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RECONNAISSANCE GROUNDWATER SURVEY OF THE OYEN MAP-AREA, ALBERTA

by

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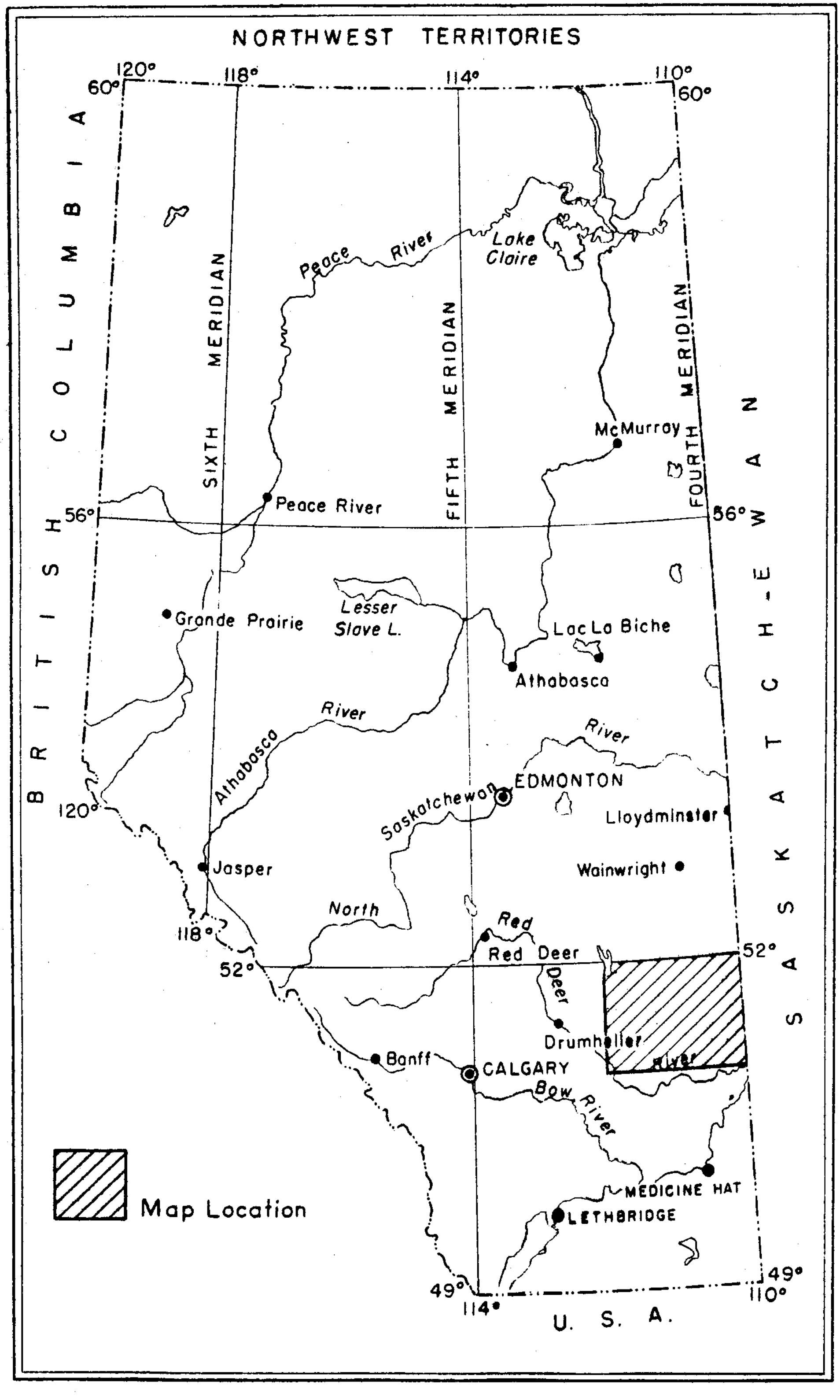

Figure 1. Location of the Oyen map-area

RECONNAISSANCE GROUNDWATER SURVEY OF THE OYEN MAP-AREA, ALBERTA

Abstract

Most wells in the Oyen area obtain domestic or farm supplies from sand and gravel within glacial deposits, from sandstones in the Edmonton or Bearpaw formations, or from deeply buried sandstones in the Belly River formation. The Belly River formation has only recently been developed in areas where shallower supplies could not be obtained.

Recharge to the area is small because of the limited precipitation and the impermeable nature of much surficial material. As a consequence, only very few aquifers are believed able to sustain yields in excess of 50 gallons per minute. Also, the chemical quality of the groundwater is commonly only fair to very poor and quite often does not meet the requirements of Alberta provincial health standards.

Groundwater probability maps for the drift and the bedrock show the relative chances of success in obtaining a yield of 5 to 10 gallons per minute. These maps, in addition to a preliminary bedrock topographic map, should aid in the search for new supplies of groundwater and provide a base for future detailed studies.

INTRODUCTION

Purpose and Scope of the Investigations

The purpose of this investigation was to delineate all proven and possible aquifer sites in order to obtain a better understanding of the geologic factors influencing the occurrence and movement of groundwater within the Oyen map-area. This reconnaissance report will serve as a necessary base for future detailed studies and, in the meantime, will provide a working basis for water well drillers and others interested in groundwater development.

The maps accompanying this report represent a compilation of all available data on the nature and occurrence of aquifers in the area. The information is scanty and its quality is only poor to fair on the average. As a consequence, much of the area has been interpreted using indirect evidence such as glacial geology, geomorphology, and soil survey data.

Location of the Area

The Oyen map-area is located between latitudes 51° and 52° north and longitudes 110° and 112° west (figure 1). The total area is about 5760 square miles. All locations referred to in the text are west of the Fourth Meridian.

Politically, the area includes Municipal District 34 and districts 2 and 3 of the Special Areas. In Alberta, the area is most commonly referred to as the Special Areas, due to special government assistance afforded since the drought period of the 1930's.

Topography and Drainage

The minor topographic features present are mainly the result of glaciation during the Pleistocene epoch. The constructional features left by the ice mantle a bedrock surface which outcrops along many of the major creeks. The extremes in topography include very rough and hilly areas, composed of hummocky moraine, and very flat, featureless terrain composed of ground moraine and lake deposits. In general, the land surface slopes from the northwest toward the southeast.

Although the major drainage systems, the Red Deer River, Sounding Creek, Monitor Creek, and Loyalist Creek (plate 1), are deeply incised, the area in general is poorly drained since the streams in the upland areas are not well integrated. This is a direct result of glaciation which has left an immature drainage system with large areas of internal drainage and numerous sloughs and intermittent lakes. Many of the small drainage ways have been dammed to provide water for stock use.

Climate

According to the Canadian Oxford Atlas of the World (Oxford Univ. Press, 1957, p. 3), the climate of this area is best described as semi-arid. The average annual precipitation is 14 inches, and most of the rainfall occurs during the summer months of June, July, and August (Alberta Bureau of Statistics, 1954, p. 4-5). The precipitation is highly variable from year to year with about one-half of the years lacking enough moisture for satisfactory crop growth.

The temperature extremes recorded at Hanna, Tp. 31, R. 14, are -50°F. and 102°F. The maximum and minimum daily mean temperatures are 17°F. and -1°F. during January, and 78°F. and 51°F. during July.

Economy

The economy is dominated almost entirely by agriculture. The principal crops are wheat, barley, oats, and flax. According to the Alberta Bureau of Statistics (1954, p. 29) the average size of the farms in this area is

1,452 acres, the second largest average size for all agricultural districts in Alberta. The average number of persons per farm is between 4 and 5. Only slightly more than 50 per cent of the farms are operated by their owners.

The importance of livestock in the economy is steadily increasing in relation to crop farming. Between 1941 and 1951, the number of acres devoted to crop farming or under fallow increased only 10 per cent whereas the amount of pasture land increased nearly 50 per cent (Alberta Bureau of Statistics, 1954, p. 31). In 1951, the average number of livestock per farm was about 25; however, at the present many of the larger farms in this area have between 100 and 200 head of cattle.

Another contributor to the economy of this area is the production of oil and gas. Large occurrences of gas have been found in the southeastern part of the area, and some small occurrences of oil.

In addition, the economy is benefited by an influx of a large number of sportsmen during the fall. The numerous lakes and sloughs provide excellent sites for duck and goose shooting during the relatively wet years.

Previous Investigations

The earliest geological investigations were made by G. M. Dawson (1875) and by J. A. Allan (1918). Since then, more detailed work has been done by Williams and Dyer (1930), Russell and Landes (1940), and by Shaw and Harding (1954).

Outside of incidental remarks concerning groundwater, no systematic studies on this subject were begun in this area until 1946. At that time, Mr. A. Golden (1946) of the Petroleum and Natural Gas Conservation Board, spent five months collecting water well information, primarily from well owners. This information has been extremely valuable in aiding the interpretations made in this study.

Other work relating to the occurrence of groundwater has been done by the Research Council of Alberta. Of interest are pump test data collected by W. A. Meneley (1959) and a bedrock channel map by R. N. Farvolden (Gravenor and Bayrock, 1961).

Acknowledgments

The author would like to thank the drillers of the area, especially Mr. D. M. Code of New Brigden, for their valuable assistance.

In addition, the author wishes to express his gratitude to G. Nielsen who assembled the data from which figures 4, 5, and 6 were taken.

GROUNDWATER GEOLOGY

Introduction

Groundwater is obtained in about equal proportions from drift and bedrock sources. Bedrock supplies are obtained predominantly from sandstone lenses in an otherwise shale sequence. Drift supplies are obtained from lenses of sand and gravel in till, from outwash sands and gravels, and from aquifers in buried bedrock channels. Groundwater probability maps (plates 1 and 3) have been prepared to show the relative chances of success in obtaining 5 to 10 gallons per minute (gpm) from bedrock or drift aquifers.

Bedrock Aquifers

The significant formations containing water-bearing zones are the Belly River, the Bearpaw, and the Edmonton, all Late Cretaceous in age. The two last-named rock units subcrop beneath the glacial deposits, whereas the Belly River is buried at depths exceeding 250 feet. The formations are essentially flat lying with inclinations of less than 1 degree.

Belly River Formation

The oldest formation, the Belly River, is composed of interfingering marine shales and continental sandstones. Numerous but very thin stringers of coal can be found in the upper part of the formation in the southeastern part of the area but are uncommon towards the north. The shales are brownish-grey to grey and the sands are loosely consolidated, silty, and fine to medium in texture.

In the eastern two-thirds of the area, the Belly River formation may be subdivided into several members. The members are sand and shale units which are distinct enough on electric longs to be correlated over wide areas. The sand members are, from oldest to youngest (figure 3), the Brosseau, the Victoria, the Ribstone Creek, and the Birch Lake (Shaw and Harding, 1954). The Birch Lake is not always distinct enough from the uppermost member, the Oldman, to be completely separated. The Oldman member is a series of alternating thin sands, shales, and coals.

The sand members may prove to be important aquifers in this area. In the eastern half of the area they represent the only reliable source of water within the bedrock. Small domestic supplies can also be developed from the thin sands within the Oldman member; this rock unit is preferred to the other members because of its shallower depth.

The municipal well recently drilled at Consort (Tp. 35, R. 5) indicates that these members will become more important sources of water in the future. This well penetrated 61 feet of Birch Lake sandstone at a depth of 672 to 733 feet. The well is completed with 60 feet of slotted casing and is rated at a maximum of 125 to 150 gpm (Robinson, 1961, p. 4). The well was put into production at 30 gpm. Some decline in pumping rate has recently been experienced due to the presence of gas in the formation. The quality of the water from the Birch Lake member at this site is given as follows:

Constituent	ppm*
Total solids	1990
Hardness	15
Sulfates	5
Chlorides	915
Alkalinity	396
pH	8.4

The water is chemically poor; however, excepting the chlorides, the quality is as good if not better than that of the water obtained from many wells at shallower depths.

One of the village wells at Cereal (Tp. 28, R. 6) obtains its water from the Ribstone Creek sandstone member at a depth of 940 feet. Although this well is almost 300 feet deeper than the municipal well at Consort, the quality of the water is not appreciably worse. The chemical quality of the water from the Cereal well is as follows:

Constituent	ppm*
Total solids	2026
Ignition loss	32
Hardness	25
Sulfates	nil
Chlorides	959
Alkalinity	400
Iron	1.5

28 grains per gallon of soda; 110 grains per gallon of Glauber's salt.

Although this water is not chemically suitable by the Alberta health standards, it may be economical to treat the water, and thus reduce the chloride and sodium contents. Treatment units utilizing the method of electrodialysis are at present on the market in the United States and may soon be readily available in Canada. One such unit is reported to yield 20 gallons of fresh water per day for an operating cost of less than one cent per gallon. Larger models are available for municipalities.

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* parts per million

Bearpaw Formation

The Bearpaw formation which overlies the Belly River subcrops beneath the drift over about 80 per cent of the area. The formation consists of dark-grey, greenish-grey and chocolate-brown fissile shales. A few sand lenses are known to occur within the shale, but except in the northwestern part of the area, they are extremely scarce.

In the northwestern part of the map area, the Bearpaw formation contains a definite and traceable sand member, the Bulwark sandstone. According to Williams and Dyer (1930, p. 36) the Bulwark sandstone is exposed along Sounding Creek and appears to be midway in the Bearpaw section.

The member consists of loosely consolidated, very fine to medium sand. The thickness of the Bulwark sandstone is variable, but commonly is reported to be about 15 to 20 feet. It may be that the Bulwark sandstone consists of two separate sand units. Drillers in the area report that the Bulwark sandstone may yield either clear "white" water or brown water. It is thought that the difference in the water reflects the presence of two distinct and separate sand units. However, because only one well reports the presence of both kinds of water at different depths, it appears that the sand units are distinctly separated in the horizontal as well as in the vertical direction. The presence of one sand unit in a well is common, but the presence of two is an exception.

The southern limit of the Bulwark sandstone is not known. Water wells reporting sandstones at elevations roughly equivalent to the known elevation (2450-2480 feet AMSL) of the Bulwark sandstone around Kirkpatrick Lake can be found as far south as township 25. Some difficulty is encountered in contouring the top of the Bulwark sandstone, indicating again the possibility of more than one sandstone unit. Using those wells which gave the most consistent picture, a structure contour map was constructed which shows a structural ridge extending southward from township 33, range 11 to Brosten Reservoir (Tp. 28, R. 8). The ridge corresponds in position with the area marked on plate 1 as having a groundwater probability of mainly good ranging to fair. The resemblance between this structural ridge and the superposed bedrock topographic high suggests that, at least in this area, the bedrock topography may be controlled to some degree by structure.

The Bulwark sandstone is extensively developed for domestic and farm water supply throughout the area indicated in plate 1. Reported yields are generally in the 5 to 10 gpm range; the lack of reported larger yields may be due to the fact that greater quantities are not often required.

In Lsd. 2, Sec. 18, Tp. 35, R. 9, a well in the Bulwark sandstone, drilled for National Bulk Carriers, was pump tested at a rate of 16.7 gpm. The formation constants determined were 500 gallons per day per foot (gpd/ft) for the coefficient of transmissibility*, and 6.3 x 10^{-5} for the coefficient of storage **. At this particular site, the aquifer is 15 feet thick, giving a permeability of 33 gallons per day per square foot (gpd/ft^2) which, according to Todd (1959, p. 53), is in the range of very fine sands.

Recharge to the Bulwark sandstone is very small. In the above pump test, the leakage through the overlying shales was determined to be 0.035 gpd/ft^2. It can be shown by a calculation based on the above aquifer coefficients, that a well pumping continuously at 15 gpm should, at the end of 10 days, receive enough leakage to balance the discharge. However, the sands are not uniform or continuous so that the pressure cone developed around the well intersects impermeable boundaries before equilibrium between discharge and leakage can be established. This causes an increase in the rate of drawdown. The net effect is that the leakage is cancelled out and the life of the well is considerably shortened. Exactly how long any particular well can pump continuously depends upon the local geologic conditions, such as the thickness and the extent of the Bulwark sandstone at the well site and the pumping rate selected. Every indication points to the fact that the Bulwark sandstone can be considered an excellent aquifer for domestic and possibly for small municipal supplies. The chemical quality of the water obtained from the National Bulk Carriers's well is as follows:

Constituents	ppm
Total solids	967
Hardness	37
Sulfates	104
Chlorides	100
Alkalinity	685
Iron	15.0
pH	8.3
High in soda	

Edmonton Formation

The Edmonton formation overlies the Bearpaw shale but is present only in the western quarter of the area (plate 2). The formation consists of thin alternating beds of white and pale grey, silty sands, shales, black shales, and coal. According to Williams and Dyer (1930, p. 44), the lithology is extremely variable both laterally and vertically. Within the area, the formation thickness varies from zero to slightly over 300 feet.

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* The coefficient of transmissibility is the rate of flow in gpd of water through a a vertical strip of aquifer, one foot wide, under a unit hydraulic gradient.

**The coefficient of storage is the volume of water released per unit surface area of aquifer when the hydrostatic head (static water level) is lowered one unit.

The Edmonton formation is an excellent aquifer for domestic and farm water supplies. The production of these small yield wells is mostly limited by the thickness of the sand units encountered and the type of well completion. Where the aquifer encountered is more than 10 feet thick, a properly completed well may produce as high as 30 gpm. Many of the wells which are located in topographic lows and which penetrate to the Edmonton formation flow at a rate commonly between 1 and 5 gpm. A short distance west of the study area flows of up to 25 gpm have been reported. The flowing wells are particularly advantageous as livestock wells.

In those areas underlain by the Edmonton formation, most domestic wells penetrate into the bedrock. These wells are preferred to wells in the drift because of the softer water that can be obtained. However, it should be noted that water from the Edmonton formation in this area commonly contains 25 to 30 grains per gallon (gpg) of soda and locally more. On the other hand, water from the drift generally contains less soda.

Summary of Groundwater Conditions in the Bedrock

Domestic and farm supplies are easily obtained from wells in the Edmonton formation or the Bulwark sandstone (plate 1). Elsewhere, occasional small supplies can be obtained at relatively shallow depths from sand lenses in the Bearpaw shale. Deep wells may obtain domestic, farm, or small municipal supplies from sandstone members of the Belly River formation. In some cases, it may be necessary to demineralize the deep waters to meet minimum health standards.

Bedrock Topography

The topographic features of the bedrock surface seem to resemble those of the present surface to a great degree. This resemblance would be more striking had the area included the nearby Neutral Hills (Tp. 36, Rs. 4 to 7) and Hand Hills (Tps. 29, 30, Rs. 16, 17). Each of these features is both a bedrock and present day physiographic high. The resemblance between these two surfaces in areas in which bedrock control is good provided the basis for contouring in those areas of plate 2 where the number of wells that recorded the top of the bedrock was small.

During and after glaciation, the bedrock topography was modified by ice deformation and stream erosion. Ice deformation is observed on aerial photographs in the northeastern part of the area. Crescent shaped ridges, believed to be bedrock by L. A. Bayrock (personal communication), are arcuate towards the south, or in the direction of ice movement. The ridges are relatively narrow and several miles in length. Their influence on the bedrock topography is unknown since not enough borehole information is available to map them in detail.

Modification of the bedrock topography by stream erosion is quite apparent and can be observed along the major creeks. It is believed that these bedrock valleys are, for the most part, preglacial in origin. The preglacial drainage was toward the south and east, with the major streams incised about 150 to 200 feet into the bedrock surface. It is believed that the position of these bedrock valleys has been little modified by glaciation; however, they may have been deepened by glacial meltwaters.

The ancestral south-flowing streams joined an eastward-flowing preglacial river which occuped the Bow bedrock channel just south of the area (Farvolden, figure 1, in Gravenor and Bayrock, 1961). The northern valley wall of the Bow channel lies along the southern boundary of township 24.

Bedrock Channel Aquifers

The materials that may be found in preglacial bedrock valleys present good possibilities for the development of small to moderate groundwater supplies. Test drilling at Hanna, in the Hanna channel, shows these channels to contain pockets of sand and gravel (figure 2) capable of supplying domestic, farm,and small municipal requirements. A 50-hour pump test performed on a well in the western gravel lens in the Hanna channel (figure 2) gave a coefficient of transmissibility of 5700 gpd/ft, and a coefficient of storage of 1.2×10^{-4}. The long term yield of a well at this site is estimated to be 60 gpm (Kunkle, 1961).

Other deposits of sand and gravel are reported in the Hanna channel at a few localities south of Hanna. In each well the permeable deposits were reported mixed to some degree with clay. Since few wells penetrate this channel, it cannot as yet be stated that the presence of clay is a general rule. The location of one site where 60 gpm can be developed suggests that other similar or better sites probably exist.

The bedrock channel underlying Antelope Lake (plate 2) is defined mainly by wells fringing the channel. These wells report some sand and gravel, and it may be inferred from this that other deep aquifers are present in the channel. Further test drilling is needed before a firm statement can be made as to the groundwater possibilities within this channel.

Drift Aquifers

Glacial deposits mantle the bedrock and vary in thickness from zero to about 250 feet. The average thickness is in the range of 50 to 75 feet. In general, the drift thickens toward the south and southeast. In the northwest, around Sullivan Lake, the bedrock is mantled by a thin veneer of drift, and southeast of Hanna it is exposed in many of the creek bottoms and road cuts. The observed exposures have been marked on plate 2. Elsewhere, the bedrock is exposed along Loyalist, Monitor and Sounding Creeks, and in the southwest along the Red Deer River.

The drift was deposited by ice moving toward the south (Gravenor and Bayrock, 1961, figure 3). The characteristic landforms left following glaciation are hummocky moraine, ground moraine, lake plains, outwash plains,

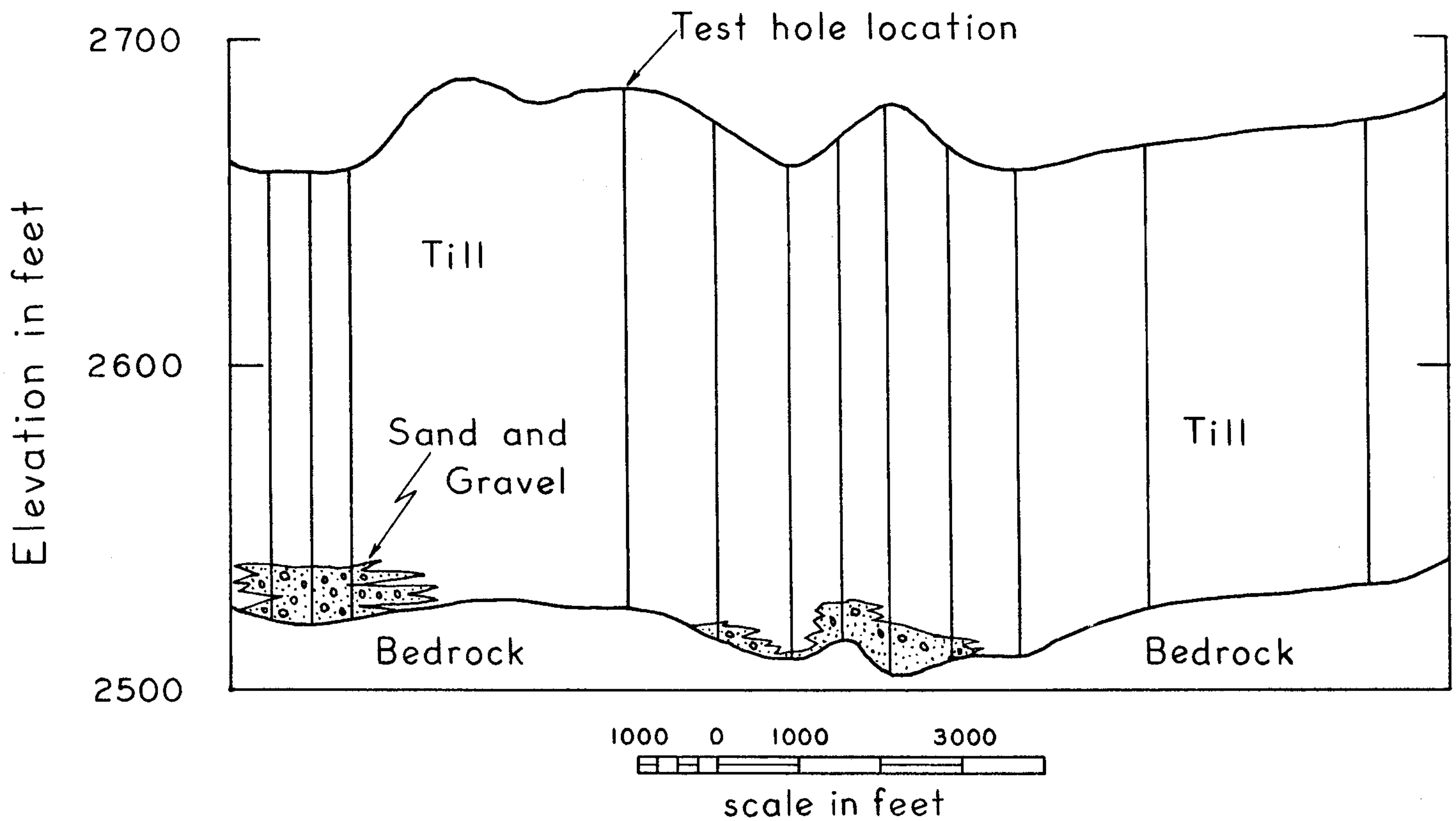


Figure 2. Cross section of the Hanna Channel west of Hanna

and stream trenches. Each of these features is indicative of the mode of origin and to some extent, of the character of the deposits forming it. Consequently, an interpretation of the glacial landforms can be used as one parameter to map the character and distribution of the glacial deposits. Such an interpretation represents the basis for the construction of plate 3. Other supporting evidence for the character and distribution of the glacial deposits comes from soil surveys (Wyatt and Newton, 1927; Wyatt, et al., 1938) and the relation of the pattern between permanent and intermittent streams and lakes. A first interpretation based on the above data was then modified by plotting available well information to account for deposits at depth. Not enough well logs are available to check the entire area; however, it is felt that the resulting map is a reasonable interpretation of the gross areal position, extent, and character of the glacial deposits.

The map permits a breakdown of the area with regard to the probability of obtaining a yield of 5 to 10 gpm from the drift. In those areas designated as "good", it is felt that the chances of obtaining a yield of 5 to 10 gpm is much better than average for the area, but the possibility is not precluded that some wells will be unsuccessful. Likewise in those areas marked as "poor", the chances of obtaining 5 to 10 gpm are much less than in any of the other areas, but the possibility is not precluded that a good well could be obtained.

Those areas designated as "good" include outwash sands and gravels, lake sands, and alluvial deposits. In many regions, such as the northwest part of the area, the deposits are thin and the saturated thickness will be subject to seasonal fluctuations in the water table. From observations made in wells in other parts of the province, it is estimated that the magnitude of the water table fluctuations may be about 6 feet, which could seriously affect the yield where the deposits are thin initially. In the Acadia Valley area, the permeable deposits consist of fine to coarse waterlaid sand overlain by deposits of lake silt and clay. The water in these deposits will be under a greater hydrostatic pressure and thus not subject to the extreme and rapid changes in water level as will the water in those deposits exposed at the surface. The maximum reported yield in those areas marked as "good" is 75 gpm. It is extremely doubtful whether a yield of this magnitude could be sustained for an extended period. The safe yield for the better wells in those areas marked as "good" probably does not exceed 30 gpm.

Those areas indicated as "mainly good ranging to fair" correspond to buried bedrock channels for which the position of the channel is fairly well documented. Deposits in the channels have been discussed in an earlier section of this report.

Areas marked "mainly fair ranging to good "correspond to the positions of stream trenches (Gravenor and Bayrock, 1956). These features served as meltwater channels during the disintegration of the continental ice sheet. In many cases sand and gravel were deposited within them although in some cases they have been infilled only by till. The villages of Chinook and Cereal utilize water from sands deposited in stream trenches.

Areas marked "fair" consist mostly of hummocky moraine or areas of outwash believed to be very thin. Hummocky moraine is for the most part composed of till but does contain numerous sand and gravel lenses randomly interspersed both vertically and horizontally. Thus, it was felt that the chances of obtaining a good supply were only average.

Those areas denoted as "mainly poor ranging to fair" coincide mostly with areas of ground moraine. The probability of obtaining water in areas of ground moraine is thought to be less than in areas of hummocky moraine because of the smaller number of sand and gravel occurrences in the former. In addition, those areas marked "mainly poor ranging to fair" also include areas of lake plain where underlying deposits of lake sand are not known to be present.

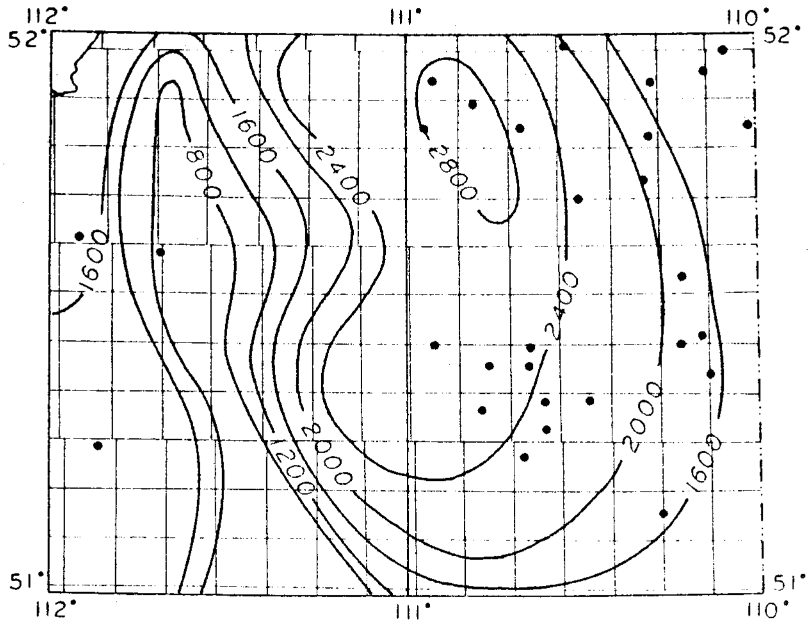
Those areas designated as "poor" are most commonly located along the major creeks. They represent areas where the glacial deposits are thin to absent. Also, these areas commonly have moderate to high relief affording an excellent opportunity for any permeable deposits to be drained.

CHEMICAL QUALITY OF THE GROUNDWATER

Chemical analyses of specific bedrock aquifers have already been cited, and a few representative analyses of water obtained from the drift plotted on plate 3. Of interest are the horizontal variations in chemical quality, for waters obtained both from the bedrock and the drift. Figures 4, 5, and 6 present the variations in total solids, hardness, and sulfates.

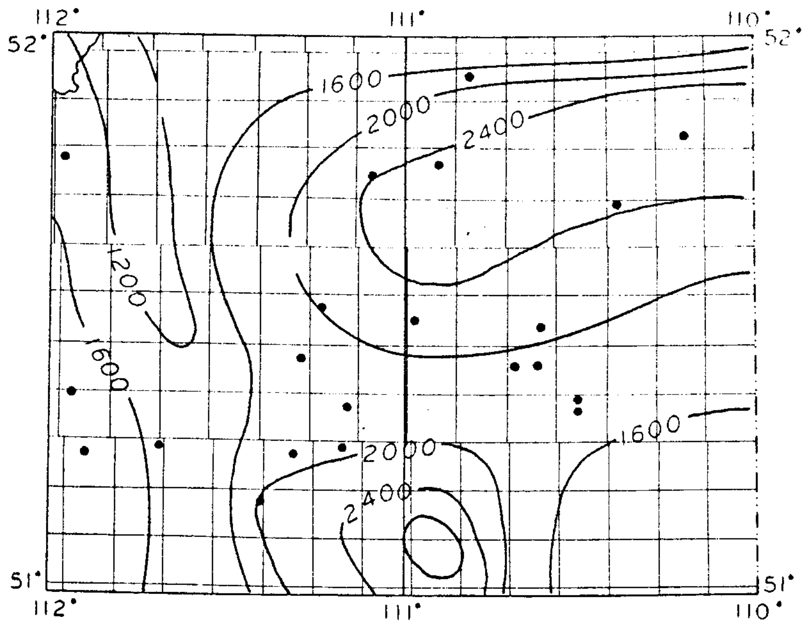
Each figure has been taken from a larger map showing the variation of the property in question over the southern portion of the province (LeBreton and Jones, 1962). The contours have been drawn on the basis of a moving average system, which is more appropriate than conventional contouring when the sample variation is large (Hackett and Zeizel, 1961). Using this system, each point on which the actual contouring was based was derived by averaging the values for wells within a standard map area, six townships square, and then plotting the average at the center of the standard area. The areas for which averages were computed were selected in such a way that there was a three-township overlap between adjacent areas, both in the north-south and east-west directions. Each control point is, therefore, used four times in obtaining averages, and the contours near the edges of each figure are based, to some extent, on control points outside the map area. When using a moving average system, the true value at any site is lost since the contours show only the probable average value. The result is lack of detail but a much better analysis of the regional picture.

There appears to be little relation between the known geology and the chemical quality as shown in figures 4, 5, and 6. The only possible relation is between the lineal low in total solids in the western part of the area and the Hanna bedrock channel (plate 2). The fact that the low is not centered over the



WATER FROM THE DRIFT

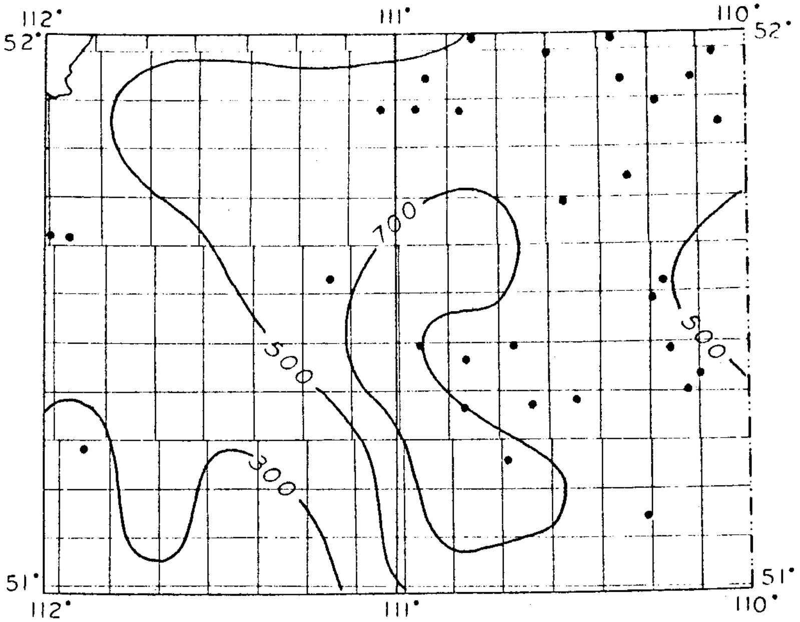
• Control point



WATER FROM THE BEDROCK

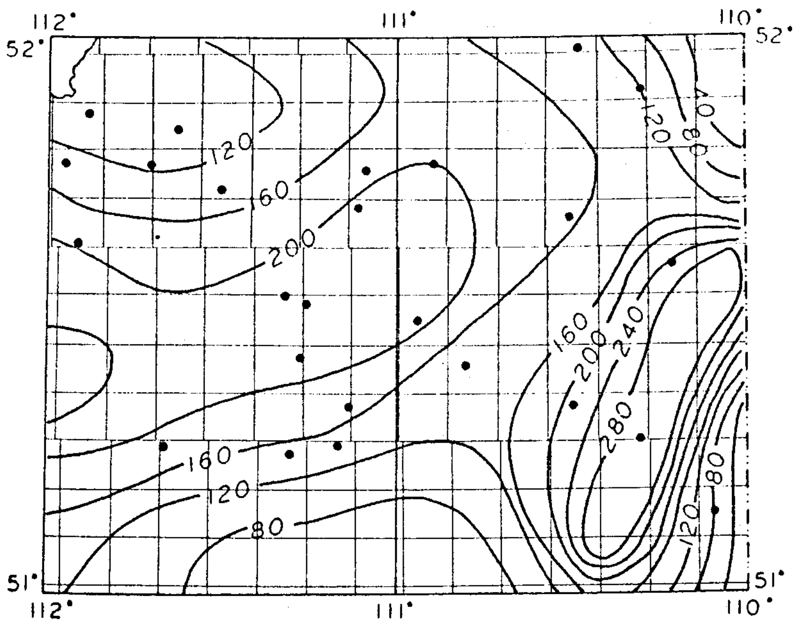
• Control point

Figure 4. Lateral and vertical variation in total solids content; values are expressed in parts per million



WATER FROM THE DRIFT

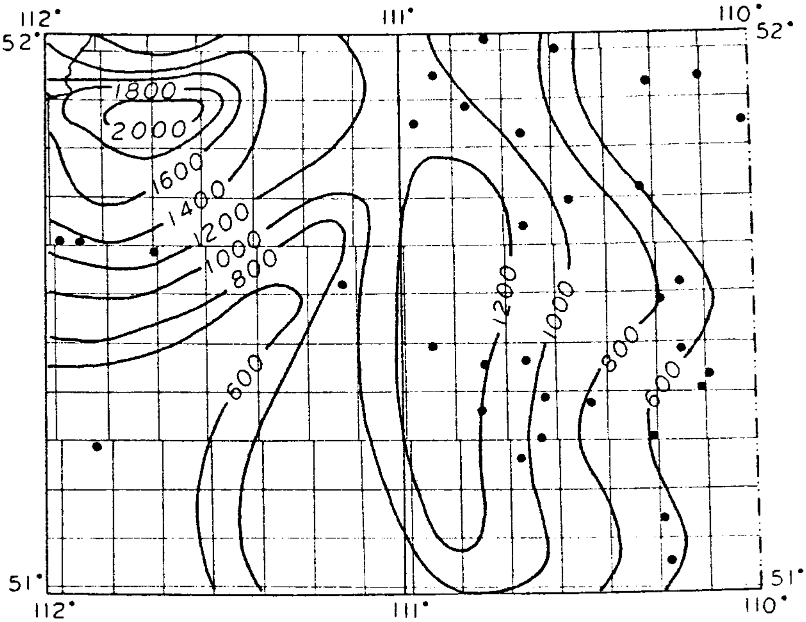
• *Control point*



WATER FROM THE BEDROCK

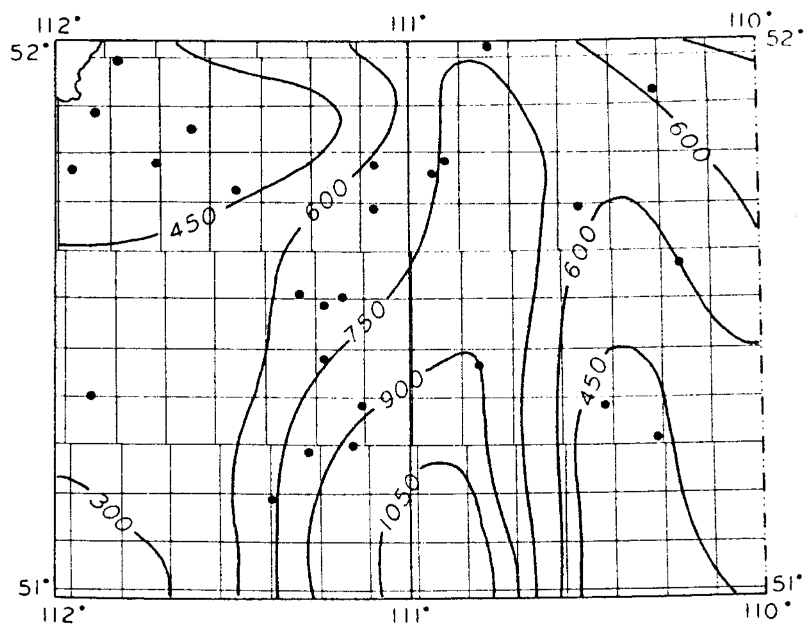
• *Control point*

Figure 5. Lateral and vertical variation in hardness; values are expressed in parts per million



WATER FROM THE DRIFT

• Control point



WATER FROM THE BEDROCK

• Control point

Figure 6. Lateral and vertical variation in sulfates; values are expressed in parts per million

channel could be due to lack of control and to the method of moving averages. If the low is related to the channel, then the channel must be acting as a drainage pathway for groundwater in that area.

Another significant relation is the difference in composition between groundwater from the bedrock and that from the drift. This is most striking for the hardness which is considerably greater in water from the drift than from the bedrock. The same general relationship holds for the sulfates, but to a lesser degree.

The suggested upper limit for total solids established by the U.S. Public Health Service (Todd, 1959, p. 185) is 1000 ppm. Because of the poor quality of much of the groundwater in Alberta, 1000 ppm is an impractical standard, and 1600 to 2000 ppm is taken to be of doubtful quality, and greater than 2000 ppm is considered unsuitable by the Provincial Analyst, C. E. Noble. In the Oyen map-area, 15 per cent of the area has groundwater from the drift in the doubtful range, and 45 per cent of the area in the unsuitable range. For water obtained from the bedrock, 30 per cent of the area has groundwater with greater than 1600 ppm total solids, and 35 per cent greater than 2000 ppm.

It is generally considered in Alberta that greater than 800 ppm sulfates is a very laxative water and unsuitable for human consumption. Again this limit is higher than that accepted in the United States. In the Oyen map-area, 50 per cent of the area has groundwater from the drift above 800 ppm, and 15 per cent of the area has groundwater from the bedrock above 800 ppm.

The chemical quality of the groundwater cannot be considered anything but poor. Sulfates and total solids are higher in this area than anywhere else in the Province (LeBreton and Jones, 1962). The poor quality is most probably due to poor surface drainage which limits the lateral movement of groundwater and to the relatively impermeable Bearpaw shale which limits the vertical movement of groundwater. The lack of movement has created stagnant conditions which reduce recharge and, thus, freshening of the water.

CONCLUSIONS

Within the area there is abundant groundwater for domestic and farm use. In some parts of the area, this water is more easily obtained than in other parts because of the presence of permeable deposits.

For uses greater than those just mentioned, the areas in which groundwater development can take place are severely restricted. Water users in the 30 gpm or more range are limited to outwash deposits, buried bedrock channel deposits, thick sand lenses in the Edmonton formation, or the deeply buried Belly River sand members. At this time, there are practically no indications that requirements in excess of 100 gpm can be met in this area except on a short term basis, or through the development of a large well field involving a great expense. Perhaps in the future, detailed studies will prove the practicability of utilizing more than one source of groundwater at a given site to increase the total yield.

It appears now that large water users will have to develop both ground and surface water sources. Such a combined system has many advantages. First, groundwater can be used during exceedingly dry years when surface runoff is almost nil. Second, surface water can be used during wet years allowing groundwater levels to recover. Third, when used conjunctively, the poorer aspects of the chemical quality of each type of water are overcome, since the more concentrated constituents in the one kind of water are commonly balanced by low concentrations in the other.

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LEGEND

EXPLANATION

This map shows, in generalized form, probabilities of obtaining 5 to 10 gallons per minute from wells completed in drift deposits. It is based predominantly on soil and topographic maps, aerial photo interpretation, lithologic logs, and on presence or absence of permanent water bodies.
As a correlation exists between probability and availability, a reported maximum well yield is presented for each probability symbol. These maxima do not necessarily represent long-term safe yield values.

PROBABILITY OF OBTAINING 5 TO 10 GPM

	MAXIMUM REPORTED YIELD
Good. Areas in which relatively shallow sands and gravel are present.	75 gpm
Mainly good ranging to fair. Areas in which deep sands and gravel are present.	60 gpm
Mainly fair ranging to good. Areas of stream-trenches which may contain sand and gravel at depths of 30 to 120 feet.	25 gpm
Fair. Water obtained mostly from pockets of sand and gravel.	10 gpm
Mainly poor ranging to fair. Water obtained mostly from pockets of sand and gravel.	10 gpm
Poor. Drift thin to absent.	—

WATER WELL SYMBOLS

65 Gr.25 — Well depth (ft.) - Water-bearing formation - Static water level (ft.)
64 H 15 ○ — Depth to bedrock (ft.) - degree of hardness - yield (g.p.m.) *

*Note: Those wells in which the yield was extremely small are labelled poor.

WATER-BEARING FORMATIONS

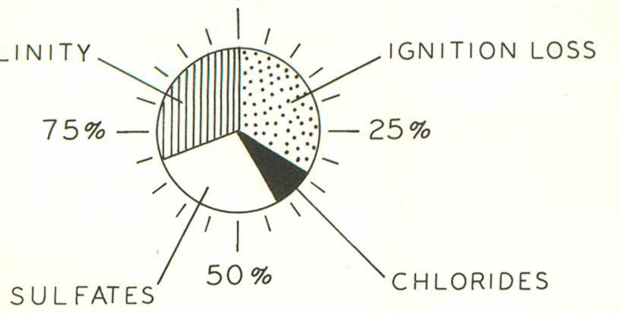
S = Sand
Gr = Gravel
Cly = Clay

DEGREE OF HARDNESS

H = Hard
M = Medium hard
S = Soft

GROUNDWATER COMPOSITION

The major constituents of the groundwater composition are presented, as percentages, in a pie diagram. The figure above the diagram represents the sum in ppm of these constituents.



Groundwater geology by G.R. Kunkle, 1961-1962

REFERENCE

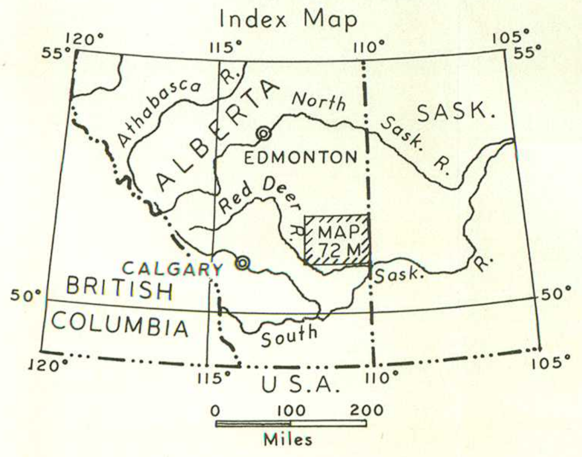
Provincial highway .... (12)
Township boundary ....
Section line ....
Town, village ....
Stream, lake or reservoir ....

Base map compiled from National Topographic Series, Department of National Defence, Army Survey Establishment, R.C.E., 1954, Sheet 72M, Scale 1:250,000

Township Division

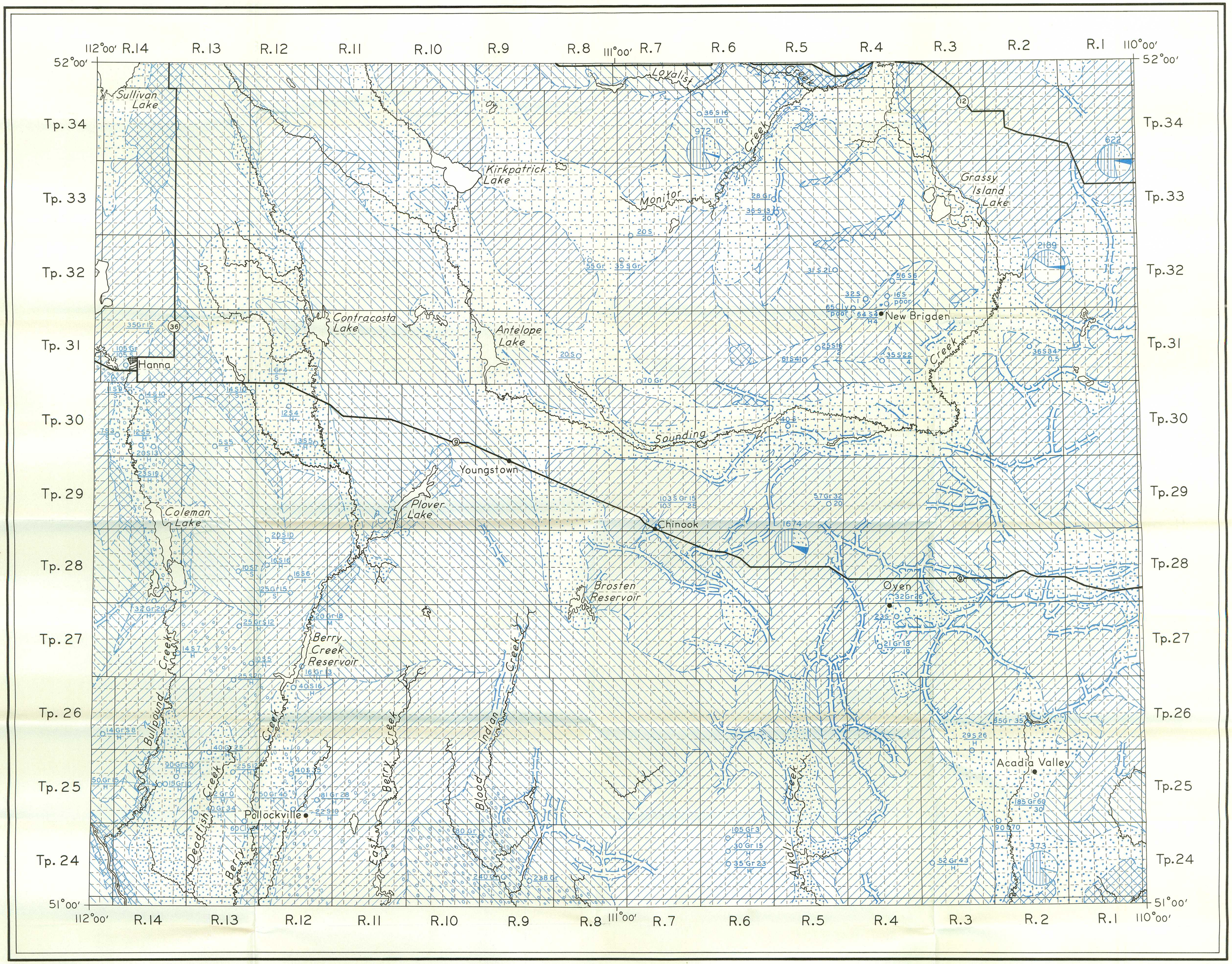
31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

Index Map



RESEARCH COUNCIL OF ALBERTA

SHEET 72 M



Map to accompany Preliminary Report 62-3

Published in 1962

PLATE 3. GROUNDWATER PROBABILITY MAP OF THE DRIFT, OYEN MAP-AREA

Scale: 1 Inch to 4 Miles

5 0 5 10 15 20 Miles

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LEGEND

EXPLANATION

This map shows, in generalized form, probabilities of obtaining 5 to 10 gallons per minute from a well completed in bedrock. The map is based primarily on existing well records.

PROBABILITY OF OBTAINING 5 TO 10 GPM

The probability of obtaining 5 to 10 gpm from wells 250 to 1000 feet deep is mainly good ranging to fair throughout entire Oyen map-area. Water obtained from these wells will be of poor quality and in most cases will need to be treated for human consumption.

The probability of obtaining 5 to 10 gpm from wells less than 250 feet deep is as follows:

Mainly good ranging to fair. Areas underlain by the Bulwark sandstone member of the Bearpaw formation, the Edmonton formation, or by both.

Mainly poor ranging to fair. Areas underlain by the Bearpaw shale only.

REFERENCE

Provincial highway

Township boundary

Section line

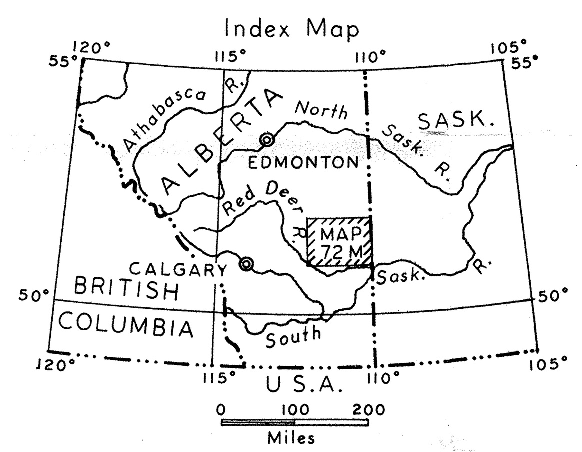
Town, village

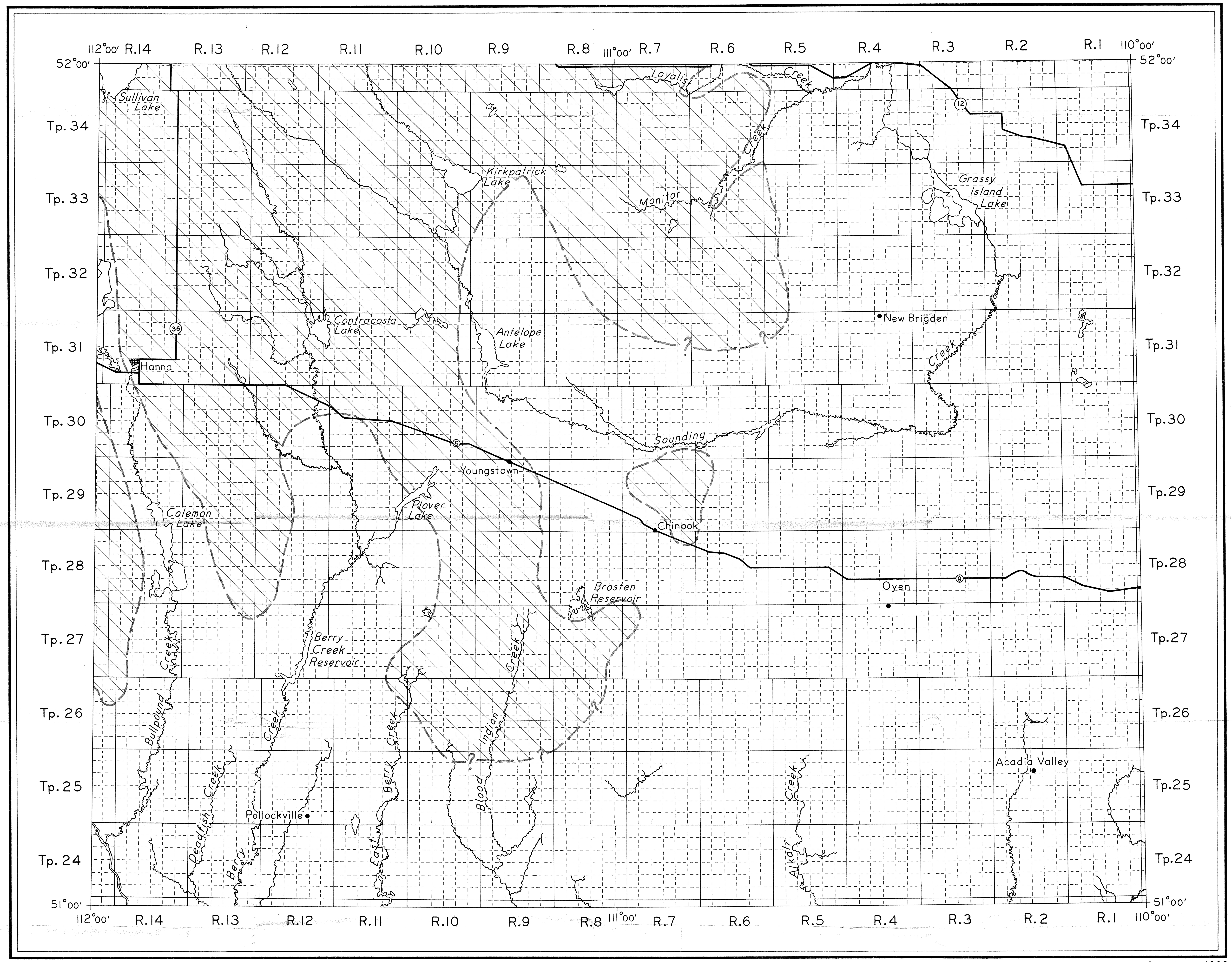
Stream, lake or reservoir

Base map compiled from National Topographic Series, Department of National Defence, Army Survey Establishment, R.C.E., 1954, Sheet 72M, Scale 1:250,000

Township Division

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1





Map to accompany Preliminary Report 62-3

Published in 1962

PLATE 1. GROUNDWATER PROBABILITY OF THE BEDROCK, OYEN MAP-AREA

Scale: 1 Inch to 4 Miles

5 0 5 10 15 20 Miles

AGS 1962-8a

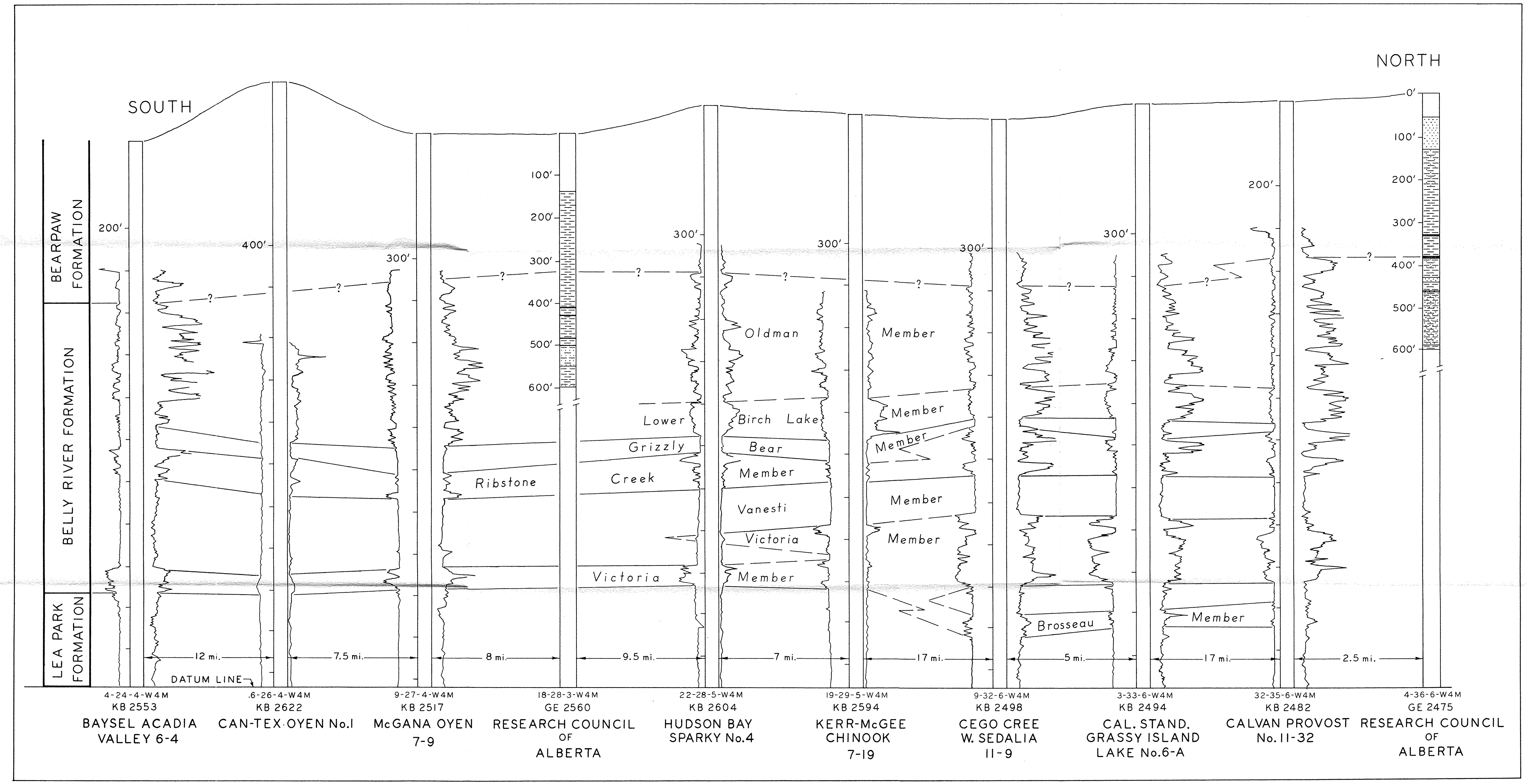


FIGURE 3. NORTH-SOUTH CROSS SECTION OF THE BELLY RIVER FORMATION

RESEARCH COUNCIL OF ALBERTA

SHEET 72 M

LEGEND

Edmonton formation: thin alternating beds of white to grey silty sandstone, grey to black shale, and coal.

Bearpaw formation: dark grey, greenish and chocolate brown shales with some sandstone lenses.

Contour on the bedrock surface, well control fair to good. ——2500——

Contour on the bedrock surface, well control poor.* — —2500— —

*Contours drawn on the basis that bedrock topography probably resembles present topography.

Contour interval 50 feet.

REFERENCE

Provincial highway .... (12)

Township boundary ....

Section line ....

Town, village ....

Stream, lake or reservoir ....

Base map compiled from National Topographic Series, Department of National Defence, Army Survey Establishment, R.C.E., 1954, Sheet 72M, Scale 1:250,000

Township Division

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
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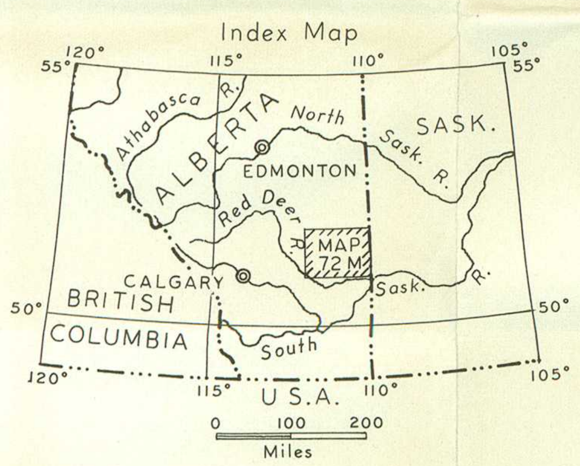

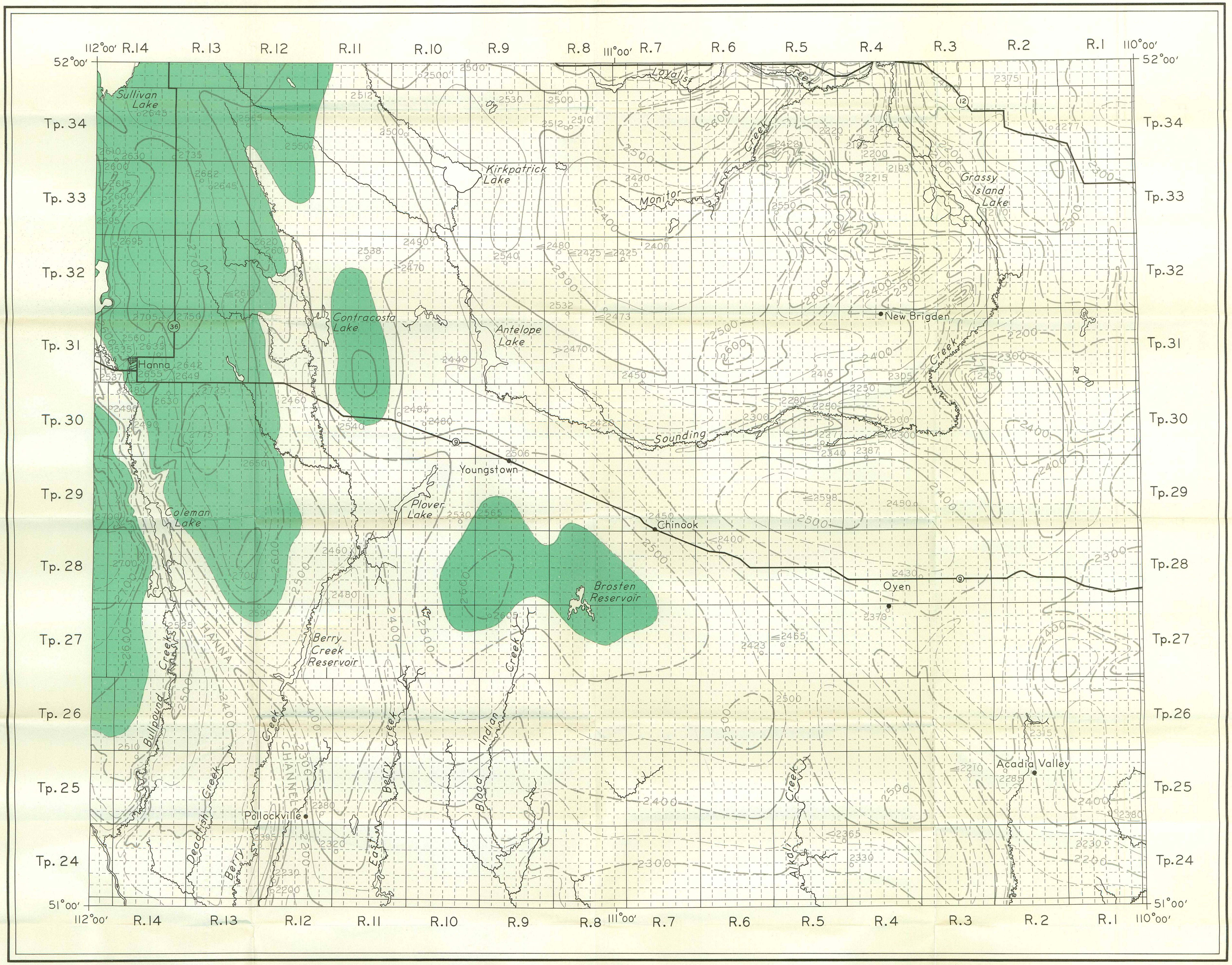

Map to accompany Preliminary Report 62-3

Published in 1962

PLATE 2. PRELIMINARY MAP OF THE BEDROCK TOPOGRAPHY, OYEN MAP-AREA

Scale: 1 Inch to 4 Miles

5 0 5 10 15 20 Miles