RESEARCH COUNCIL OF ALBERTA

REPORT 72-12

A LEGEND AND GUIDE FOR THE PREPARATION AND USE OF THE ALBERTA HYDROGEOLOGICAL INFORMATION AND RECONNAISSANCE MAP SERIES

compiled by

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FOREWORD

"A Legend and Guide for the Preparation and Use of the Alberta Hydrogeological Information and Reconnaissance Map Series" is the result of a two-year cooperative effort by the members of the Groundwater Division, Research Council of Alberta. Those who participated formally at various stages of the development and preparation of the legend are: V. A. Carlson, G. M. Gabert, G. F. Ozoray, D. R. Stevenson, O. Tokarsky, and J. Tóth. Miss A. M. Badry finalized compilation and wrote Chapter One. R. Green critically edited the manuscript.

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ABSTRACT

The hydrogeological mapping project undertaken by the Groundwater Division, Research Council of Alberta, created the need for a composite legend and guide for reference and use with the two map series: information and reconnaissance at scales of 1:50 000 and 1:250 000, respectively. The division of the legend and guide into three chapters serves a useful purpose.

Chapter One places hydrogeological mapping in Alberta in perspective and introduces mapping principles and procedures applied in the Alberta Hydrogeological Information and Reconnaissance Map Series.

The legends, including descriptive notes, for the Alberta Hydrogeological Information Map Series (AHIMS), at a scale of 1:50 000, and for the Alberta Hydrogeological Reconnaissance Map Series (AHRMS), at a scale of 1:250 000, outlined in Chapters Two and Three respectively, are individually designed to be an entity. The information map series are, in actuality, a data storage file. On the other hand, the reconnaissance map series are interpretive and represent a regional picture of the existing groundwater conditions in the particular Alberta environment.

The legend is designed to serve a dual purpose: first, as a guide for plotting (in the case of the 1:50 000 information maps) or construction (in the case of the 1:250 000 reconnaissance maps); and second, as an explanatory reference for the map reader.

CHAPTER ONE

A GUIDE TO THE PREPARATION OF THE ALBERTA HYDROGEOLOGICAL INFORMATION AND RECONNAISSANCE MAP SERIES AND THE USE OF THE LEGENDS FOR THESE MAPS

INTRODUCTION

A hydrogeological mapping program was initiated in 1968 by the Groundwater Division, Research Council of Alberta. The program aims to complete hydrogeological mapping of the province of Alberta at scales of 1:50 000 and 1:250 000. The 1:50 000 scale maps constitute information sheets, containing basic hydrogeological data and related information. Known as the Alberta Hydrogeological Information Map Series (AHIMS), these maps constitute in sets of sixteen an "Atlas" for each 1:250 000 scale map area. The 1:250 000 scale maps, called the Alberta Hydrogeological Reconnaissance Map Series (AHRMS) comprise a regional synthesis of basic hydrogeological data. This latter scale of mapping will result in a complete interpretive regional synthesis of the hydrogeology of the province.

The reconnaissance series of maps will be published, whereas, initially at least, the information series of maps will be maintained as an open-file atlas available for consultation at the offices of the Research Council.

The need for the legends outlined in Chapters Two and Three arose as a consequence of this hydrogeological mapping project. The map preparer and the map reader both require a legend. Although a legend appears on each individual published map, it is designed as a quick reference for the map reader, and is characterized by brevity. Consequently, greater detail may be desired or further explanation to that given by the map legend; hence the need for this expanded legend. It is of course necessary that a detailed legend be prepared, outlining the manner in which information is to be recorded, for the benefit of those engaged in the plotting or construction of the maps. This expanded legend not only defines the symbols but includes other relevant information or explanatory notes which clarify or distinguish the use of the mapping symbols.

The reader or preparer of an Alberta Hydrogeological Map, Information or Reconnaissance, is encouraged to read the remainder of Chapter One for background information necessary in order to obtain the maximum possible use from the maps or the respective legends. This chapter introduces the reader to the scope of hydrogeological mapping within the Alberta context and defines the aim and the projected use of the information and reconnaissance maps.

HYDROGEOLOGICAL MAPPING WITHIN THE ALBERTA CONTEXT

Map Reference System

The Alberta Hydrogeological Information and Reconnaissance Map Series use the National Topographic System (NTS) maps as base maps.

Figure 1 illustrates the index to the National Topographic System, consisting of a grid of meridians and parallels as applied to Alberta. The largest unit of the System is the basic quadrangle, representing the sheet-lines of a standard 1:1 000 000 map; one such quadrangle, 84, has been shaded (Fig. 1). A primary quadrangle is subdivided into 16 blocks, lettered A to P, indicating sheets of the 1:250 000 map series. Thus each map sheet is identified by the primary quadrangle number and a letter designation, such as 84H (Fig. 1). The dimensions of a block are one degree of latitude by two degrees of longitude, the areas of individual blocks varying from 4900 to 6200 square miles. One 1:250 000 map area is covered by an Alberta Hydrogeological Reconnaissance Map, and Alberta is covered by 50 whole or part NTS map sheets at this scale. One sixteenth of the area of a 1:250 000 sheet constitutes a sheet of the 1:50 000 scale; these are numbered from 1 to 16 as, for example, 84H/16 (Fig. 1). These maps are sometimes published in east (E) and west (W) halves. Each sheet covers 15 minutes of latitude by 30 minutes of longitude and map areas range from 300 to 390 square miles. An Alberta Hydrogeological Information Map (AHIM) covers the area of one such map sheet.

Map Scale and Its Application to Hydrogeological Mapping in Alberta

It is appropriate to comment on map scale as, of necessity, scale imposes limitations on the quantity and type of information on a map. The NTS maps constitute the base maps for the AHIMS at a scale of 1:50 000 or 1 1/4 inches to 1 mile (approximately). Basic data is plotted on the map sheets according to the symbols outlined in Chapter Two. The NTS maps of 1:50 000 scale are also the basic field maps used by the Groundwater Division. As an individual map of the AHRMS covers a 1:250 000 map sheet (1 inch to 4 miles, approximately), the scale reduction necessitates generalization of the information presented, resulting in a regional synthesis.

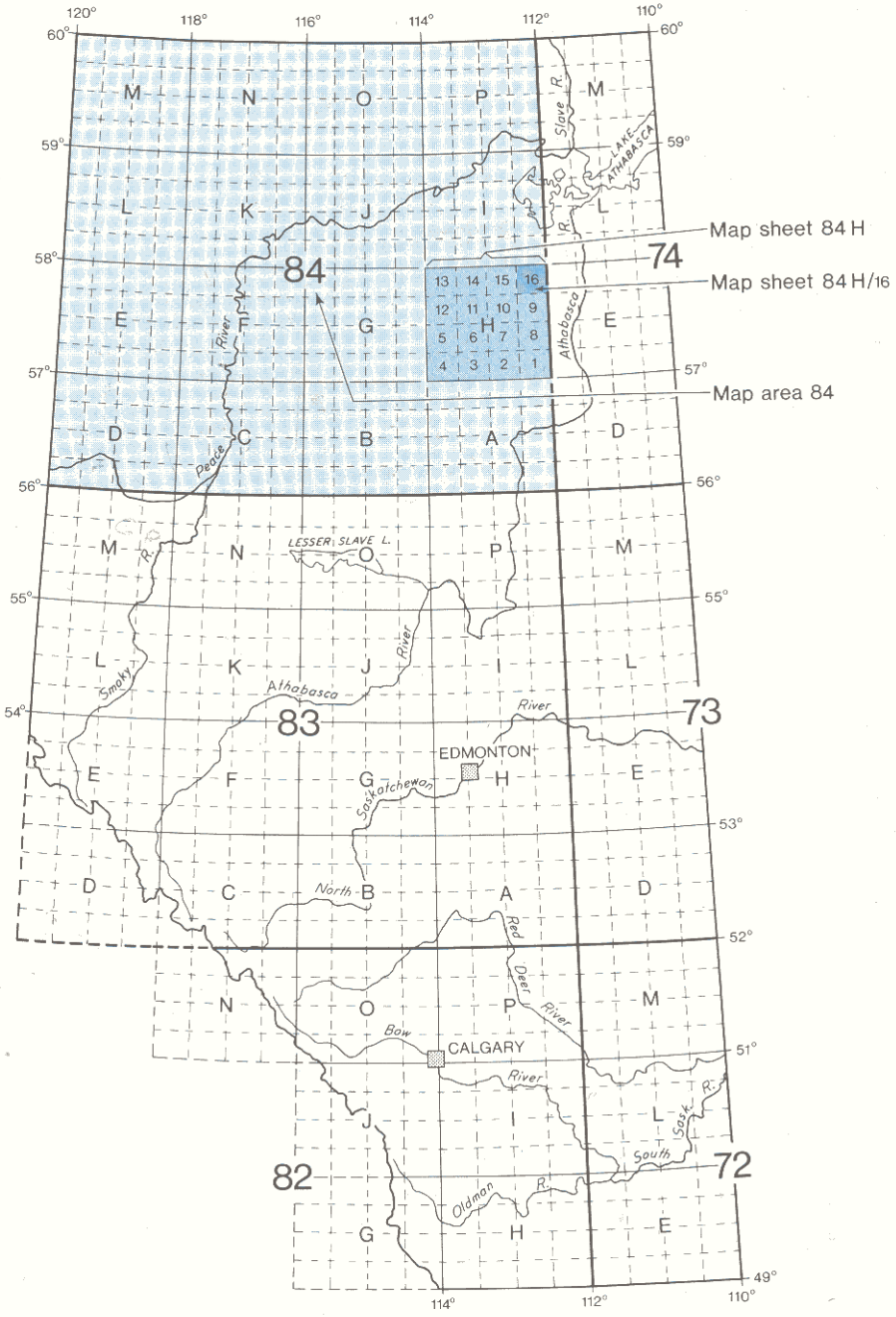


Figure 1. Index map to the National Topographic System for Alberta.

Land Reference System and Its Application to Hydrogeological Mapping in Alberta

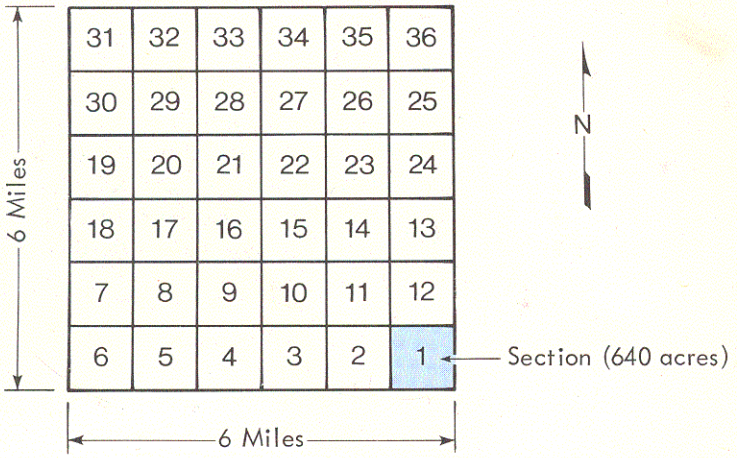
To prepare or use the Alberta Hydrogeological Maps, familiarity with the land-survey units in Alberta is necessary. The system and terminology are illustrated in figure 2, and figure 3 shows a township-range grid superimposed on the province of Alberta. Townships are numbered northward from the Canada-United States International Boundary (the Forty-Ninth Parallel of latitude). The ranges are numbered westward from each principal meridian (Mer.). Within Alberta there are three principal meridians (Fig. 3): the fourth meridian at 110°00' west longitude, the fifth meridian at 114°00', and the sixth meridian at 118°00'. According to the Dominion lands system, a Township (Tp.) is an area six miles square containing 36 sections, each 1 mile square. A section (Sec.) is divided into 16 legal subdivisions (Lsd.) (Fig. 2).

Usually, the location of a well is reported either as a point defined in terms of distances from the corner of a land-survey unit (e.g. 100 feet west and 500 feet south of the northeast corner of section 5), or as an area - typically the legal subdivision or the "quarter section" (Fig. 2) -in which the well is situated. If a well location is defined in terms of a legal subdivision or more precisely, then that well is considered to be accurately located. Distinction is made in the 1:50 000 scale map legend for accuracy of well location. (At the 1:250 000 scale the term "accurate location" becomes meaningless, and no differentiation is made.) Each well is characterized by an index number, based on its location according to the land-survey system. This number consists of the Mer., Tp., R., Sec., and a unique identifying number which should appear within the well symbol on the 1:50 000 information maps (see p. 31). For example, the index number 4-50-21-36-1 denotes well number 1 in Sec. 36, Tp. 50, R. 21, W. 4th Mer. The significance of this system lies in the ease of immediate location of any particular well file, stored in the Central Data File, that may be required for examination.

Central Data File

The Central Data File is a centralized file of hydrogeological data, representing a complete and easily used base for preparation of the hydrogeological information series of maps. The Central Data File is organized according to the land-survey units with the following order of priority. The primary division of the Central Data File is a grouping according to the meridian; that is, west of the fourth, fifth or sixth meridian. Under each of these the data is filed according to township, and within each township folders are organized sequentially according to range, then section, quarter section or legal subdivision, and finally according to index number.

Sections in a township are numbered as follows:



Legal subdivisions (Lsd.) in a section are numbered as follows:

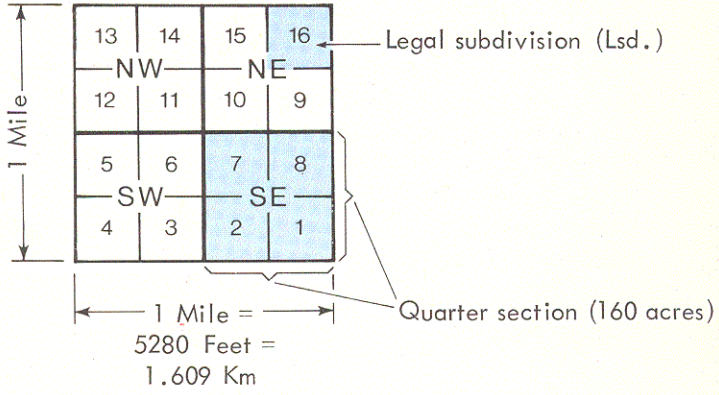


Figure 2. System and terminology of the land-survey units in Alberta.

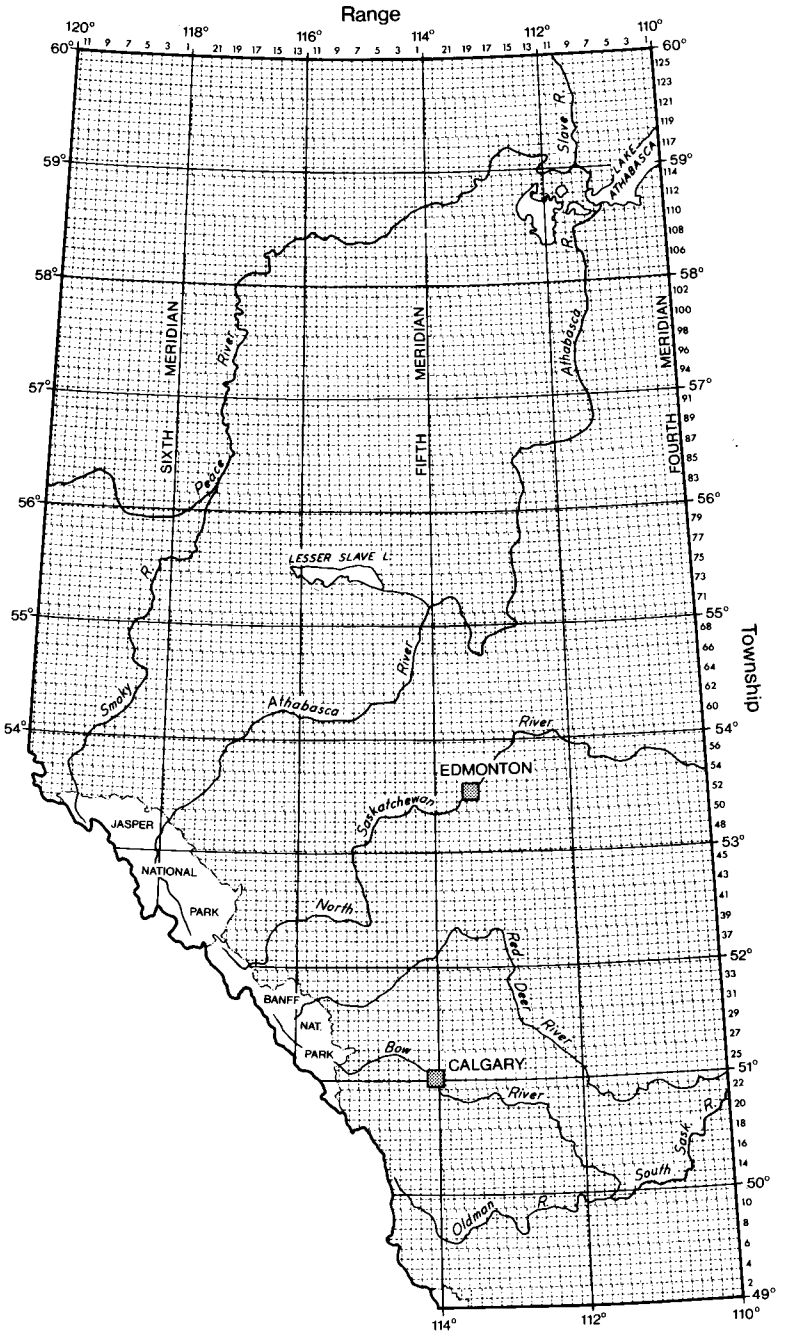


Figure 3. Township-range grid superimposed on the province of Alberta.

A DIRECTIVE FOR EFFICIENT USE OF MAP AND LEGEND

To the Map Reader

To realize the maximum potential of the information maps it is important to keep clearly in mind that these 1:50 000 maps are an information series or data storage file. Through consultation of any of these maps, a well may be accurately located by index number, as noted above; the corresponding file obtained from the Central Data File may provide more detail that cannot be included on the map as, for example, further chemical information or pump test details, and so on. This same principle applies to any symbol that defines an information point on the maps.

The main principle to be noted by the reader of the reconnaissance maps is a general one: the detail represented on a map should at all times be commensurate with scale. In direct consideration of scale, the reconnaissance maps present an interpretive regional picture of groundwater conditions in a particular area. At this scale, therefore, every individual symbol is important in itself, whether it defines unique or anomalous conditions of, for example, water level, transmissivity, or well yield, in the general or regional context. Thus, in a regionally defined and color coded area of low well yield, a well symbol with a figure of 500 (that is, a yield of 500 imperial gallons per minute) placed above it indicates a local and anomalous situation.

The legends outlined in Chapters Two and Three are designed to expand or explain the basic legend of any individual map sheet. To maintain coherence and to avoid confusion, explanatory notes are an integral part of this legend and so depart from a legend sensu stricto. This was deemed necessary to avoid the confusion which would result from the use of numerous footnotes. Where any added explanatory information is of a lengthy or tabular form, reference is given to the Appendix.

A short glossary defines or explains words or terms, such as transmissivity, or features, such as saline lake, so that their meaning is absolutely clear and consequently that the interpretation intended by the author of the map is the one understood by the reader. A map reader will find it helpful and at times necessary to familiarize himself with the meaning of certain words or terms used in interpretation or representation on either series of hydrogeological maps. Any word to be found in the glossary is indicated by a footnote.

To the Map Plotter or Constructor

The information and reconnaissance maps plotted or constructed within the framework of the Groundwater Division are to use the symbols

outlined in the legends for the respective maps. It is hoped any other hydrogeologic map compilation within Alberta will adhere to those symbols outlined in the legends in Chapters Two and Three.

Every attempt should be made to represent the information with the symbols available. However, if it is considered necessary to include some information for which no provision has been made, an appropriate symbol, that will have no possible confusion with any other, may be introduced. It will then be defined or explained on the pertinent map sheet only. Such a symbol should be used, however, only with the approval of the divisional editorial staff.

The legend defines, where relevant, both the recommended color of the symbol in "Verithin" pencil color numbers and the size of the symbol. These should be adhered to. Printing of numbers or letters around the well symbol, except for specially noted situations, should be in black ink.

To the AHIMS Plotter

The 1:50 000 scale map plotter should have at hand all the necessary drafting equipment, including colored pencils, a Rapidograph pen (size 000), a template with the appropriate size circles for the symbols, and a straight-edge graduated in millimeters.

Finally, a number of points should be stressed concerning use of the Central Data File by the map plotter.

1) In areas of abundant data, where it is physically impossible to plot on the map sheet all of the information available, be very selective and record the most reliable and complete data first.

2) Clip the corner of each file folder as the contained information is plotted on the map, so that plotted and unplotted data folders will be readily separable; updating of the 1:50 000 maps thus will be easy to achieve.

3) Estimate the elevation of each unsurveyed observation point as it is plotted and record the value in the appropriate place on the file folder. This information will be useful, for example, in drawing water level contours.

4) Assign an index number to every observation point as outlined in the AHIMS legend, to facilitate the locating of any particular observation (e.g. a well) within a section containing more than one observation point.

5) Record the map sheet number in the appropriate place on the file folder.

6) Double check replacement of files in the Central Data File so that they are not misfiled and in effect lost.

To the AHRMS Constructor

A number of points are emphasized for the reconnaissance map constructor.

1) Familiarity with the symbols outlined in the legend is imperative, as is their use in constructing a map. No new symbols should be introduced without approval of the divisional editorial staff.

2) Note the map scale and symbol size relation. Adjust the symbol sizes and scales to any change in scale of work sheets for the construction stage of the map.

3) Final drafts of the component parts of the hydrogeological map should be at the following scales:

MAIN MAP	1:250 000
HYDROGEOLOGICAL PROFILES	1:250 000
SIDE MAPS	1:500 000 (for ease in drafting; to be printed at 1:1 000 000)

4) Include a legend for each individual map (i.e. for the MAIN MAP including the HYDROGEOLOGICAL PROFILES, and for each SIDE MAP).

LIMITATIONS OF THE LEGENDS

Although an attempt is made to adhere to a number of basic principles in preparing a detailed and general legend of this type, certain limitations are inherent and worthy of comment.

A primary limiting factor is the economic one. The cost of producing a published 1:250 000 hydrogeological map is reduced considerably by using existing base map materials from the Canada Department of Energy, Mines and Resources[1]. Overlays received from this source include the

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[1] The assistance of the Surveys Branch, Alberta Department of Highways and Transport in obtaining film base materials of the Canada National Topographic System maps is greatly appreciated.

grey base map containing the township grid, locations of cities and towns, highways and roads, dams, quarries, and so on; the blue hydrography overlay which includes natural surface-water features, marshes, canals and irrigation ditches; and the brown overlay of topographic contours. It is evident that use of these base materials conflicts with the concept of retaining the color red for man-made artificial features. However, where artificial features such as canals or irrigation ditches already appear in blue as part of the hydrography overlay, or dams in black, these colors should be maintained for any additional features of the same type. However, if these features are all to be added, the red indicated in the legend should be used.

As previously mentioned, it is probable that some symbols that will be required for use on these maps have not yet been defined, in the initial stages of a program intended to cover a province as geologically diverse as Alberta. Thus occasionally a new symbol may have to be added to a particular map, and ultimately as an addendum to the general legend.

Some inconsistencies in symbol designation of a particular feature arise with a change of scale from 1:50 000 to 1:250 000 because of the problem of accommodation of information. However, as each legend is designed to be a separate entity, no serious misinterpretation should arise in this regard.

One final point deserves mention. The two legends, one for each map scale, were evolved as the mapping program developed. Two maps, "Hydrogeological Map Grimshaw-Chinook Valley NTS 84C/4 and 84C/5 Alberta" (Tokarsky, 1970) and "Hydrogeological Map Red Deer Area NTS 83A" (Le Breton and Green, 1970), have been published using earlier versions of the map legend, and as a consequence some symbols appearing on these maps differ from those presented here. This situation applies also to some of the Atlases of Basic Sheets at 1:50 000 scale, a number of which were plotted prior to the final consolidation of this legend. However, as each map has its own accompanying legend no serious confusion should arise.

CHAPTER TWO

LEGEND FOR THE ALBERTA HYDROGEOLOGICAL INFORMATION MAP SERIES

INTRODUCTION

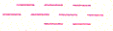
"A Legend for Hydrogeological Maps" published by the International Association of Scientific Hydrology (IASH) was consulted and used as a guide in preparing the map symbols used on the 1:50 000 scale "Alberta Hydrogeological Information Map Series" (Basic Sheets).

Wherever possible the IASH symbol has been adopted, but where different hydrological feature symbols such as streams, areas subject to inundation, and others already appear on the legends of the Canadian 1:50 000 NTS base maps, these have been retained although they conflict with the IASH legend. Hydrological symbols defined in the base map legend (i.e. 1:50 000 NTS maps) are not reproduced here.

Other major changes or additions to the existing IASH symbols arose primarily from the need to represent greater or different detail than the IASH legend provides for. This applies in particular to the expanded use of the well symbol.

It should be noted that where it is physically impossible for all available data to be put on the map or its margins, the existing data should be graded in order that the most reliable and complete items will be illustrated first. It is important that this point be noted by both the map preparer (so that the map is representative of the best data in the Central Data File) and the map reader (so that he is aware of the possible availability of additional data).

(SCALE 1:50 000)

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
GEOLOGY		
1. An observed and potentially important outcrop	×	black 4 mm
Where the outcrop is observed to expose only surficial materials a subscript "s" should be used to denote this fact.	$\times_s$	black 4 mm
HYDROGRAPHY		
1. Natural pond or water hole (P or T, if known)[2] (Note: The method of representing the chemistry of a stagnant water condition as well as that of moving water, as a stream, is shown under HYDROCHEMISTRY.)		indigo blue (741) 6 mm Ø
2. Saline lake[3] (Note: The shading is along the inside of the lake boundary as illustrated.)		perimeter: indigo blue (741) shading: lavender (742 1/2)
3. Area of noticeable salt precipitates		lavender (742 1/2)

HYDROMETRY

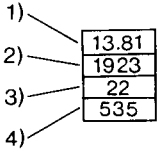
1. Stream gauging station

   a) Location — △ — black, 4 mm

   b) Information box

   Specific data should be recorded in the information box according to the following number code:

   1) Average annual discharge in cubic feet per second
   2) Year of commencement of observations
   3) Number of years averaged for average annual discharge figure
   4) Other pertinent data, such as drainage area in square miles

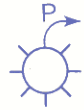
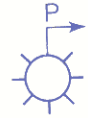
   black

   (Note: A black reference line relates the information box to the appropriate station.)

2. Lake level recording station —  — black, 4 mm

[2]The letter P or T over a symbol indicates that the feature represented is permanent or temporary, respectively. The absence of a letter indicates that the condition is unknown.

[3]A definition is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
HYDROGEOLOGY		
A. Springs[4]		
1. Spring, flow rate unknown (P or T, if known)[5]		indigo blue (741) 6 mm Ø
2. Spring, flow rate known (P or T, if known)[5]		indigo blue (741) 6 mm Ø
3. Spring, with records of flow rate collected over a period of time		spring outline: indigo blue (741) 6 mm Ø inner circle: indigo blue (741) 1 mm Ø
4. Spring, accurately located (i.e. located by co-ordinates or by a field check to at least the accuracy of an Lsd.) (Note: The inside of the spring symbol is reserved for hydrochemical data; see HYDROCHEMISTRY.)		spring outline: indigo blue (741) 6 mm Ø inner dot: black

B. Placement of Hydrogeological Data around the Spring Symbol

Hydrogeological data are recorded around the outside of the spring symbol according to the number code shown. The number code specifications are outlined below.

spring outline: indigo blue (741)
6 mm Ø

1. Characteristic feature of springs
   - I drained
   - II ponded
   - III soap hole[6], quicksand
   - IV mud flow
   - V mineral deposit (e.g. Fe, travertine)
   - VI other

2. Nature of rock openings ?
   - I – intergranular
   - F – fracture
   - C – cavity

3. Structure of aquifer
   1. veneer
   2. interlensed or interbedded
   3. thick formation

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[4] A detailed note on springs is given in the Glossary.

[5] The letter P or T over a symbol indicates that the feature represented is permanent or temporary, respectively. The absence of a letter indicates that the condition is unknown.

[6] An explanation is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant

4. Lithology of aquifer, according to the following code:

Material	Coded Symbol
coal	c
clay	cl
dolomite	d
gravel	g
igneous	i
limestone	ls
quartzite	qt
sand	s
sand and gravel	s+g
sandstone	ss
shale and sandstone	sh+ss
shale or claystone	sh
silt	st
siltstone	sts
till	t

5. Flow rate[7] (imperial gallons per minute)

6. Variability[8] { a) constant; b) sub-variable; c) variable }

7. Total dissolved solids (ppm)

8. Water temperature in °C

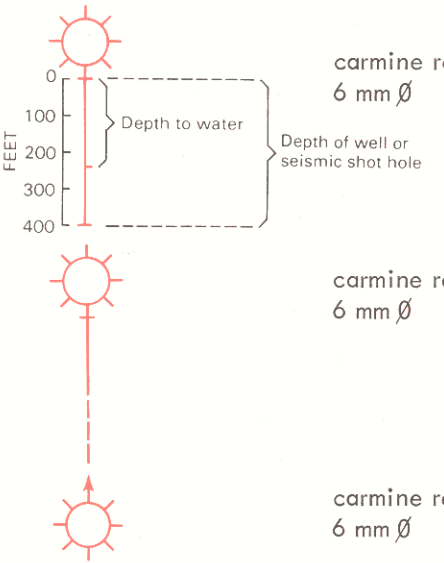
WELLS AND OTHER ARTIFICIAL WORKS

A. Water Wells

1. Water well, nonflowing

The depth[9] of the well (from the land surface) and the depth to water (from the land surface) are shown in the manner indicated. Refer to Placement of Hydrogeological Data around the Well Symbol for the method of representing the available hydrogeological data.

Note that for a very deep water well, for example a water source well used by an oil company, it may be necessary to use the method of the broken line as illustrated.



carmine red (745)
6 mm Ø

carmine red (745)
6 mm Ø

2. Water well, flowing

carmine red (745)
6 mm Ø

[7] A conversion table, Table 2, relating the Meinzer spring order number to metric and English units of discharge, is given in the Appendix (page 89).

[8] An explanation is given in the Glossary.

[9] The depth scale for all wells, etc., is 1 mm to 20 ft.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
3. Water well, nonproducing (NP = nonproducing)		carmine red (745) 6 mm Ø
4. a) Water well, depth unknown		carmine red (745) 6 mm Ø
b) Water well, depth shallow This includes shallow auger holes drilled for the purposes of groundwater exploration. The primary purpose of such a hole is usually the determination of the water table. A water sample may have been taken and therefore a chemical analysis is often available.		carmine red (745) 6 mm Ø
5. RCA test well The letters "RCA" are to be placed as close as possible to the symbol so that the related well is obvious. (Note that such a well will generally be represented by item 8 which follows.)		carmine red (745) 6 mm Ø
6. Recharge well[10]		carmine red (745) 6 mm Ø

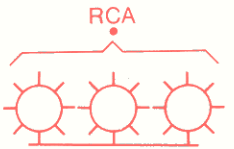
7. Well, accurately located

   (i.e. located by co-ordinates or by a field check to at least the accuracy of an Lsd.)

well symbol: carmine red (745)
6 mm Ø
inner dot: black

8. Test well with more than one piezometer in a single borehole, or with groundwater data collected from several depths during drilling.

   The horizontal bar indicates a single borehole and the dot indicates its location. In most instances this symbol represents an RCA test well in which case the letters "RCA" appear above the location dot.

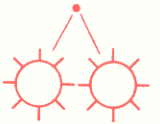


carmine red (745)
6 mm Ø

9. Adjacent wells

   This may refer, for example, to two closely spaced wells located at a single farm dwelling, as a stock well and a house supply.

   Reference lines to a location dot relate the two (or more) wells to the specific location they have in common.



carmine red (745)
6 mm Ø

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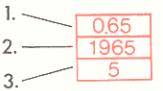
[10] A definition is given in the Glossary

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
10. Observation well		
a) with automatic recorder		carmine red (745) inner circle: 6 mm Ø outer circle: 8 mm Ø
b) without automatic recorder		carmine red (745) inner circle: 6 mm Ø outer broken circle: 8 mm Ø
c) information box for observation well Specific data should be recorded in the information box according to the following number code: 1. Mean annual water level fluctuation in feet 2. Year of commencement of observations 3. Years of record averaged for mean annual water level fluctuation figure		carmine red (745)

Note: A red reference arrow relates the information box to the appropriate well. If the observation well belongs to the RCA network of observation wells, the letters "RCA" placed close to the symbol indicate this fact.

Seismic Shot Holes

1. Seismic shot hole reported to have flowed, unknown depth

carmine red (745)
2 mm Ø

2. Seismic shot hole reported to have flowed, known depth

carmine red (745)
2 mm Ø

The placement of data around the shot hole symbol is according to the number code shown. The number code specifications are as follows:

1. Shot hole depth in feet
2. Reported aquifer interval
3. Aquifer material[11]
4. Flow rate in imperial gallons per minute
5. Temperature
6. Hydrostatic level in shot hole (refer to 3. Hydrostatic level of water in a well, which follows)

If hydrochemical data is available it is represented on a 6 mm Ø circle as explained under HYDROCHEMISTRY and related to the shot hole by a black reference arrow. Place the value of the total dissolved solids in ppm below the pie diagram.

---

[11] See p. 22 for a list of aquifer materials and corresponding code symbols.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
C. Placement of Hydrogeological Data around the Well Symbol The placement of hydrogeological data around the well symbol is according to the number code shown. (Note that this is analogous to the number code shown for the spring symbol.) The number code specifications are as follows: 1. Well depth in feet 2. Open interval, reported aquifer interval, and well completion Open interval is that part of the well which is capable of yielding water to the well. Aquifer interval is that portion of the lithologic sequence in the well which is known to be water yielding. The well completion is recorded using the following code: slotted casing: A; open hole: B; screen: C; cribbed: D. The aquifer interval follows the appropriate letter of this code and is placed in parentheses as, for example, A(63-72). Where the open interval data are available they are placed below this as $\frac{\text{A(63-72)}}{\text{B85-95}}$; however, if only the open interval is known it may be written as B85-95.		carmine red (745) 6 mm Ø

3. Hydrostatic level of water in a well

   For a non-flowing well this is the depth to water below ground level.

   For a flowing well this is the height to which water would rise in a stand pipe above ground level.

4. Aquifer material [12]

   The method of recording the aquifer material conforms with (2) above: The aquifer material is parenthetical as, for example, (ss). If only the open interval of the well is known, record all materials across this interval as, for example, ss+sh+c. If, however, the available data define both the aquifer interval and the open interval they will be recorded as, for example, (ss)
   ss+sh+c
   That is, the reported aquifer material is sandstone and the materials across the open interval include sandstone, shale and coal.

   Note: If geophysical or mechanical logs are available, add E after aquifer material, as, for example, ssE.

---

[12] See p. 22 for a list of aquifer materials and corresponding code symbols.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
5. Safe yield[13] (Q) or estimated safe yield		
a) Q from a pump test of sufficient length (generally considered to be of a minimum duration of one week) to measure regional hydraulic conditions	125*	carmine red (745)
b) Q from a short pump test or good bail test A short pump test or "good bail test" is generally considered, for the purpose of hydrogeological mapping in Alberta, to be of the minimum duration of two hours and to have time drawdown and/or time recovery data sufficiently accurate to determine aquifer characteristics.	125	carmine red (745)
c) Estimated Q, based on apparent transmissivity	125	black
6. Transmissivity[13] (T) or apparent transmissivity[13]:		
a) T from a pump test of sufficient length (see 5a above) to measure regional hydraulic conditions	14500*	carmine red (745)
b) T from a short pump test or good bail test (see 5b above)	14500	carmine red (745)
c) Apparent T	14500	black
7. Total dissolved solids in ppm	1000	red

8. Water temperature °C

9. Index number for the well

black &
carmine red (745)

This consists of the meridian, township, range, section, and a unique identifying number for each well, placed within the well symbol. For example, 4-50-21-36-1 denotes well number 1 in Sec. 36, Tp. 50, R. 21, W. 4th Mer. In practice, only the identifying number will be used on the map since the township, range, etc., are denoted by the well location on the map.

10. Elevation

black &
carmine red (745)

The surveyed or estimated[14] ground elevation of the well is placed directly above the well symbol as illustrated. A small "e" placed after the elevation indicates that the elevation is estimated rather than surveyed.

D. Oil, Gas and Other Well Symbols

1. Oil well

black
2 mm Ø

2. Gas well

black
2 mm Ø

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[13] A definition and further explanation is given in the Glossary.

[14] The estimated ground elevation should be based on at least a 25-foot contour interval.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
3. Suspended well, drilled for oil or gas		black 2 mm Ø
4. Abandoned well, drilled for oil or gas		black 2 mm Ø
5. Waste disposal well This includes wells generally termed salt water disposal wells (by oil companies) and other wells used for waste disposal (refer to Other Artificial Works below for a symbol for lagoonal sewage disposal).		black 2 mm Ø
6. Borehole[15], lithologic data only		
a) Structure test hole Because a structure test hole is generally of great depth, record the logged interval as a number value in feet in the position indicated. An E-log may be available and this information should appear in the position indicated. Where a detailed litholog is also available, this should be indicated by writing E,L in the second position of the well symbol.		black 2 mm Ø

b) Other This could apply, for example, to an exploratory hole drilled in the search for coal or for stratigraphic purposes to determine lithology, etc. The depth should be recorded as shown and if a litholog (L) is available represent this information as shown.		black 2 mm Ø
E. Other Artificial Works		
1. Storage reservoir for surface water (P, T or D, if known)[16]		carmine red (745) 6 mm Ø
2. Dugout or borrow pit (P, T or D, if known)[16]		carmine red (745) 6 mm x 3 mm
3. Gravel pit (P, T or D, if known)[16]		carmine red (745)
4. Spring catchment The tangent square (of the same size as the spring symbol) is placed around the symbol where the spring has been developed for use, as for stock watering, a domestic supply, an industrial supply, etc.		carmine red (745) 6 mm x 6 mm

[15] An explanation is given in the Glossary.

[16] The letter P or T over a symbol indicates that the water contained is permanent or temporary, respectively. The absence of a letter indicates that the water condition is unknown. The letter D indicates that the feature was dry when visited.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
5. Recharge pit		carmine red (745)
6. Lagoon used for sewage disposal (L = lagoon)		carmine red (745)
7. Infiltration gallery[17]		carmine red (745)
8. Water pipeline		carmine red (745)
9. Dam The number indicates reservoir capacity (in million cubic feet).		carmine red (745)
10. Hydroelectric station		carmine red (745)
11. Canal		carmine red (745)
12. Drainage canal, or artificial drain		carmine red (745)
13. Mine		carmine red (745)

14. Quarry

carmine red (745)

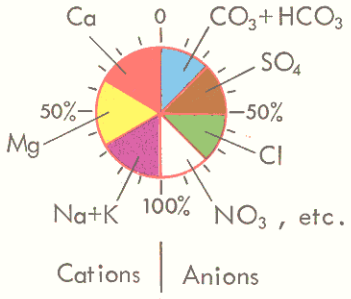
Note: As certain of these symbols may appear on the NTS basemap materials the color designated herein may differ. For example, infiltration galleries, water pipelines, dams, etc., may already appear in a different color. In such an instance, the same color should be used for any features added. However, if the features are not already represented use the color and symbol given here.

HYDROCHEMISTRY

A. Representation of Hydrochemical Data within the Spring or Well Symbol

1. Chemical Pie Diagram

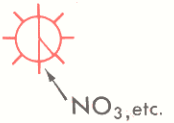
Hydrochemical data, other than total dissolved solids, is recorded as percentages of the total anions or cations (equivalents per million) on a pie diagram on the inside of the well or spring symbol. The cations are placed in the left half of the pie diagram, and the anions in the right half, in the order shown. For a quick and easy interpretation, each constituent has been assigned a distinctive color.



circular symbol: indigo blue (741) or carmine red (745)

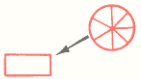
Ca: carmine red (745)
Mg: yellow ochre (736)
Na+K: lavender (742 1/2)
CO_3+HCO_3: true blue (758)
SO_4: dark brown (756)
Cl: light green (738 1/2)
Other: uncolored

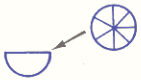
[17] A definition and further explanation is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
Note: (1) If Ca+Mg are expressed together, the color is to be the carmine red (745) of Ca.		
(2) Where Ca and Mg have been determined separately and Mg is less than (<) 5%, this is indicated by placing a black "x" on the left-hand side of the pie diagram above the Ca pie-sector.		
(3) Where any other constituent, as NO_3, etc. appears in an appreciable quantity, the appropriate percentage of the pie diagram should be left white and a small reference arrow should indicate what the constituent is.		
(4) In all cases, ion values are to the nearest 10 per cent; therefore any values <5% do not appear.		
2. Total dissolved solids (in ppm)		
a) TDS <3000 ppm		well symbol: carmine red (745) bar: black; scale: 1 mm = 100 ppm
b) TDS ⩾3000 ppm		well symbol: carmine red (745) bar: black; scale: 1 mm = 500 ppm

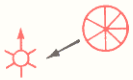
B. Representation of Hydrochemical Data for Other Features

1. If hydrochemical data are available for features other than wells or springs, use a circular symbol of the appropriate color (i.e. with an artificial feature such as a dugout carmine red (745) should be used; with a surface hydrologic feature such as a stream or pond, an indigo blue (741) circle should be used). A reference arrow should be used to relate the chemical pie diagram to the feature, as illustrated.





2. In addition, it may be necessary to use the circle symbol with the chemistry represented on it and a reference arrow to relate it to a flowing shot hole. Use of this method of representation will ensure differentiation of shot holes and flowing wells.



METEOROLOGY

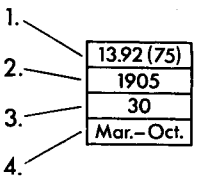
1. Location of meteorological site

a) Meteorological station

black

b) Standard rain gauge, only

black

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
2. Information box for meteorological site Specific data should be recorded in the information box according to the following number code: 1. Mean annual precipitation in inches (per cent rainfall), 2. Year of commencement of observations, 3. Number of years of record averaged for mean annual precipitation figure, 4. Other pertinent data, such as months of record if not on a twelve-month basis. Note: A black reference line relates the information box to the appropriate site symbol.		black

3. Precipitation data

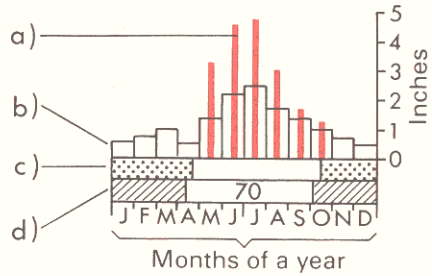
The available precipitation data should be recorded on the figure symbol in the manner indicated.

a) Mean monthly potential evapotranspiration[18] (4 mm = 1 inch)

b) Mean monthly precipitation (4 mm = 1 inch)

c) Period when surface is usually snow covered

d) Period with mean daily temperature below freezing (0°C). Figure indicates percentage of mean annual precipitation falling as rain.



black
&
carmine red (745)

The symbol is related to the appropriate meteorological site by a black reference line.

[18] Evapotranspiration estimates should be based on the Thornthwaite method. If, however, some other method or source of information is used this is to be indicated by an appropriate footnote.

CHAPTER THREE

LEGEND FOR THE ALBERTA HYDROGEOLOGICAL RECONNAISSANCE MAP SERIES

INTRODUCTION

In formulating the legend for the Alberta Hydrogeological Reconnaissance Map Series (AHRMS) consideration was first given to the symbols outlined in "A Legend for Hydrogeological Maps" (IASH, 1962), as for the Alberta Hydrogeological Information Map Series (AHIMS). Wherever possible existing symbols were used. Although the legends for both the AHIMS and the AHRMS are separate entities, they conform as closely as possible, for obvious practical considerations. Inevitably, however, the scale reduction from the 1:50 000 information series to the 1:250 000 reconnaissance series introduces constraints and requires some symbol modification. Proper use of the respective legends will reduce the importance of any differences induced by this scale change.

As this is a general legend, an attempt has been made to make it complete. However, two main facts should be kept in mind in this regard. First, not all of the symbols tabulated here will be used on any one map, the particular number being a function of the quantity and quality of existing information. Second, little would be gained by designing symbols to portray theoretically possible conditions that are unlikely to be encountered in the Alberta situation. If situations arise where such symbols are required then they can be formulated, for use on a particular map sheet only, with the approval of the divisional editorial staff. For the sake of consistency, only those symbols outlined here should be used, unless representation of a specific new feature or situation is of prime importance.

Each map sheet of the AHRM series consists of:

(i) a 1:250 000 scale (or in a few cases 1:125 000) map showing well yield areas, water tables, recharge and discharge areas, and important specific features or situations — this is referred to as the main map;

(ii) four cross sections illustrating the geology, vertical changes in well yield and hydrochemistry, and groundwater flow patterns — these are referred to as hydrogeological profiles;

(iii) a number of ancillary maps at a scale of 1:1 000 000 illustrating relevant material such as bedrock geology, surficial geology, selected meteorological data, distribution of hydrogeological data points, and various hydrochemical parameters; these are referred to as side maps. The bedrock geology, meteorology, data density and major ion hydrochemistry side maps should appear on all AHRMS sheets; other side maps are optional, at the author's discretion.

The legend is designed so that the main map legend, which includes that of the related hydrogeological profiles, is separate from that of the side maps. Symbols are given for the geology, meteorology, hydro-

chemical and data density side map legends. The published scale of the side maps is 1:1 000 000, but they should be constructed at a scale of 1:500 000 for ease in drafting.

The style and size of the symbols illustrated in the following legend are those that should appear on the published map sheet. Therefore, an appropriate readjustment in size should be made by the map constructor using a different working scale, as noted above. For instance, if 1:125 000 is used as the working scale for a main map (and the hydrogeological profiles), all symbol sizes and scales should be doubled.

It is reemphasized that the small 1:250 000 scale of the reconnaissance map necessitates that the map be general, interpretive, and that it defines areal conditions. The purpose of an AHRM sheet is not to define specific local conditions, and so symbol use by the map author must be selective.

LEGEND FOR THE MAIN MAP (including HYDROGEOLOGICAL PROFILES)

(SCALE 1:250 000)

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
TOPOGRAPHY AND BASE MAP FEATURES		
1. Relief: topographic contours The topographic contours used are those of the published 1:250 000 NTS maps. Overlays are obtained through the Alberta Department of Highways and Transport.		brown (756) fine line
2. Related artificial features Symbols should conform as closely as possible to those of NTS sheets. (As noted in the introduction these symbols will be governed by the base overlays which contain the township-range grids, town locations, main highways and secondary roads, and location of railroad networks.)		
GEOLOGY		
1. Geological boundary This applies only to the hydrogeological profiles as geology does not appear on the main map. Often a geological boundary coincides with a yield boundary. For clarity, both are usually shown.		brown (756)

2. Aquifer description

Only the principal aquifers are represented on the main map. Lithological symbols are shown under LITHOLOGY below.

3. Strike and dip

The short bar indicates the dip direction, the long bar the strike direction; the numerals indicate the dip in degrees.

black

4. Structure may be represented by:

a) a fault with direction of movement

black

b) a fold axis

black

5. Buried valley[19]

a) buried valley boundaries

brown (756)

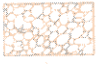
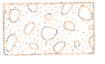
b) thalweg of buried valley

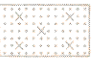
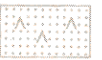
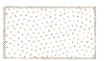
i) defined

ii) estimated or approximate

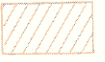
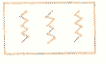
brown (756)

[19] A definition and further explanation is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
Often the boundaries of a buried valley may not be definable but the location of the thalwegs may be known or approximated. However, if the available data allow boundaries to be delineated in addition to locating the thalwegs, the author may desire to represent both, particularly if the valley is wide.		
6. Name abbreviations for stratigraphic and lithologic units of rock[20], e.g.:	Ka; Qps	black
The rock unit name abbreviations are the same as those for the GEOLOGICAL SIDE MAP (see Table 3 in the Appendix).		
LITHOLOGY		
The lithology of the principal aquifers on the MAIN MAP is represented according to the following symbols:		
1. gravel		brown (756)
2. sand and gravel		brown (756)
3. sand		brown (756)

4. sandstone		brown (756)
5. sandstone, bentonitic		brown (756)
6. sandstone, quartzitic; quartzite		brown (756)
7. silt		brown (756)
8. siltstone		brown (756)
9. claystone shale		brown (756)
10. conglomerate		brown (756)
11. limestone		brown (756)
12. dolomite		brown (756)
13. porous volcanic materials (ejecta)		brown (756)

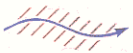
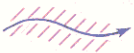
[20]This applies to the hydrogeological profiles only which illustrate the sequence of rock units in the stratigraphic section in the particular map area.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
14. sodium salt		brown (756)
15. gypsum		brown (756)
16. anhydrite		brown (756)
17. fractured rocks		brown (756)
18. coal		brown (756)

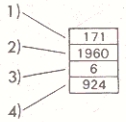
Note:

1) Symbols for unconsolidated material are randomly distributed; the consolidated material symbols form regular patterns. For example, contrast sand and sandstone.
2) The density of a particular symbol (e.g. individual sand grains) need not be great as long as it remains distinct.
3) Combinations of those symbols given may be made but any additional symbols should conform as closely as possible to those already used.
4) On the hydrogeological profiles, the author may wish to represent the lithology of other than the main aquifers. This should be done if it clarifies or enhances other information presented.

HYDROGRAPHY

1. Lake or slough, perennial		perimeter: indigo blue (741)
2. Lake or slough, seasonal		perimeter: indigo blue (741)
3. Saline lake[21]		perimeter: indigo blue (741) shading: lavender (742 1/2)
4. Marsh, muskeg		indigo blue (741)
5. Area inundated during floods		indigo blue (741)
6. Stream, perennial, with direction of flow		indigo blue (741)
7. Stream, intermittent, with direction of flow		indigo blue (741)
8. Stream, perennial, observed to be polluted		stream: indigo blue (741) shading: carmine red (745)
9. Stream, perennial, with observed high salt content, TDS $\geqslant$2000 ppm		stream: indigo blue (741) shading: lavender (742 1/2)
10. Disappearance point of stream		indigo blue (741)

[21] A definition is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
11. Natural pond or water hole (no surface outlet) (P or T, if known)[22]	P	indigo blue (741) 4 mm Ø
12. Surface water divide		indigo blue (741)
13. Area of noticeable salt precipitates		lavender (742 1/2)
HYDROMETRY		
1. Stream gauging station		
a) Location	△	black 2 mm
b) Information box		
Specific data should be recorded in the information box according to the following number code:		
1) Average annual discharge in cubic feet per second 2) Year of commencement of observations 3) Number of years averaged for average annual discharge figure 4) Other pertinent data, such as drainage area in square miles		black
(Note: A black reference line relates the information box to the appropriate station.)		
2. Lake level recording station	△	black 2 mm

3. Sources of data

Hydrometric data are obtained from published data — particularly Surface Water Data Alberta (Inland Waters Branch, Environment Canada, Ottawa) published annually, and Selected Characteristics of Streamflow in Alberta (Neill et al., 1970).

Note that calculated data regarding runoff appropriately appear in the report which accompanies a particular Alberta Hydrogeological Reconnaissance Map.

HYDROGEOLOGY[23]

A. Springs[24]

1. Spring, flow rate unknown (P or T, if known)[22]

indigo blue (741)
2 mm Ø

2. Spring, flow rate known

The flow rate value (in igpm) is situated as close as possible to the symbol.

spring outline: indigo blue (741)
number: indigo blue (741)

---

[22]The letter P or T above a symbol indicates that discharge is permanent or temporary, respectively. The absence of a letter indicates that the information is unknown.

[23]A definition is given in the Glossary.

[24]For a detailed note on springs refer to the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
3. Spring, flow rates measured over a period of time		indigo blue (741)
4. Spring information Specific information may be added in the appropriate position.[25] Although the flow rate is generally given the addition of other information is not compulsory and should be included only for very specific reasons.		indigo blue (741)
B. Groundwater		
1. Water table[26] contour[27]		true blue (758)
2. Nonpumping water level[26] contour[27]		
a) defined		true blue (758)
b) assumed		true blue (758)
3. Vertical component of groundwater movement is downward (hydraulic head decreases with depth)		
a) water table contour		true blue (758)
b) nonpumping water level contour, defined		true blue (758)
c) nonpumping water level contour, assumed		true blue (758)

4. Vertical component of groundwater movement is upward (hydraulic head increases with depth)

   a) water table contour —  — true blue (758)

   b) nonpumping water level contour, defined —  — true blue (758)

   c) nonpumping water level contour, assumed —  — true blue (758)

5. Direction and velocity of groundwater flow (feet/day) — 

true blue (758)

6. Groundwater divide —  — true blue (758)

7. Boundary of area of artesian flow —  — true blue (758)

   The row of dots lying inside the artesian boundary are point symbols indicating upward movement of groundwater within the designated area.

8. Groundwater barrier —  — true blue (758)

9. Contour lines on the top and/or base of water-bearing rock unit (i.e. the aquifer), with elevation in feet above mean sea level (MSL) — 

fine black

[25]See Placement of Hydrogeological Data around the Spring Symbol in the previous chapter, Legend for the Alberta Hydrogeological Information Map Series.

[26]A definition and further explanation is given in the Glossary.

[27]Elevations are in feet above mean sea level (MSL).

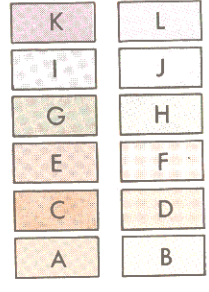
Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant

C. Groundwater Probability

1. Range of average expected yield of wells (in igpm)[28]

Possible: estimated from qualitative information (flow regime, lithology, etc.)

Probable: estimated from quantitative information (pump or bail tests, etc.)



more than (>) 500 igpm (approx. 2500 l/min)	lavender (742 1/2)
100-500 igpm (approx. 500-2500 l/min)	sky blue (740 1/2)
25-100 igpm (approx. 100-500 l/min)	light green (738 1/2)
5- 25 igpm (approx. 25-100 l/min)	rose (743 1/2)
1- 5 igpm (approx. 5-25 l/min)	orange (737)
less than (<) 1 igpm (less than 5 l/min)	canary yellow (735)

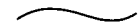
Note:

(1) A color on the main map, representing the particular range of average expected yield, is the sum of the potential yields to single wells of individual aquifers through the entire section to the base of investigation generally taken as 1000 feet below the ground surface. The vertical distribution of the yields, summed for the main map, is shown on the hydrogeological profiles by the appropriate colors.

(2) The indicated average expected yields to wells are predictions based on the best data available at the time of map compilation; due to data shortcomings and special conditions local discrepancies between predicted and actual yields are inevitable.

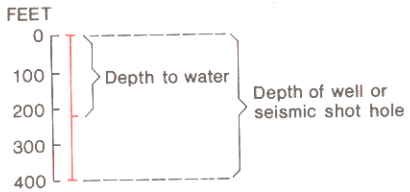
(3) In many instances, for reasons of scale, the water table has to be shown coincident with the land surface, and therefore the yield colors of the uppermost hydrogeologic unit are projected to the surface.

2. Yield area boundary

Contacts between colors representing different yield ranges are shown by a solid line.  black

Note: Where lines bounding ranges of yield coincide with other lines on the main map or the hydrogeological profile, as for example rock unit boundaries, the yield area boundaries are shown. In most cases, both are shown for clarity.

[28]A letter designation of each individual color block on a manuscript map or profile materially assists the draftsman in differentiating possible and probable yield areas. These letters do not appear on the final published map.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
WELLS AND OTHER ARTIFICIAL WORKS		
A. Wells		
Depth scale[29]		
1. Water well, nonflowing Groundwater information available includes some or all of the following data: depth of well (from the land surface), depth to water (from the land surface), well completion, producing interval, aquifer lithology, and type of water.		carmine red (745) 2 mm Ø
2. Water well, flowing		carmine red (745) 2 mm Ø
3. Water well, nonproducing		carmine red (745) 2 mm Ø

4. Well, shallow depth

   This includes shallow auger holes drilled for the purpose of groundwater exploration. The primary purpose of such a hole is usually the determination of the water table. A water sample may have been taken and therefore a chemical analysis is often available.

carmine red (745)
2 mm Ø

5. RCA test well

   The RCA is to be placed as close as possible so that the related well is obvious.

   Note that such a well will generally be represented by 9 below.

carmine red (745)
2 mm Ø

6. Recharge well[30]

carmine red (745)
2 mm Ø

7. Water well, with the same information as (1) above; and, in addition, estimates of safe yield and apparent transmissivity

carmine red (745)
2 mm Ø

8. Water well, with the same information as (1) above; and, in addition, values for transmissivity and a 20-year safe yield calculated from a good bail test or a short pump test

carmine red (745)
2 mm Ø

9. Water well, with the same information as (1) above, plus values for transmissivity and a 20-year safe yield calculated from a pump test of sufficient length to reflect regional hydraulic conditions

carmine red (745)
2 mm Ø

---

[29] The depth scale for all wells, etc., is 1 mm to 20 ft at a map scale of 1:250 000.

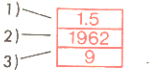
[30] A definition and further explanation is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
10. Test well with more than one piezometer in a single borehole or with groundwater data collected from several depths during drilling The horizontal bar indicates a single borehole and the dot indicates its location; the well symbols indicate the type of hydraulic test carried out. In most instances this symbol represents an RCA test well in which case the letters "RCA" appear above the location dot.		carmine red (745) 2 mm Ø
11. Adjacent wells This may refer, for example, to two closely spaced wells located at a single farm dwelling, as a stock well and a house supply. Reference lines to a location dot relate the two (or more) wells to their specific location.		carmine red (745) 2 mm Ø
12. Observation well		
a) with automatic recorder		carmine red (745) inner circle: 2 mm Ø outer circle: 3 mm Ø
b) without automatic recorder (Note: If the observation well belongs to the RCA network of observation wells, the letters "RCA" placed close to the symbol indicate this fact.)		carmine red (745) inner circle: 2 mm Ø outer broken circle: 3 mm Ø

c) information box

carmine red (745)

The author may elect to record specific data for the observation well by an information box with the information arranged according to the following number code:



1) Mean annual water level fluctuation in feet
2) Year of commencement of observations
3) Years of record averaged for mean annual water level fluctuation figure

12. Well information

carmine red (745)
2 mm Ø

Pertinent well information may be added by writing numbers and letters in the appropriate position. (Refer to Placement of Hydrogeological Data around the Well Symbol given in the previous chapter, page 28.)

Note: This method of representation is used only rarely and very selectively. It proves useful, however, for such entities as a 20-year safe yield value (which is placed close to the symbol in carmine red) especially where this represents an anomalous yield situation to the areally defined.

B. Shot Holes

1. Seismic shot hole reported to have flowed, unknown depth

carmine red (745)
2 mm Ø

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
2. Seismic shot hole reported to have flowed, known depth[31] The length of the uninterrupted line below the horizontal bar indicates depth.		carmine red (745) 2 mm Ø
C. Oil, Gas and Other Well Symbols		
1. Oil well		black 1 mm Ø
2. Gas well		black 1 mm Ø
3. Suspended well, drilled for oil or gas		black 1 mm Ø
4. Abandoned well, drilled for oil or gas		black 1 mm Ø
5. Waste disposal well This includes wells generally termed salt water disposal wells by oil companies and other wells used for waste disposal. (Refer to OTHER ARTIFICIAL WORKS for the symbol for lagoon sewage disposal.)		black 1 mm Ø
6. Borehole[32], lithologic data only		
a) Structure test hole		black 1 mm Ø

b) Other (such as an exploratory hole for coal, or a core hole to determine lithology, etc.) — black, 1 mm Ø

7. Depth[31] of exploratory well (used on hydrogeological profiles) — black, 1 mm Ø

The vertical line portion of oil, gas or other exploratory test well symbols indicates the well depth ; the dashed portion indicates the surface casing interval where applicable or where known (otherwise, a solid line is used).

Note: On the main map exploratory wells appear as point symbols only.

D. OTHER ARTIFICIAL WORKS

1. Storage reservoir for surface water (P, T or D, if known)[33] — carmine red (745), 4 mm Ø

2. Dugout or borrow pit (P, T or D, if known)[33] — carmine red (745), 4 mm x 2 mm

3. Gravel pit (P, T or D, if known)[33] — carmine red (745), 4 mm x 2 mm

[31] The depth scale for all wells and seismic shot holes is 1 mm to 20 ft at a map scale of 1:250 000.

[32] An explanation is given in the Glossary.

[33] The letter P or T above a symbol indicates that the water contained is permanent or temporary, respectively. The absence of a letter indicates that the water condition is unknown. The letter D indicates that the feature was dry when visited.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
4. Spring catchment The tangent square (of the same size as the spring symbol) is placed around the symbol where the spring has been developed for use, as for stock watering, a domestic supply, an industrial supply, etc.		carmine red (745) 2 mm
5. Recharge pit[34]		carmine red (745)
6. Lagoon used for sewage disposal (L = lagoon)		carmine red (745)
7. Infiltration gallery		carmine red (745)
8. Water pipeline		carmine red (745)
9. Dam (reservoir capacity in millions of cubic feet)		carmine red (745)
10. Hydroelectric station		carmine red (745)
11. Canal, irrigation canal, flood waters		carmine red (745)
12. Drainage canal, or artificial drain		carmine red (745)
13. Mine		carmine red (745)

14. Quarry — carmine red (745)

Note: As certain of these symbols may appear on NTS basemap materials the color designated herein may differ. For example, infiltration galleries, water pipelines, dams, etc., may already appear in a different color. In such an instance, the same color should be used for any features added. However, if the features are not already represented use the color and symbol given here.

HYDROCHEMISTRY [35]

1. Total dissolved solids, in ppm

   a) defined — 1000 — black

   b) approximate — 1000 — black

   Values of 500, 1000, 1500 and 2000 ppm are shown where possible. Higher values may be shown at 2000 or 5000 ppm intervals. Values of 250 and 750 ppm may be shown if considered necessary or valuable to map interpretation.

---

[34] A definition is given in the Glossary.

[35] This portion of the MAIN MAP LEGEND applies only to the hydrogeological profiles. The hydrochemistry is shown on an individual side map and does not appear on the main map. The colors are consistent for chemistry represented on the hydrogeological profiles and the hydrochemical side map.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant

2. Chemical isograms

Isograms indicate the 60 per cent cation or anion content of water. The color code is as follows:

	defined	approximate	
Ca			carmine red (745)
Ca + Mg			carmine red (745)
Mg			carmine red (745)
Na + K			lavender (742 1/2)
$HCO_3 + CO_3$			true blue (758)
SO_4			dark brown (756)
Cl			grey

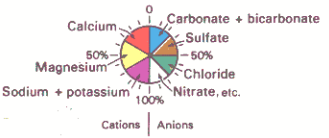
The teeth point in the direction of lesser cation or anion content.

3. Chemical pie diagram

black
8 mm Ø

The chemistry of representative waters may be shown in pie diagram form. Any such pie diagram is related to a particular well, spring or surface water location by a reference line (in black).

Major ion constituents are recorded as percentages of the total cations or anions, in the left or right halves of the pie diagram, respectively. Percentages are calculated on an epm (equivalents per million) basis. The common major ions or ion pairs are assigned specific colors, and are arranged in the order illustrated in the pie diagram.



Ca: carmine red (745)
Ca+Mg: carmine red (745)
Mg: yellow ochre (736)
Na+K: lavender (742 1/2)
HCO_3+CO_3: true blue (758)
SO_4: dark brown (756)
Cl: light green (738 1/2)
Other: uncolored

Note: 1. If Ca+Mg are expressed together the color will be the carmine red (745) of Ca.

2. Where Ca and Mg have been determined separately and Mg is less than(<) 5%, this is indicated by placing a black X on the left-hand side of the pie diagram above the Ca pie sector.

3. Where any other constituent as NO_3, etc. appears in an appreciable quantity, the appropriate percentage of the pie diagram is left white.

4. In all cases, ion values are rounded to the nearest 10 per cent; therefore any value <5% is omitted.

LAYOUT GUIDE FOR HYDROGEOLOGICAL PROFILES

The position of the four hydrogeological profiles A-A', B-B', C-C', and D-D' and their arrangement around the main map are indicated by the figure below.

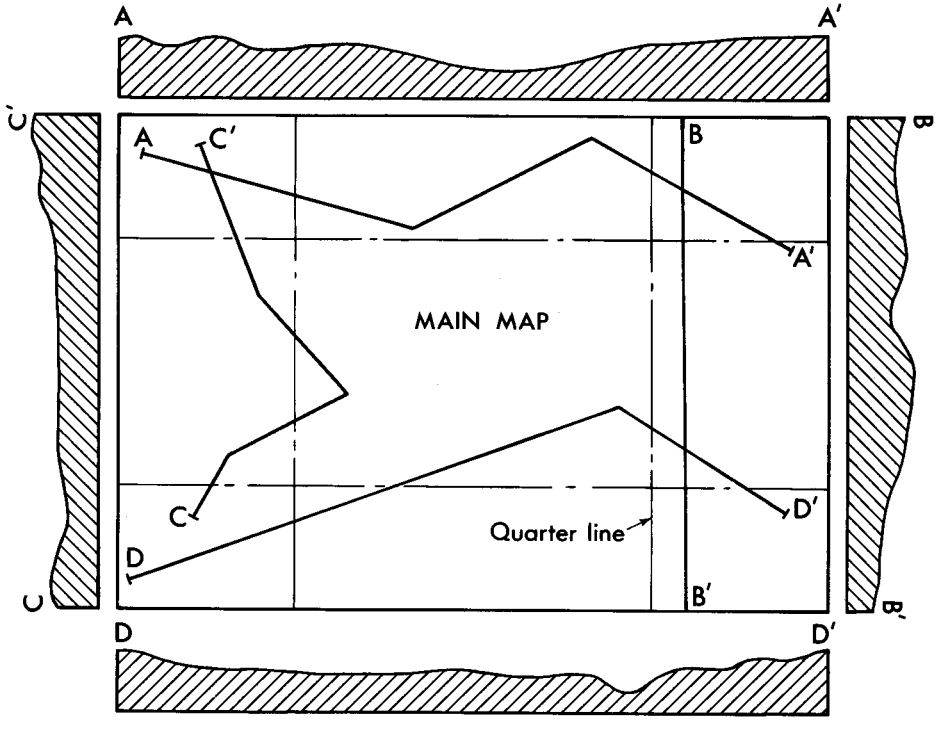


Figure 4. Layout Guide for Hydrogeological Profiles.

Note:

1) Letter designations are to be consistent for the map series.

2) The bases of profiles A-A', B-B' and C-C' lie adjacent to the main map; the top of profile D-D' lies adjacent to the main map.

3) The length of a profile does not exceed the length of the adjacent map edge.

4) Except for specific reasons the line of a cross section should approximate that of the quarter lines running parallel with the map edge.

LEGEND FOR METEOROLOGICAL SIDE MAP

(SCALE 1:1 000 000)

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
1. Isohyet, mean annual precipitation in inches	—20—	black
Mean annual precipitation is recorded on the METEOROLOGICAL SIDE MAP according to the following color code:		
Mean annual precipitation		
less than 15"		light green (738 1/2)
15"-20"		sea green (737 1/2)
20"–25"		sky blue (740 1/2)
25"-30"		true blue (758)
30"-40"		indigo blue (741)
more than 40"		lavender (742 1/2)
2. Permafrost		
a) Boundary of continuous permafrost		black
b) Boundary of discontinuous permafrost		black
Note: The apices on the symbol point towards the frost-free area.		

3. Location of meteorological site

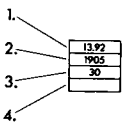
a) Meteorological station — black

b) Standard rain gauge only — black

4. Information box for meteorological site

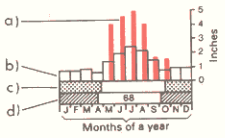
The information should be recorded in the box according to the following number code:

1. Mean annual precipitation in inches
2. Year of commencement of observations
3. Number of years of record averaged to determine the mean annual precipitation figure
4. Other pertinent data, such as months of record if not on a twelve-month basis.



black

The information box is related to the symbol by a black reference line.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
5. Precipitation data The available precipitation data should be recorded on the figure symbol in the manner indicated. a) Mean monthly potential evapotranspiration[36] (2 mm = 1 inch) b) Mean monthly precipitation (2 mm = 1 inch) c) Period when surface is usually snow covered d) Period with mean daily temperature below freezing (0°C). Figure indicates percentage of mean annual precipitation falling as rain. The symbol is related to the appropriate meteorological site symbol by a black reference line.		black & carmine red (745)
6. Source of data Most meteorological data are obtained from published information — particularly Climatic Maps for Alberta (Longley, 1968) and Monthly Record of Meteorological Observations (Meteorological Branch, Canada Department of Transport). The information sources should be indicated.		

[36] Evapotranspiration estimates should be based on the Thornthwaite method. If, however, some other method or source of information is used this should be indicated by an appropriate footnote and the actual source noted in the Source of data.

LEGEND FOR GEOLOGICAL SIDE MAP

(SCALE 1:1 000 000)

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
TOPOGRAPHY		
Topography is not shown on the GEOLOGICAL SIDE MAP. (See MAIN MAP.)		
GEOLOGY		
1. Rock units[37] and stratigraphy	TKp	letter symbols: black
Letter symbols and colors of units should conform with the usage of the Geology Division, Research Council of Alberta.		
2. Rock unit, formation boundary		black
3. Contact between formations with significantly contrasting permeabilities		black
The line is the same as a rock unit boundary but thicker.		
4. Isopach of drift, feet	500	carmine red (745)

[37] For a detailed list of abbreviation symbols for rock units in Alberta refer to the Appendix, Table 3a (p. 90) and Table 3b (p. 91).

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
5. Contour on the top of rock unit or marker bed, with elevation above mean sea level	—1700—	Colors are left to the discretion of the editor; they are darker than the rock unit color.
6. Strike and dip	⊀	black
7. Axis of anticline, with direction of axial plunge	—+→	black
8. Axis of syncline, with direction of axial plunge	—+→	black
9. Fault	——	black
The direction of the downthrow side may be indicated by the addition of an arrow		
10. Overthrust fault (teeth on upper plate)	—▼—▼—	black

LITHOLOGY

The lithology of the rock unit or formation does not appear on the GEOLOGICAL SIDE MAP: the author may wish to describe the lithology in the legend, as, for example Kk — Kaskapau Formation: shale. The lithology of the main aquifers is shown on the MAIN MAP. The author may elect to define the lithology of more than the main aquifers on the hydrogeological profiles.

LEGEND FOR HYDROCHEMICAL SIDE MAP[38]

(SCALE 1:1 000 000)

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
1. Chemical pie diagram A complete description of the pie diagram, constituents, color designation, etc., is given under HYDROCHEMISTRY for the MAIN MAP legend described previously. Note: The inclusion of pie diagrams is at the discretion of the author. They should be used only where they amplify the content of the map.		
2. Data control point The distribution and density of data points, that are the basis for drawing the HYDROCHEMICAL SIDE MAP, are recorded according to the following color code:		
a) a data control point marking the location of a well with a chemical analysis	•	carmine red (745)
b) a data control point marking the location of a spring with a chemical analysis	•	indigo blue (741)

[38] For a sample HYDROCHEMICAL SIDE MAP see figure 5 (page 79).

Subject and Explanatory Notes		Symbol	Color (Verithin color number) Size, if relevant
3. Total dissolved solids[39] (in ppm)			
a) defined		500	black
b) estimated, approximate			black
Contours for 500, 1000, 1500 and 2000 ppm are shown where possible. Higher values may be contoured at 2000 or 5000 ppm intervals. Values of 250 and 750 ppm may be shown if necessary.			
4. Anion-cation constituents		60% defined / approximate	
a) Cation isograms	Ca		carmine red (745)
Isograms on the map indicate 60 per cent content of a particular cation, with the teeth indicating the direction of lesser cation content.	Mg		carmine red (745)
	Ca+Mg		carmine red (745)
	Na+K		lavender (742 1/2)
b) Anion areas			
Areas of solid color indicate over 60 per cent of a particular anion; uncolored areas indicate that the content of each anion is less than 60 per cent. (See figure 5, page 79, Sample Map for 1:1 000 000 Hydrochemical Side Maps.)	HCO_3+CO_3		solid true blue (758)
	SO_4		solid dark brown (756)
	Cl		solid light green (738 1/2)

Maps: Within the solid blue colored area the the HCO_3+CO_3 content is greater than 60 per cent; within the solid brown colored area the SO_4 content is greater than 60 per cent; and, within the uncolored area the contents of both HCO_3+CO_3 and SO_4 are less than 60 per cent.

	40%	
The author may elect to show (by broken isograms) constituents of less than the usual minimum 60 per cent (e.g. 40 per cent) if these represent anomalous conditions on a particular map sheet.	Ca	carmine red (745)
	Mg	carmine red (745)
	Ca+Mg	carmine red (745)
	Na+K	lavender (742 1/2)

[39] A definition and further explanation is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant

5. Hydrochemical facies[40]

The hydrochemistry within a particular map area may be further defined by assigning a facies class.

a) Simple facies

A water of simple facies (e.g. Ca/SO_4 has one cation and one anion component each constituting over 60 per cent of the specified ion contents.)

b) Complex facies

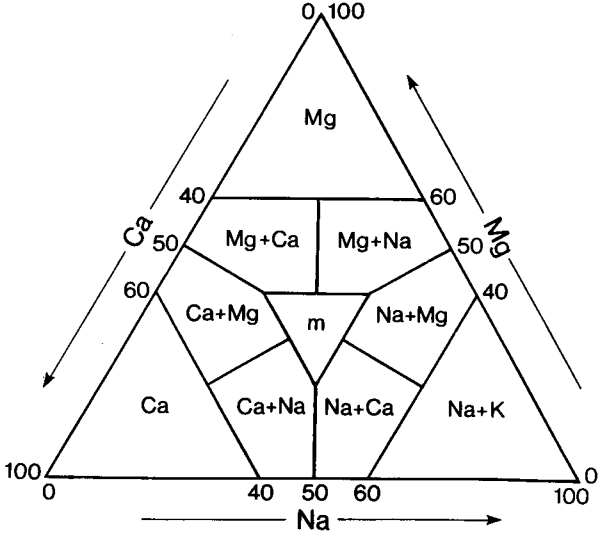
Where a water is indicated by two anions (cations) (e.g. $Ca/Cl+SO_4$) the first-mentioned anion (cation) is predominant and present in amounts of between 40 and 60 per cent, the subsidiary anion (cation) is predominant over the unmentioned anions (cations), and is present in amounts from 20 to 50 per cent.

In instances where neither of the two mentioned anions (cations) is defined as predominant, the water is shown as, for example, $Ca/Cl\&SO_4$; first mention of the Cl ion does not indicate predominance over SO_4.

A water with a cation (anion) composition indicated by the letter "m" (e.g. m/SO_4) has all three major cations (anions), i.e. Na, Ca, Mg (HCO_3, SO_4, Cl), present in amounts less than 40 per cent.

The major facies classes are indicated in the triangular diagrams below.

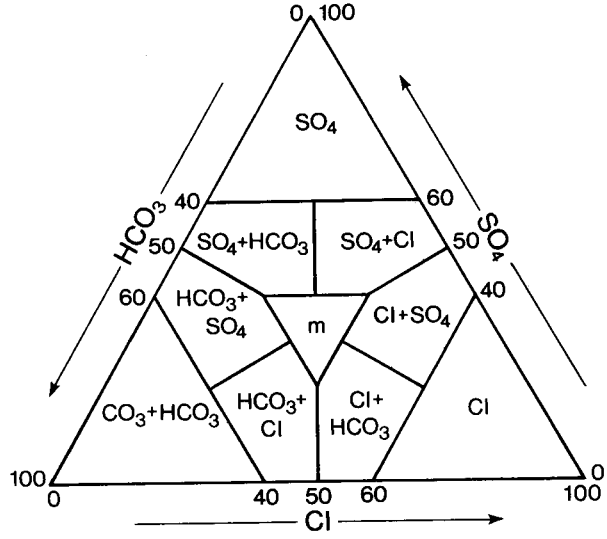
a) Cation facies



[40]A definition and further explanation is given in the Glossary.

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant

b) Anion facies



Note: Highly variable chemistry may necessitate the combining of small fields of different constituents into larger fields of mixed constituents. The resulting fields are designated by (e.g.): Ca + Mg/SO_4 & HCO_3; Na + Mg/SO_4 & HCO_3; Ca + Na/SO_4 & HCO_3 } m(ixed) SO_4 & HCO_3

The author may elect:

1. to designate the entire blue field uniformly as Ca & Na/HCO_3, or
2. to divide it into two fields indicating the major cations by:
   a) Na + Ca/HCO_3, and
   b) Ca + Na/HCO_3

The second choice is illustrated on this sample map.

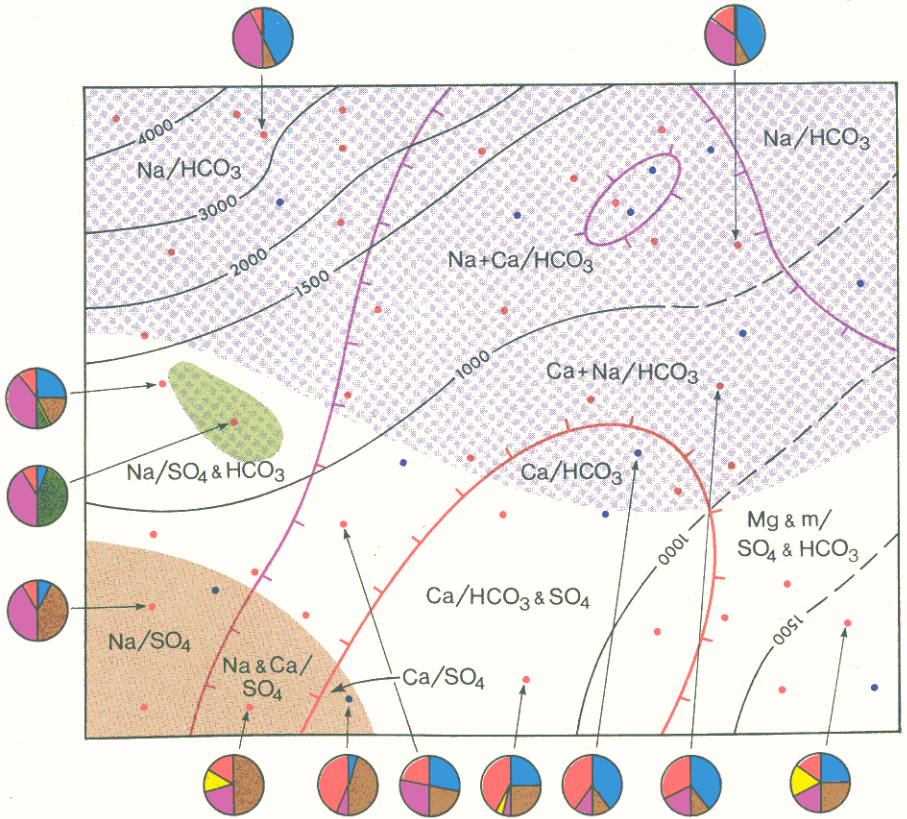


Figure 5. Sample map for 1:1 000 000 Hydrochemical Side Maps.

LEGEND FOR DATA DENSITY SIDE MAP

(SCALE 1:1 000 000)

Subject and Explanatory Notes	Symbol	Color (Verithin color number) Size, if relevant
1. Subdivision The data density side map should be divided on the basis of township and range		grey
2. A qualitative impression of the relative density of the data used in constructing yields and in drawing water level contours appearing on the main map, etc., is given by representing wells and hydrogeological surface features by dots according to the following color code:		
a) Wells with water level information only	•	true blue (758)
b) Wells with yield information (i.e. production tests)	•	carmine red (745)
c) Hydrogeological surface features	•	indigo blue (741)
Note that the wells and springs (with available hydrochemical data) used in constructing the HYDROCHEMICAL SIDE MAP and in drawing isograms on the hydrogeological profiles appear as point symbols on the HYDROCHEMICAL SIDE MAP.		

ADDITIONAL SIDE MAPS
(SCALE 1:1 000 000)

In addition to the four standard side maps: GEOLOGY, METEOROLOGY, HYDROCHEMISTRY, DATA DENSITY, the author of a reconnaissance map may include two others at his discretion up to a total number of six side maps. These may pertain to such parameters as Iron, Fluoride, Ca/Mg ratio, etc., where these are considered important to hydrogeological interpretation within the map area.

Re: IRON CONTENT SIDE MAP (SCALE 1:1 000 000)

Suggested values for drawing a side map of the IRON CONTENT of the groundwaters in a map area are contours of 0.3 ppm (the suggested upper limit of concentration for a potable water supply), 1 ppm and 5 ppm, defining intervals of less than (<) 0.3 ppm, 0.3 to 1 ppm, 1 to 5 ppm and more than (>) 5 ppm. If necessary, the author may define further contours; for example 10 ppm, 15 ppm, etc., if a further breakdown over 5 ppm is deemed of significance.

Re: FLUORIDE CONTENT SIDE MAP (SCALE 1:1 000 000)

Appropriate contours for drawing a side map of the FLUORIDE CONTENT of the groundwaters within a map area are those with values of 1 ppm, 1.5 ppm and 5 ppm defining intervals of less than (<) 1 ppm, 1 to 1.5 ppm (accepted limits of concentration for prevention of tooth decay and upper limit, 1.5, for prevention of mottling of teeth), 1.5 to 5 ppm (accepted concentration for producing no other harmful effects than mottling of teeth) and more than (>) 5 ppm.

Re: OTHER SIDE MAPS (SCALE 1:1 000 000)

No suggested values for contouring other parameters as, for example, the Ca/Mg ratio, are outlined here. The author should use his own discretion to define intervals which are representative of his particular data.

Note that the data points locating those waters analysed for the pertinent parameter should appear as black dots.

KEY MAP

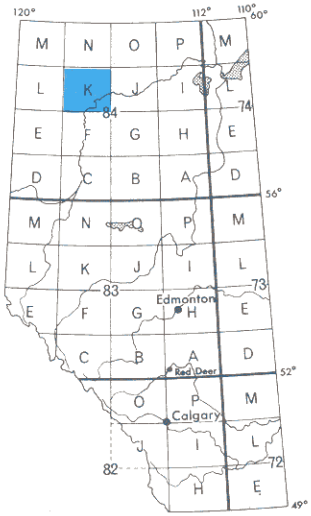


Figure 6. Sample key map showing location of a map sheet in the Alberta context.

The sample key map above illustrates the method used to locate a particular reconnaissance map sheet (e.g. 84K) within the context of the Province of Alberta, which shows its relative position to other map sheets of the AHRMS.

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APPENDIX
TABLES RELEVANT TO THE USE OF THE LEGENDS

Table 1. Some Abbreviations Used in the Legend

Abbreviation	
AHIM	Alberta Hydrogeological Information Map
AHIMS	Alberta Hydrogeological Information Map Series
AHRM	Alberta Hydrogeological Reconnaissance Map
AHRMS	Alberta Hydrogeological Reconnaissance Map Series
epm	equivalents per million
ft	feet
IASH	International Association of Scientific Hydrology
igpd	imperial gallons per day
igpm	imperial gallons per minute
l/min	liters per minute
l/s	liters per second
Lsd.	legal subdivision
Mer.	meridian
mm	millimeters
MSL	mean sea level
NTS	National Topographic System
ppm	parts per million
Q	safe yield in igpm
R.	range
RCA	Research Council of Alberta
Sec.	section
T	transmissivity in igpd/ft
Tp.	township
W. 4th Mer.	west of fourth meridian

Table 2. Relation of Meinzer Spring Order Number to English and Metric Units of Discharge

Spring Order	Discharge	
	English (igpm)	Metric (l/s)
1	≧132,000	≧10,000
2	13,200-132,000	1,000-10,000
3	1,320-13,200	100-1,000
4	132-1,320	10-100
5	13.2-132	1.0-10
6	1.32-13.2	0.10-1.0
7	0.13-1.32	0.01-0.10
8	<0.13	<0.01

Table 3. (a) Abbreviation Symbols for Some Alberta Rock Units

Rock Unit	Symbol	Rock Unit	Symbol
Alberta Gp	Ka	La Biche Fm	Klb
Alice Creek Fm	Kac	Lea Park Fm	Klp
		Loon River Fm	Kl
Bad Heart Fm	Kbh		
Banff Fm	Mbf	Mannville Gp	Kmv
Battle Fm	Kb	McMurray Fm	Km
Bearpaw Fm	Kbp	Medicine Hat Sand	Kmh
Belly River Fm	Kbr	Milk River Fm	Kmr
Blackstone Fm	Kbk	Mt. Head Fm	Mmh
Blairmore Fm	Kbl	Oldman Fm	Ko
Blood Reserve Fm	Kbo		
Bow Island Fm	Kbi	Paddy Mem	Kpd
Brazeau Fm	TKb	Pakowki Fm	Kpa
		Paskapoo Fm	TKp
Cadomin Fm	Kcd	Peace River Fm	Kp
Cardium Fm	Kcr	Pekisko Fm	Mpk
Clearwater Fm	Kc	Pelican Fm	Kpl
Colorado Gp	Kco	Porcupine Hills Fm	Tp
Cypress Hills Fm	Tc	Pouce Coupe Mem	Kpc
Dunvegan Fm	Kd	Puskwaskau Fm	Kpw
Eastend Fm	Ke	Ravenscrag Fm	TKr
Edmonton Fm	Ked	Scollard Mem	Ksc
Foremost Fm	Kfm	Shaftesbury Fm	Ksh
Frenchman Fm	Kfc	Shunda Fm	Msh
		Smoky Gp	Ks
Gething Fm	Kge	Spirit River Fm	Ksr
Grand Rapids Fm	Kg	St. Mary River Fm	Ksm
Grosmont Fm	Dg	Viking Fm	Kv
Hand Hills Fm	Th		
Harmon Mem	Kh	Wabamun Gp	Dwb
Hay River Fm	Dh	Wapiabi Fm	Kwb
		Wapiti Gp	Kwt
Ireton	Di	Waterways Fm	Dw
Joli Fou Fm	Kj	Willow Creek Fm	TKw
		Winterburn Gp	Dwn
Kaskapau Fm	Kk	Whitemud Fm	Kw
Kneehills Tuff	Kkh		

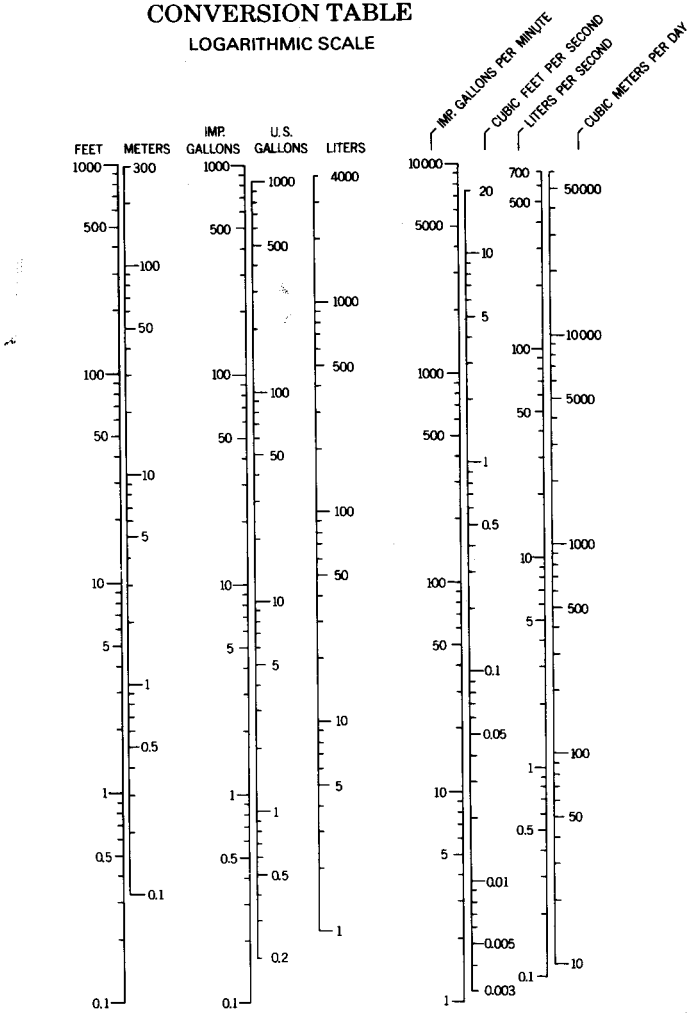
Table 3. (b) Abbreviation Symbols for Some Recent Materials

Material	Symbol
unconsolidated deposits	Qd
gravel	Qg
sand and gravel	Qsg
till	Qt
preglacial gravels	Qpg
glacial gravels	Qgg
glacial sand and gravel	Qgsg
glacial sand	Qgs
preglacial sand	Qps
Saskatchewan sands and gravels	Qpsg
lacustrine clays, silts	Ql

Table 4. The Major Geologic Time Units and their Abbreviation Symbols

Time Unit			Symbol
Cenozoic			TQ
	Quaternary		Q
	Tertiary		T
Mesozoic			M
	Cretaceous		K
	Jurassic		J
	Triassic		Ŧ
Paleozoic			P
	Permian		P
	Carboniferous		C
		Pennsylvanian	P
		Mississippian	M
	Devonian		D
	Silurian		S
	Ordovician		O
	Cambrian		Ꞓ
	Precambrian		Ꝑ

Table 5. A Conversion Table Relating English, American (U.S.), and Metric Units of Distance, Volume, and Rate



GLOSSARY

It is imperative that the connotation received by the map reader for a certain word or term is the one intended by the author. A Glossary is included in order that the exact meaning of certain words or terms is clearly that applied in the context of hydrogeological mapping in Alberta. The definitions or explanations of the following terms are based primarily on Elsevier's Dictionary of Hydrogeology (Pfannkuch, 1969), various texts on hydrogeology, and on the practice and publications of the Groundwater Division, Research Council of Alberta. The words or terms are listed alphabetically for ease in location. Only those words or terms marked and referenced in the legends are described here.

apparent transmissivity: Apparent transmissivity is calculated from a short bail or pump test by use of the following formula: $T = \frac{264\,Q}{\Delta s}$, where T = transmissivity in imperial gallons per day per foot, Q = pumping rate in imperial gallons per minute and Δs = the drawdown in feet per log cycle. Only an initial water level and a final water level, after a known period of water withdrawal, are available (see transmissivity below).

borehole: Borehole is used to refer to generally deep holes drilled for exploratory purposes. The broad term includes structure test holes, and others as exploratory holes to determine coal and other mineral reserves, coreholes drilled for lithologic data, etc.

buried valley: A valley formerly occupied by a stream and now buried by more recent deposits. Most often these are preglacial river valleys filled with glacial materials.

hydrochemical facies: The concept of hydrochemical facies is a means of describing the diagnostic chemical character of water solutions in aquifers. These facies reflect the effects of chemical processes in the lithologic environment and the contained groundwater flow patterns (Back, 1961).

hydrogeology: Study of subsurface waters in their geological context (Pfannkuch, 1969).

infiltration gallery: A horizontal permeable conduit to intercept and collect groundwater by gravity flow; water entering the gallery generally flows to a collection sump from which it is pumped for use.

recharge pit: A large pit or shaft used to recharge groundwater supplies under the action of gravity.

recharge well: A well into which recharge water is introduced for the purpose of increasing groundwater supplies by conducting surface water into an aquifer.

safe yield (to a well): Rate at which a well can be pumped continuously for a specified length of time (20 years is used for mapping purposes in Alberta) without drawing the water level in the well below the top of the aquifer.

saline lake: A lake containing water with high salt concentration, usually with no outflow.

soap hole: An area on the land surface characterized by a local weakness of limited extent underlain by a viscous admixture of sand, silt and clay rendered liquid in nature by the presence of water. For the purpose of hydrogeological mapping in Alberta, any natural surface discharge is classed as a spring. Therefore, a soap hole at the 1:250 000 scale will appear as a spring, but reference to the corresponding 1:50 000 map sheet and consultation of Placement of Hydrogeological Data Around the Spring Symbol will identify the soap hole.

spring: Any natural surface discharge large enough to flow. This includes small discharge or surface seepage which generally are indications of slower movement of groundwater to the ground surface. This seepage water may pond and evaporate or it may flow, depending upon the magnitude of the seepage, the climate and the topography. Springs occur in many forms and have been classified at various times on the basis of cause, rock structure, discharge, temperature and variability. The presentation of the information around the spring symbol in the eight slots available (see Placement of Hydrogeological Data Around the Spring Symbol in Chapter 2) in effect is a classification according to each of these features. At the 1:250 000 scale for ease of comparison of springs, the flow rate value is placed near to the spring in the indigo blue (741) color. Again for quick evaluation this value is in igpm. If it is desired that the discharge classification be according to the Meinzer spring order number, reference may be made to Table 2 in the Appendix for a quick conversion of the English units of discharge to metric units of discharge or the Meinzer spring order number.

total dissolved solids: The total concentration of dissolved minerals in water. The total dissolved solids is a general indication of the overall suitability of water for many types of uses. It may be determined from the weight of the dry residue remaining after a sample of water has evaporated or by adding together the individual determinations for all the ions in the water.

transmissivity: Product of the coefficient of permeability of the aquifer and the thickness of the aquifer. In actuality it is a measure of the flow capacity of an aquifer. This parameter is measured in imperial gallons per day per foot (igpd/ft).

variability of springs: $\text{Variability} = \frac{\text{max. discharge} - \text{min. discharge}}{\text{average discharge}} \times 100$

a) $V < 25\%$ (constant)
b) $25\% \leq V < 100\%$ (sub-variable)
c) $V \geq 100\%$ (variable)

Obviously the variability as calculated from existing records of discharge will tend to be less than the actual value. If the variability has been calculated from only a few measurements, then it may be so much smaller than the actual variability as to be incorrect. Consequently, the variability figure for a spring is reliable only when frequently measured flow-rate values are available over a period of several years.

water level: Level of the free surface of a water body or water column, as the water level in an individual well.

water table: Upper surface of a free groundwater body at atmospheric pressure. The water table is generally considered to be a replica of the topographic or land surface; the balance between the evaporation and precipitation largely determines the conformity. Other factors as, for example, the distribution of permeable strata exert modifying influences. A contour of the water table is a line on the water table all points along which have the same altitude. Only where water levels in wells reliably reflect the water table, can water table contours be drawn.