, while the greatest problems in obtaining a well supply are to be expected in the yellow-colored areas.

Ten of the pump-tested wells appear to be capable of production in excess of 25 igpm. Of these ten, nine are completed in gravel areas and one in a sandstone area, and the well in sandstone has been rated at exactly 25 igpm. Of these same ten wells, one may be capable of producing in excess of 500 igpm and two in excess of 100 igpm. In actual fact more wells than just these may be capable of high production rates but not all wells were pump tested, and the type of completion used in many of the wells would not allow a high production rate, or even give an indication of it, in any case. There are four main areas where production rates of 5 to 25 igpm or more appear feasible. These are:

(1) an area within gravel south of the Bow River. This, as interpreted here, is a narrow linear trend which probably coincides with the deepest parts (the thalweg) of an old buried river system. It is always extremely difficult to predict the exact location of the thalweg, especially when it is as narrow as this one appears to be.

(2) a linear area north of the Bow River, of gravel and associated, probably fractured, shale.

(3) and (4) two areas of sandstone north of the Bow River. There are also other smaller sandstone areas and areas where the sandstones have not been tested that would be capable of this rate of production.

WELL COMPLETION AND TESTING

Four basic types of well completion have been used on the reserve:

(1) open hole

(2) slotted casing

(3) screen with or without a sand pack

(4) blank casing or liner to bottom of hole.

Completions (1) and (2) are most common in bedrock, whereas completions (3) and (4) and sometimes (2) are used in sand and gravel. Completion (4) has been used quite extensively. Our experience, brief as it is, with this type of completion has been that the well yield is drastically reduced from what it could be. Water enters only through the open end of the casing at the bottom of the hole. Fine material can be drawn in with the water and accumulate sufficiently to cut down the yield. This method of completion is certainly simple and inexpensive and may provide sufficient water for domestic use, but if large amounts of water are required this type of completion is not recommended. Even with a screen or slotted casing, a long development time is often required to remove the fine material from around the screen or casing. One or two days, or possibly longer, of surging and bailing may be required in some cases.

Pumping or bailing tests have usually been conducted in some manner on most wells. The results of the testing, however, have not always been recorded by the drillers, and usually measurements of drawdown or recovery have not been taken. A pump test, together with drawdown and/or recovery measurements and other required data such as pumping rate should be carried out on each well drilled.

CONCLUSIONS

Wells completed in gravel are likely to have the highest yields. Not all gravels, however, are water-bearing. It is not a simple task to locate areas where water-bearing gravels will be encountered. Some of the more favorable areas have been outlined on the enclosed map although it should be recognized that this is a very preliminary interpretation based on limited and not always reliable data. In areas where bedrock is at or near the surface, a knowledge of the stratigraphy and structure of the formations is very useful in selecting a well location. Well completion, in sand and gravel areas especially, requires care and skill.

RECOMMENDATIONS

1) Water wells should be properly located by the Department of Indian Affairs at the time that they are drilled. These locations should be forwarded to the Research Council of Alberta at the termination of the drilling contract where they can be matched with the drillers' logs.

2) Drillers should be required to submit the results of a proper pump test of some set duration to the Department of Indian Affairs for each well. Drawdown and/or recovery measurements should be made during the test, and the time of

measurement, total pumping time, and the pumping rate recorded.

3) Well locations should be selected keeping the subsurface conditions in mind.

4) The flow rates of springs should be determined. These given an indication of the pumping rate that may be expected from properly located, nearby wells.

5) Wells in thick drift areas should always be drilled to bedrock unless sufficient water is obtained before this, even if several hundred feet of drilling is necessary, as there is a chance of encountering water-saturated gravels or sands at the base of the drift.

6) If a well supply for the community of Morley is required in the future, I would suggest that one of the springs east of the town could be developed. One of these springs when visited in January 1973 was flowing at an estimated 50 igpm. If this spring is perennial and is not subject to wide fluctuations in flow rate, it appears possible to maintain a town supply from it alone. Another alternative would be to test drill at points on the upland above this and other large springs to try to intercept the water which feeds the springs. The required amount of water should be obtainable.

7) Some follow-up and checking of the recommendations in this report is required. The author should be contacted when the next contract is let. Details of driller and time and place of drilling should be provided. Arrangements can then be made with the driller for sample collection and testing at selected sites.

REFERENCES

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O. Tokarsky,
Research Council of Alberta,
Groundwater Division,
March 6, 1973.

Tp. 26
Tp. 25
Rge 8
Rge 6
Rge 5
Ghost Reservoir
Chiniki Lake
GROUNDWATER PROBABILITY - MORLEY INDIAN RESERVE
LEGEND
Lithology of main aquifer
gravel and sand
sandstone
shale
Average expected well yield
>25 igpm
5-25 igpm
1- 5 igpm
< 1 igpm
> 100 igpm
> 500 igpm
water well
spring
Abbreviations
Bears - Bearspaw
Chin - Chiniquay
Hollo - Holloway
Pou - Poucette
Pow - Powderface
Roll - Rollinmud
Small - Smalleyes
Two - Twoyoungmen