

WATER RESOURCES STUDY

of the

PROVINCE OF NEWFOUNDLAND AND LABRADOR

for

ATLANTIC DEVELOPMENT BOARD

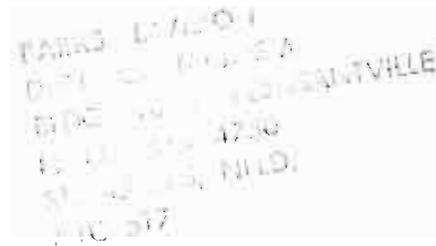
Volume TWO A

NATURAL WATER RESOURCES INVENTORY

THE SHAWINIGAN ENGINEERING COMPANY LIMITED  
JAMES F. MacLAREN LIMITED

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VOLUME TWO A  
NATURAL WATER RESOURCES INVENTORY



VOLUME TWO A

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METHODOLOGY

MADE IN CANADA  
LOVELL'S "Kopy" PROCESS  
A REVOLUTIONARY PROCESS



PART I - METHODOLOGY

The main objective of this portion of the study is an assessment of natural water availability and of changes induced by man's activity in the natural hydrologic and hydrogeologic conditions. As such, it corresponds to Phase B - Water Supply, Section 1 and 2 of the Terms of Reference.

According to the Terms of Reference, the study of the natural water resources availability should cover the total area of the Province. For this reason, methods of assessing the water availability in any area are required since, in some cases, changes in plans will result in locating new developments in areas which were not initially designated for such purposes.

Since the study had to be based on existing data, the methodology had to adapt itself to the amount of data available. Most of the available information pertained to meteorology and hydrology, and development of preliminary quantitative areal and time variation of these characteristics throughout the Province was possible. However, because of the relative scarcity of the data in the whole Province and especially in Labrador, this required the application of special techniques. Although for this stage of the study the estimates obtained are considered adequate, further investigations to improve the data and to check and complete the results obtained are necessary. The few analyses available on surface water allowed only approximate generalized appraisals of surface water quality. Data on groundwater quantity and quality were insufficient for more than a general qualitative appraisal, with extremely rough quantitative indications.

In using the results included in this part of the study, it should always be borne in mind that they were developed for general planning purposes, and as such are not valid for use in particular local problems for which special investigations will still be required.

1 SURFACE WATER METHODOLOGY

1.1 Surface Water Quantity Methodology

1.1.1 Methodology of Areal Distributed and Interrelated Meteorological and Hydrological Characteristics

Many of the meteorological characteristics have a continuous areal distribution and can be represented by isolines on maps. Some of the hydrological characteristics, especially runoff and actual evaporation averages over a period of a year or more, are also amenable to representation by isolines.

Because of the particularities of the information available, the meteorologic and hydrologic data that can be analyzed in their areal distribution (precipitation, temperature, evaporation, runoff) have been processed using a technique for combining them to produce more meaningful results. Since there are very few meteorological stations in the Province and most of them are located on the seacoast, their data have reduced relevance to the meteorologic conditions inland. On the other hand, the river gauging stations, although mostly located near the seacoast, are recording data on basins which expand far inside the central areas of the Island and the interior of Labrador. Since the meteorologic and hydrologic data are closely interrelated, by combining the local data obtained from the meteorologic stations with the data recorded by the river gauging stations an assessment of the areal distribution of certain meteorologic and hydrologic characteristics could be obtained. The combination of the two series of data was done through the intermediary of the physiographical characteristics which, in the final analysis, influence both the meteorologic and hydrologic phenomena to a large extent.

With this in mind the methodology of assessing meteorologic and related hydrologic characteristics has taken the following general steps: (Figure 1-1)

1. An analysis of available data on the meteorologic characteristics considered, assessment of reliability, and synthesis of missing data by correlation and double mass curve techniques.
2. A preliminary assessment of relationship between the meteorologic and the related physiographic characteristics.

3. A preliminary estimation of areal distribution of the meteorologic characteristics according to areal distribution of physiographic characteristics.
4. A selection of relationships between meteorologic and hydrologic characteristics developed theoretically and/or determined statistically for regions similar to the area under study.
5. A preliminary estimation of the hydrologic characteristics from the area distribution of the meteorologic characteristics and relationships between meteorologic and hydrologic characteristics.
6. An analysis of recorded hydrologic data, assessment of reliability, correction for systematic errors and changes in storage, and synthesis of missing data by correlation techniques.
7. A comparison of recorded (step 6) and estimated (step 5) hydrologic characteristics on the basis of basin data.
8. A correction on the basis of step 7 of preliminary estimation of meteorologic characteristics (step 3) and/or relationships between meteorologic and hydrologic characteristics (step 4).
9. A correction of preliminary assessment of relationships between the meteorologic and the related physiographic characteristics (step 2).
10. Iteration of steps 5, 7, 8, and 9 as many times as required to obtain, in step 7, a satisfactory agreement between computed and estimated hydrologic characteristics.
11. A final estimation of areal distribution of the meteorologic and hydrologic characteristics based on the last accepted iteration.

The application of this methodologic outline is illustrated in detail in Sections 8 and 16.

1. 1. 2 Use of a Computerized Square Grid System for  
Physiographic, Hydrologic, Meteorologic, and  
Other Data Storage Processing and Retrieval.

Since the areal distribution of the meteorologic and hydrologic characteristics with the physiographic characteristics requires the assessment of the areal distribution of the physiographic characteristics and, because of the large amount of work involved in both establishing the areal distribution of all the characteristics and in the performance of the iterative computations, a computerized system was considered extremely helpful.

In order to adapt a computerized system to this type of operation, the study area had to be converted to a schematic representation that was manageable by computers. A very simple and reasonable way of doing this was to divide the study area into a grid, the area afterwards being considered as consisting of a series of squares. These squares reproduce the area in the same way as a series of rectangular stones produce a mosaic, or a series of points produce a television picture.

The grid interval determines to a large extent the accuracy of the representation, since the finer the grid the more detail. Nevertheless, for a given set of conditions, the gain in accuracy obtained by further decreasing the grid interval diminishes greatly around a certain value of the interval, and further increase of the number of squares was not warranted. In general, the grid interval is determined by the size of the area, the size of the individual drainage basins considered, the detail of the available data, the required accuracy, the size of the available storage capacity of the computer, the budget of the study, etc. For usual problems, grid intervals between 0.5 and 5 miles can be considered. The use of the grid marked on the transverse mercator projection maps, scale 1:250,000, (Surveys and Mapping Branch, Department of Mines and Technical Surveys, 1960), as the basic framework was accepted since it enabled different groups working on the same study to have a common reference. This grid has an interval of 10 km (about 6 miles)\*.

\* Supplementary data on elevation at the middle of the interval and center of the square, however, increases the accuracy of this grid to at least that which would have been obtained with a grid interval of 4 miles.

When a study along a river was considered with progressively increasing size of drainage basin, its characteristics could be assessed by progressively adding the corresponding square or parts of squares. A physical, hydrologic, or other characteristic such as elevation, runoff, or population was assumed to be attached undifferentiated to a square, hence the partial squares at the boundaries were considered with their average characteristic in the computation. This introduced a certain error, especially for small basins where the ratio between boundary squares and fully-included squares is large. Although, for some very particular cases, the errors may be significant, in general if the ratio between the size of the average drainage area and the area of one grid square is larger than six\*, the accuracy was sufficient for any practical purposes.

The square grid system can be used for storing, processing, computing, and plotting information on physical, meteorologic, hydrologic, hydropower characteristics, economic, and demographic characteristics of the study area. A few examples will illustrate this:

- a) Physical characteristics. The average elevation of a river basin can be obtained by averaging the elevation recorded in each grid knot, square center, and mid-interval of the grid for the squares included in the basin. This closely approximates the value of the average elevation obtained by planimetering the areas between successive contours. If the area-elevation distribution (hypsothetic) curve is sought, the distribution curve of these elevations will produce a very close approximation.

Other physical characteristics can be computed from the elevation data. The physical characteristics are slope, azimuth, and barrier height (see Volume Eight, Appendix A). Several other characteristics of the watershed are also amenable to computer processing using the grid system (area of lakes, marshes, forest, soil characteristics, bedrock geology, distance to the sea in a given direction, shortest distance to the sea, etc.).

\* Due to supplementary elevation data in the middle of the interval and center of the square, acceptable accuracy has been obtained with the adopted grid for basins larger than 70 square miles. However, for smaller basins the accuracy becomes doubtful and the application of the techniques is acceptable for preliminary estimates only, and should always be checked by other means.

- b) Climatologic and meteorologic information. The grid system allows the storage and retrieval of basic climatologic and meteorologic data (in the square where the station is located), and to obtain such information for a given area is a simple operation. Comparisons between physical characteristics of neighbouring stations can indicate what correlations should be developed for synthesizing missing data. Also, an important advantage is that, by using the information stored, preliminary correlations between climatologic and physical characteristics at climatologic gauging stations can be developed.

These correlations then allow the use of the file on physical grid characteristics for estimating the value of the climatologic characteristics for each square. A correlation of this type is, for example, that between a dependent variable such as average precipitation or temperature and independent variables such as elevation, latitude, distance from the sea, distance from the sea in direction of prevailing winds, barrier height, etc. Once the correlations are established, the values of average precipitation or temperature can be estimated for each square of the grid, and digital maps or isohyet or isotherm maps can be produced for the study area.

The methods can be expanded if necessary for the estimation of the distribution of extremes (maximum or minimum temperature, precipitation, windspeed, etc.) or other statistics as, for example, standard deviations of yearly or monthly precipitation.

- c) Hydrologic information. This can be processed in a similar way as the climatologic and meteorologic information. Since hydrologic data, especially flow and runoff, represent average figures for the basin, a preliminary distribution of the data can be done by using the results of the climatologic-physical correlations and estimated (preliminary) relationships between meteorologic and hydrologic characteristics. Preliminary maps of annual average runoff, maximum and minimum annual runoff with different frequencies, and other hydrologic characteristics having a continuous areal distribution can be produced using this technique. By using the available information and the iteration technique described in Section 1.1.1, corrections have been made to both the hydrologic and meteorologic data up to a satisfactory level of consistency.

The computerized grid system was also useful in storing, retrieving, and processing information on demographic, economic, and other characteristics of the area as shown in Volume Three A, Section 2. Table A-5 in Volume Eight, Appendix A gives a summary of the input-output possibilities of the computerized square grid system in different fields.

The above sets forth the reasons for using the computerized grid system for the present study covering the Province. In the course of setting up the system, discussions were held and correspondence exchanged with the Canada Departments of Transport and Agriculture to check availability of programs which could be used in processing the meteorologic and hydrologic data. As a result, it was agreed that processing of a part of the meteorologic information available will be done by the DOT using their computing facilities and programs.

1. 1. 3 Approach for Hydrologic Characteristics which have a Discontinuous Areal Distribution

Some of the very important hydrologic characteristics, for example peak flood flows, minimum flows with different probabilities, and the corresponding runoff values are not amenable to representation by isolines. This is because these characteristics are the result of a complex interaction between the meteorologic input and the river basin system, and the latter can differ very much from one basin to another. The most important factors for the above examples are the surface and ground storage through which the meteorologic inputs (precipitation and snowmelt) are routed. Other factors, such as forest area, agricultural land, etc., can contribute and accentuate the differences so that similar inputs can result in dissimilar outputs.

In order to obtain generalized relationships for these characteristics, the approach consisted of the following steps:

1. An analysis of available data for reliability, correction for systematic errors and changes due to man's activity, and synthesizing of missing data by correlation.
2. An assessment of the hydrologic characteristics at each gauging station using the available data and statistical or deterministic processing.

3. Verification of hydrologic characteristic values obtained statistically by the most adequate deterministic method, and of those obtained using a deterministic approach by statistical analysis, whenever possible.
4. Correlation of hydrologic characteristic values obtained statistically with the aggregated physiographic characteristics of the corresponding basins.
5. An assessment of aggregated physiographic characteristics in ungauged basins, and by using them with the correlations established in step 4, an estimate of hydrologic characteristic values in the ungauged basins.

The approach will be discussed further and illustrated in Sections 17, 18, 19.

It should be noted that, no matter what processing technique is used, statistical or deterministic, the physiographic characteristics of the basins were required for steps 3 and 4 or 5. The computerized grid system, as shown in Section 1.1.2, is able to provide the data for any basin for which the percentage of included squares has been established.

## 1.2 Surface Water Quality Methodology

The water quality studies carried out in the framework of this report have the following objectives:

- a) Assessing water quality criteria for different uses.
- b) Establishing the water quality characteristics of natural water bodies.
- c) Estimating the adequacy of water quality for present water use, and possible treatment requirements.
- d) Assessing future water quality requirements in connection with the developing economy, future treatment requirements, and the effect of changes introduced by future water uses in water quality including the effect on natural water bodies.

To attain these objectives, the following steps will be undertaken:

1. 2. 1 Water Quality Guidelines

A statement of general guidelines for various water demand, for industrial and municipal use and for non-consumptive uses such as fish, wildlife, and recreation. Quality classifications have been made by physical, chemical, radiological, bacteriological, and biological characteristics.

The statement has been based on a review of existing North American water quality standards and requirements, as they relate to industrial and municipal demand and non-consumptive uses, and made with the aim of recommending standards for raw and treated municipal supplies and for making economical analyses of projects for water treatment to meet such standards and requirements.

1. 2. 2 Data Collection and Review; Correlation with Regional Factors

Existing data have been collected from whatever sources are available and location of sampling ascertained. A grab sampling program was instituted to fill in gaps where possible and to check estimations of water quality in basins where data were lacking.

For river basins where reasonably complete data are available, correlation has been established with the physical, geographical, geological, hydrological, demographical, and industrial factors in order to interpolate quality in basins where data are lacking. Special attention was paid to study areas and selected river basins.

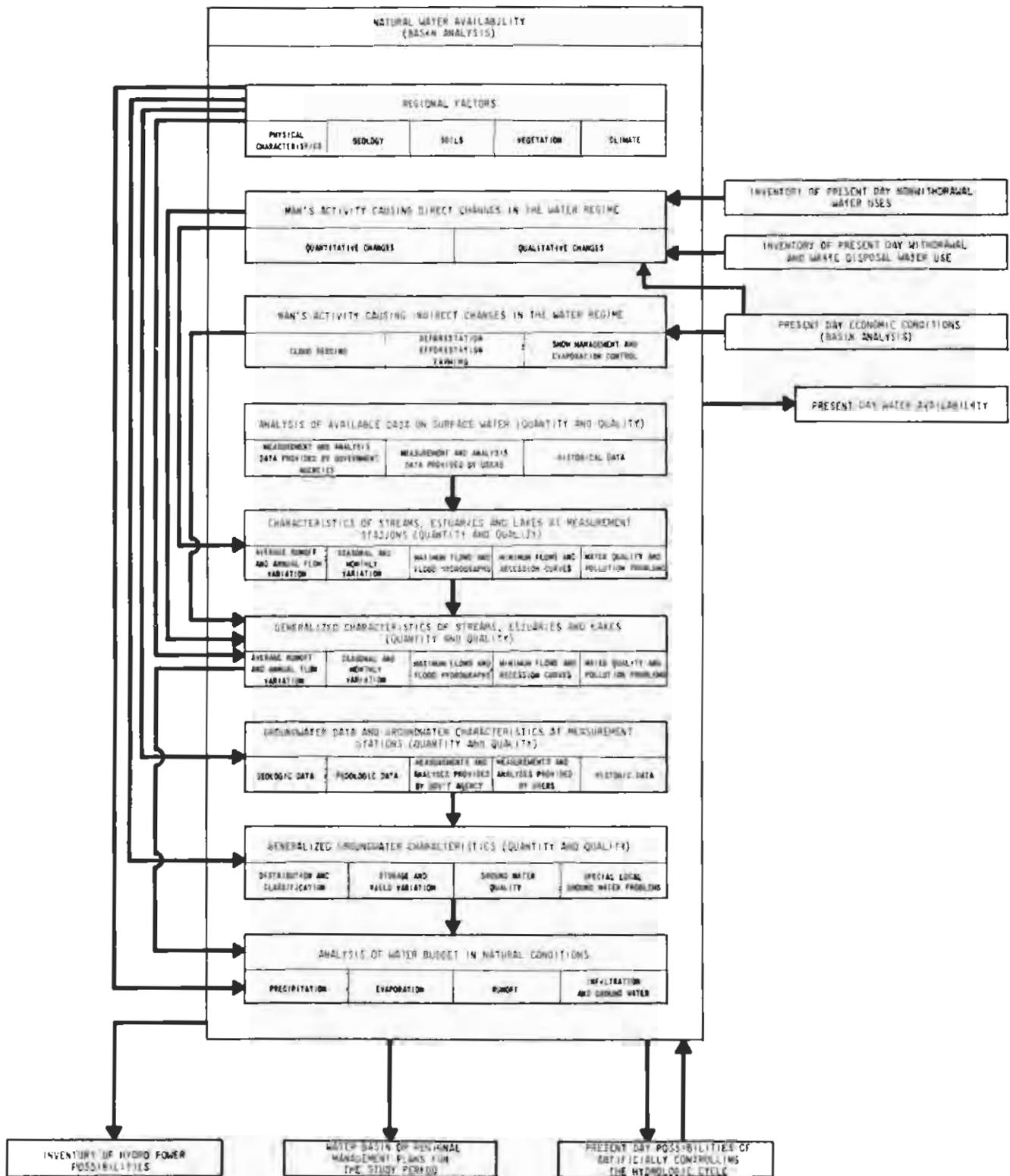
Whenever it was considered that there were serious gaps in available data, these have been identified, and recommendations made for establishment of data collection programs in consultation with the appropriate authorities.

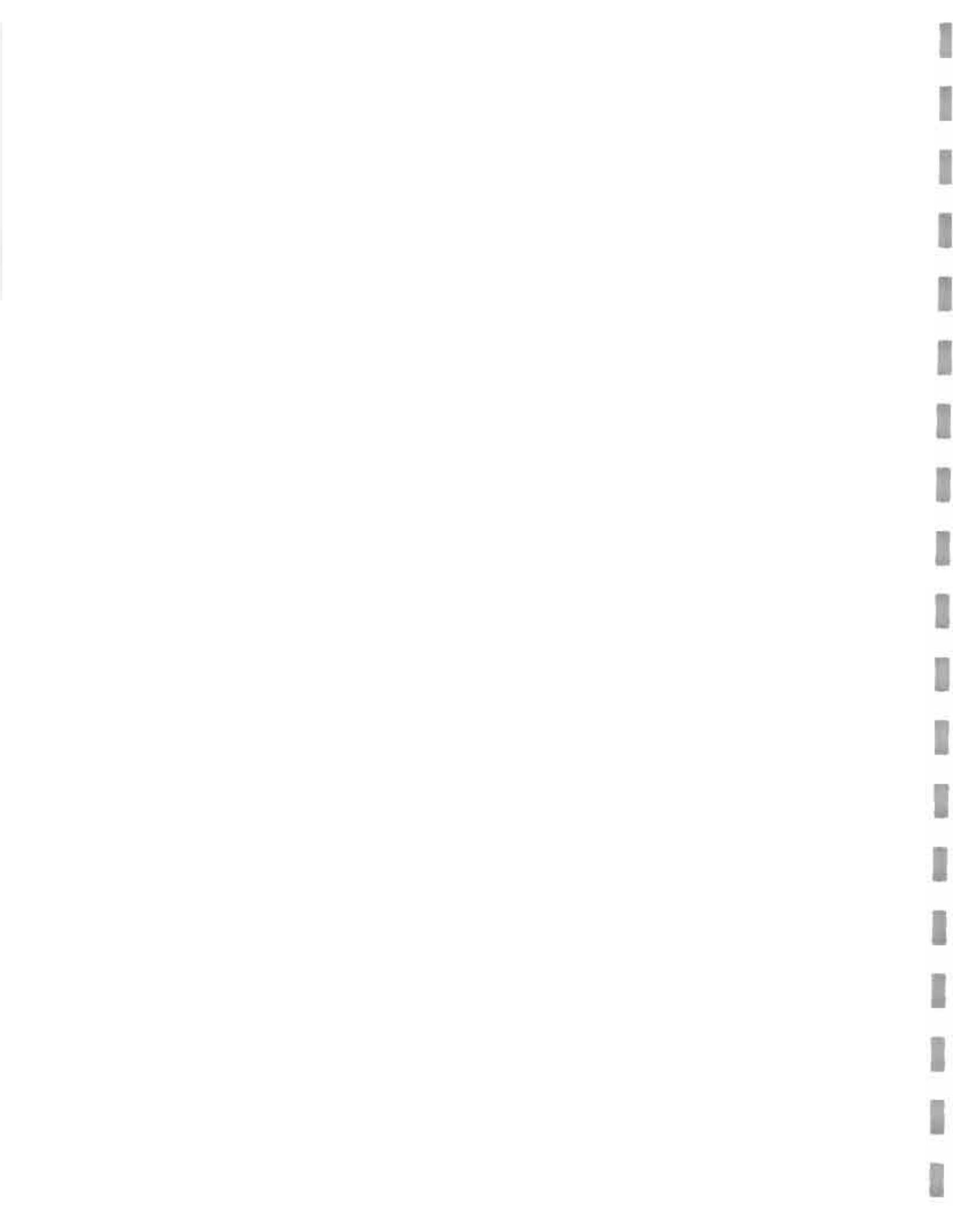
1. 2. 3 Man's Activity Causing Changes in Water Quality

This section comprises a review of information on existing quality of water used and of pollution by mining, industrial, municipal, and other sources, and identification of present or potential problem areas. The changes in river flows have been considered in relation to present or forecast waste loads.



### METHODOLOGIC PRECEDENCE CHART FOR WATER QUANTITY AND QUALITY





2 GROUNDWATER METHODOLOGY

2.1 Groundwater Quantity Methodology

The Terms of Reference, recognizing the lack of basic quantitative information on the Province's aquifers, require only the compilation, review, and analysis of data, and indications on maps of those areas suitable for groundwater prospecting and possible development.

It must be recognized that the lack of accurate data on precipitation, runoff, and evaporation makes it almost impossible to estimate the water infiltrated to the aquifers from a hydrologic budget. Furthermore, since an important portion of the groundwater is returned to the rivers upstream of gauging stations, it cannot be distinguished from the flow provided by releases from surface storage.

The assessment of possible groundwater occurrence was based therefore on the combined analysis of the geologic and physiographic features of the Province, including the occurrence and characteristics of surface water bodies, in conjunction with the analysis of data on well log sheets and yields, mine dewatering operations, and other pertinent information. Consequently the methodology used consisted of the following steps:

1. Compilation, review, and analysis of existing bedrock geology information to estimate permeability, weathering depths, faults, and other features related to groundwater.
2. Preliminary presentation on maps of the bedrock geology with indications of possibilities of important aquifers in the bedrock, and of main features related to bedrock aquifers at different depths.
3. Compilation, review, and analysis of information on surficial geology (glacial and recent) with indications on permeability (transmissibilities), and ranges of possible depths and yields for the most significant phreatic aquifers.
4. Preliminary presentation on maps of the surficial geology with superimposed data on surficial water bodies, with indications on important phreatic aquifers, and of their main features (depths, yield, and time variability).

5. Compilation, review and analysis, and map presentation of data on wells, mine dewatering, and other pertinent groundwater data, and comparison with preliminary conclusions drawn from steps 1, 2, 3, and 4 and correction of conclusions where necessary and possible.
6. Review of surface water recession curves, including analysis of possible surface storage, and comparison of surface and groundwater quality data during droughts and floods for checking conclusions on groundwater storage and depletion.
7. Final presentation on maps of bedrock and surficial geology with indications on aquifer possibilities, present day level of exploitation and problem areas.

## 2.2 Groundwater Quality Methodology

The objectives of the groundwater quality studies carried out in this report were:

- a) The establishment of the water quality characteristics of natural groundwater.
- b) The assessment of the changes in water quality occasioned by present water use.
- c) The estimation of the adequacy of water quality for present and future water use and possible treatment requirements.

Attainment of these objectives has been achieved primarily through:

- i) Review of existing water quality standards and requirements.
- ii) Analysis of existing data on groundwater quality.
- iii) Investigation of problem areas exposed by analysis of existing data.
- iv) Development of relationship between groundwater quality and bedrock and/or surficial materials with which groundwater is in contact.

Existing data have been collected from all available sources, and where possible grab samples for chemical analyses were obtained to expand the geographical coverage. Since most use of groundwater is by individuals in private homes rather than municipalities or industries, very little data were available on water quality for review.

Special attention has been given to the problems of salt water intrusion into groundwaters as well as the bacteriological pollution of groundwater as a result of improper disposal of domestic wastewaters.







PART II - PHYSIOGRAPHIC CHARACTERISTICS

3 GEOMORPHOLOGY AND TOPOGRAPHY

3.1 Island of Newfoundland

The Island consists basically of a tilted plateau, which is higher in the west than the east. The highland areas in the west range from 600 to 2000 feet in elevation, with some peaks rising to over 2500 feet. In much of these areas, the originally rolling topography has been extensively altered by erosion to produce a rugged terrain. The central part of the Island has an elevation which usually ranges from 600 to 1000 feet, and the rolling topography has been less modified by erosion than in the highland areas. The eastern part of the Island, including the Avalon Peninsula, is at a generally lower elevation, and has an undulating topography where only isolated peaks reach an elevation of 1000 feet.

The pattern of the topography is largely controlled by geological factors. Some areas of more resistant rocks form highlands, while others of less resistant rocks form lowlands. The drainage pattern of the Island was originally developed by the erosion of valleys along the lines of weakness produced by folding and faulting. For this reason, it tends to parallel the main trend of the geological structure of the Island, which is southwest to northeast. The original drainage pattern has been extensively modified by the glaciation of the Island which over-deepened some of the valleys and interrupted the drainage network on the plateaus by the deposition of drift. As a result of the modification of the drainage pattern, the plateaus are now covered with lakes and swamps over a large part of their area.

The depression of the Island relative to sea level by the load of ice on the land and the fluctuations in sea level due to the amount of water held as ice, has resulted in the formation of fjords and other features of a drowned topography. Since the end of the glaciation the Island has been rising as can be seen from the raised beach deposits at elevations of up to more than 100 feet above the present sea level and rivers which are now actively eroding deltaic deposits laid down at a time of higher sea level. There is some evidence to suggest that at least the northern part of the Island is still rising.

### 3.2 Labrador

Labrador forms the eastern extremity of the Canadian Shield. The Shield is an ancient peneplain, much of which was buried by subsequent deposition and then re-exposed by erosion of the sedimentary cover. In late geological time, uplift took place and the surface is being modified by erosion. The uplift has been greatest where the Labrador plateau rises to the northeast and south, and reaches elevations in excess of 5000 feet in the Torngat Mountains along the north Atlantic seacoast, and elevations in excess of 3500 feet in the Mealy Mountains south of Lake Melville. The level of the plateau in the interior of Labrador is generally between 1000 and 2000 feet, with occasional hills rising to 3000 feet.

The drainage is generally immature, due to recent uplift of the land surface and the effects of the glaciation, but some rivers flow through deeply incised gorges that have developed as the land surface has tilted, resulting in the drainage flowing in the opposite direction to the general tilt of the land surface in parts of the course of some rivers. The best developed valley is that of the Churchill River.

The central interior is termed the Labrador Lake plateau which is an area where the glacial activity during the Pleistocene age has interfered with the drainage leaving a large concentration of lakes and swamps. More than 11,000 square miles of the surface of the interior plateau is occupied by lakes.

The seacoast is generally rugged with many long, deep fjords, particularly in the north where the depth of water is 1000 feet or more. Uplift of the land surface relative to the sea in post-glacial time is indicated by raised beaches and raised dissected deltas.

### 3.3 Numerical Representation of Topographic Data

Topography is a physiographic characteristic which substantially influences the climate, vegetation, hydrology, and general economic development of a region. A square grid was used to obtain numerical values of the main topographic characteristics. As shown in Volume Eight, Appendix A, Table A-5, by means of four elevations determined on each square of the grid, it was possible to compute the following data for an area or basin.

- a) The average elevation.
- b) The angle to the horizontal and the azimuth of the slope. (Both figures are indices rather than actual values because of approximations involved in averaging the conditions within a square).
- c) The barrier height in various directions.
- d) The hypsographic curve for each basin.

Figures 3-1 and 3-2 show the average elevation and slope in each square of the grid for the Island. Tables 14-1 and 14-2 show the values of the aggregate (average) values of the topographic characteristics listed above under (a), (b), and (c) for a series of more important basins on the Island.

Figure 3-3 shows the hypsographic curves of the main river basins of the Island and of the Churchill River in Labrador obtained by using the approach indicated in Volume Eight, Appendix A, Table A-5, Output 2.

Figures 3-4 and 3-5 show the average elevation and average slope, by square grid, for Labrador.



NEWFOUNDLAND  
 SQUARE GRID DISTRIBUTION OF  
 AVERAGE ELEVATION

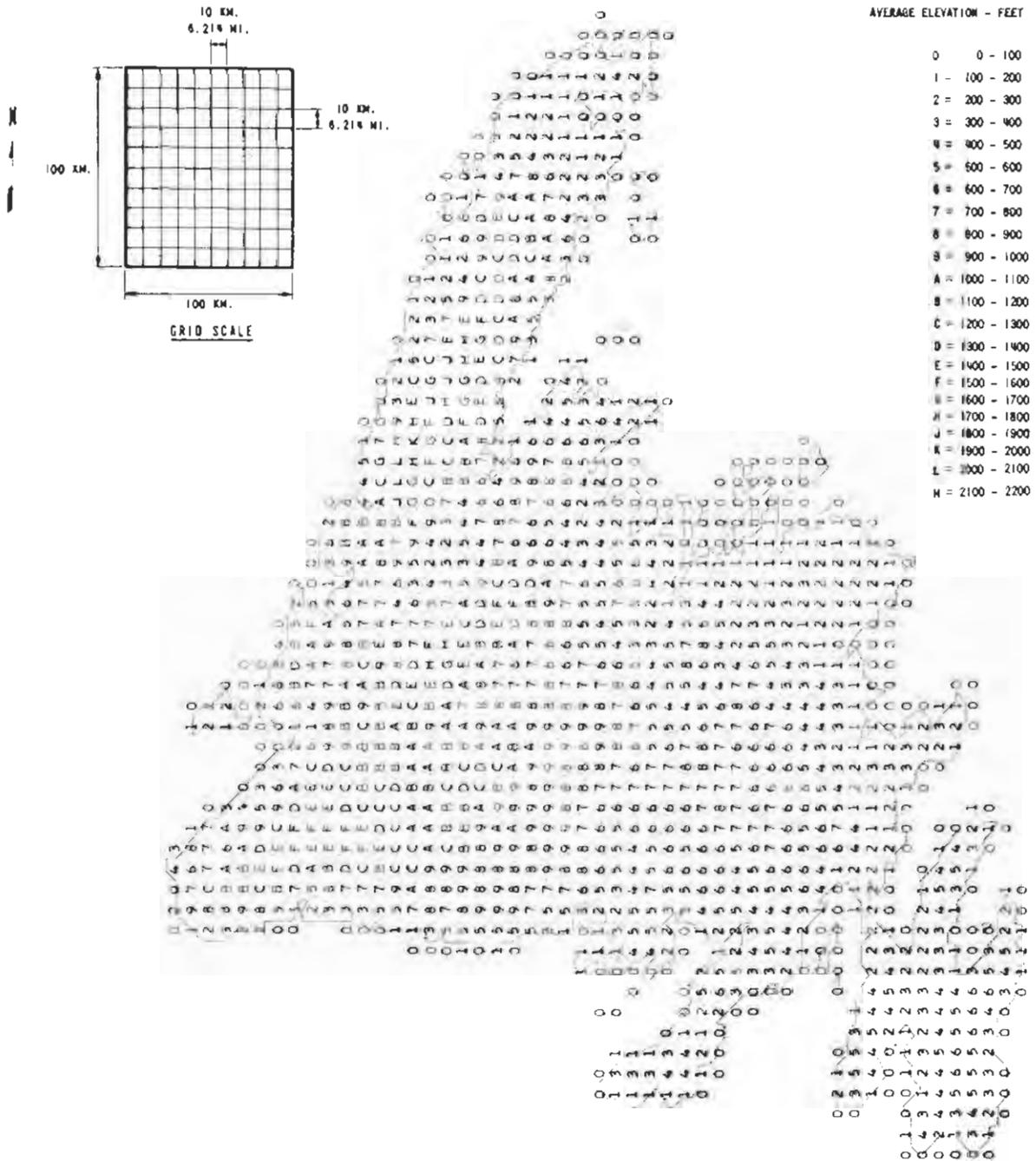


FIGURE 3-1

NEWFOUNDLAND  
 SQUARE GRID DISTRIBUTION OF  
 AVERAGE SLOPE

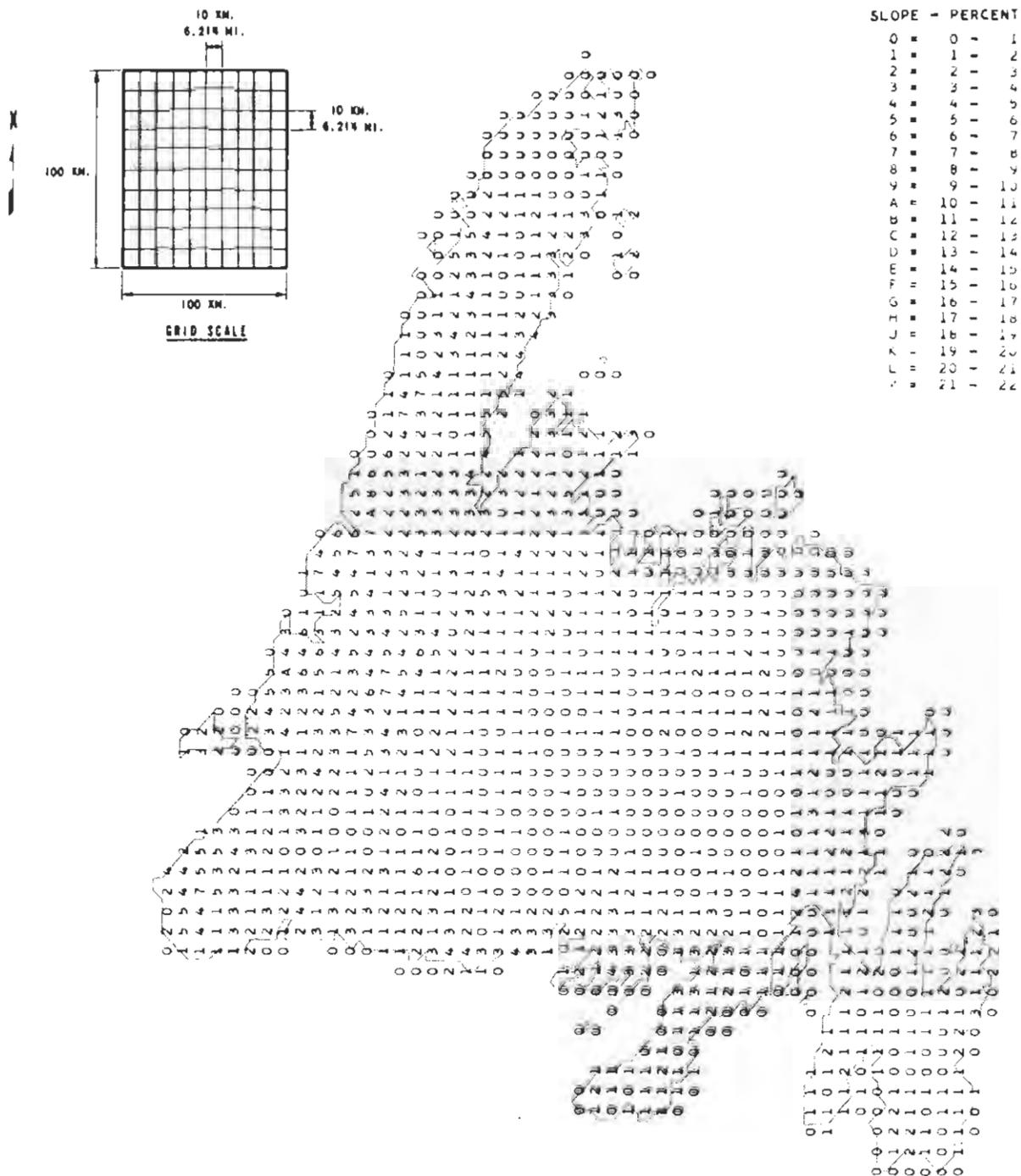
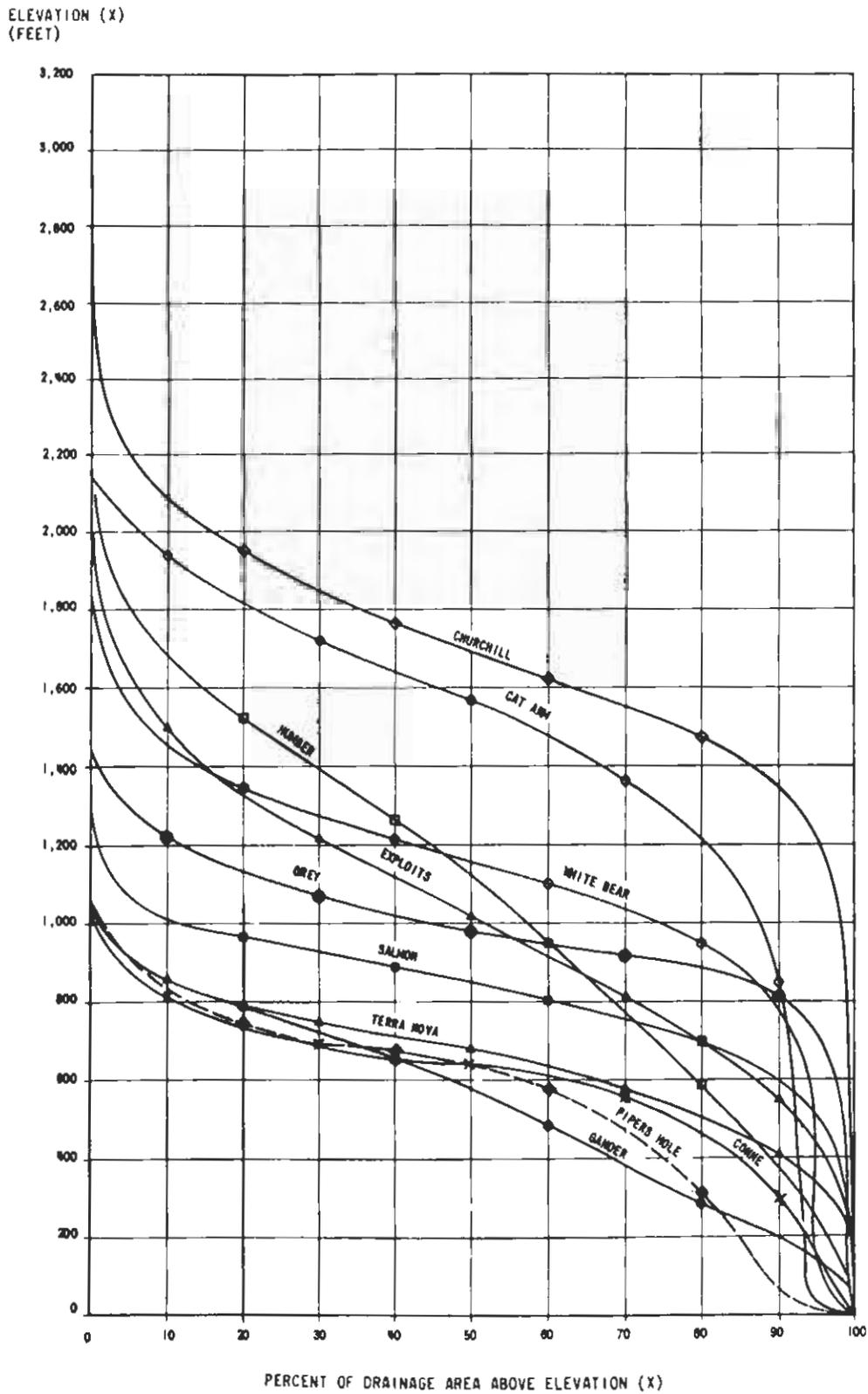
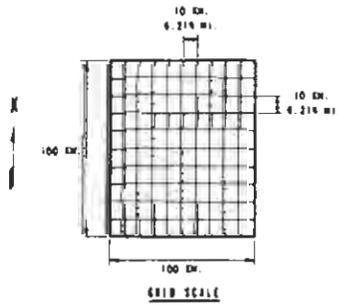


FIGURE 3-2

### NEWFOUNDLAND HYPSOGRAPHIC CURVES OF ISLAND AND MAIN RIVER BASINS



LABRADOR  
 SQUARE GRID DISTRIBUTION  
 OF AVERAGE ELEVATION



AVERAGE ELEVATION-TENS OF FEET-

0	=	0	-	9
1	=	10	-	19
2	=	20	-	29
3	=	30	-	39
4	=	40	-	49
5	=	50	-	59
6	=	60	-	69
7	=	70	-	79
8	=	80	-	89
9	=	90	-	99
A	=	100	-	109
B	=	110	-	119
C	=	120	-	129
D	=	130	-	139
E	=	140	-	149
F	=	150	-	159
G	=	160	-	169
H	=	170	-	179
I	=	180	-	189
J	=	190	-	199
K	=	200	-	209
L	=	210	-	219
M	=	220	-	229
N	=	230	-	239
O	=	240	-	249
P	=	250	-	259
Q	=	260	-	269
R	=	270	-	279
S	=	280	-	289
T	=	290	-	299
U	=	300	-	309
V	=	310	-	319
W	=	320	-	329
X	=	330	-	339
Y	=	340	-	349
Z	=	350	-	359



FIGURE 3-4

4 BEDROCK GEOLOGY

4.1 Island of Newfoundland

The geology of the Island is presented in the map entitled "Geological Survey of Canada, Map 1231A, Geology, Island of Newfoundland, 1967", the most recent geological map of the Island, which is included as Figure 4-1 in the pocket at the end of this volume.

The Island of Newfoundland represents the northeastern extremity of the Appalchian system, and is composed of rock of Pre-Cambrian and Paleozoic age. It can be divided into three regions: a western region, dominated by the Long Range complex; a central region, often referred to as the mobile belt; and an eastern region sometimes referred to as the Avalon terrain. The boundary between the western region and the mobile belt runs roughly from White Bay to the Cape Anguille Mountains. The boundary between the mobile belt and the Avalon terrain runs from Hare Bay, in Bonavista Bay, southerly to Fortune Bay.

The western and eastern regions are composed largely of Pre-Cambrian rocks overlain by Lower Paleozoic deposits. The mobile belt has a roughly symmetrical arrangement with clastic deposits on the margins followed by a thin zone of ultra-basic intrusions and a central area of thick Ordovician and Silurian volcanic and sedimentary rocks. At the present time, no correlation has been established between the Pre-Cambrian rocks of the western and eastern regions.

The rocks over most of the Island have undergone extensive alteration since their deposition. As indicated on Figure 4-2\*, much of the material in the Northern Peninsula and mobile belt has been metamorphosed. As a result, most of the rocks have lost much of any original porosity they possessed which has decreased their potential as a source of water.

There have been a large number of plutonic rocks intruded into the Island, particularly in the mobile belt. The age of these intrusions varies from Pre-Cambrian to Devonian, but there are no intrusives which are presently known to be younger than Devonian.

\* For a discussion of groundwater potential see Volume Two B, Part VII, Section 35.6.

The structural geology of the Island shows a dominant northeast-southwest trend, which is followed by the contacts between major rock types and by the major folding and faulting.

A large proportion of the known mineralized areas in the Island occur in the mobile belt and a number of important mines have been developed in this area, such as the base metal mines at Buchans, Whalesback, Tilt Cove, Gullbridge, the Advocate asbestos mines, and others. Among the mines that have been developed in the Avalon terrain are the fluorspar mines at St. Lawrence and the iron ore mines at Bell Island. There have also been attempts to recover oil from the vicinity of Parsons Pond on the Northern Peninsula, which have not been commercially successful. At the present time, numerous companies are active in the exploration for minerals in many parts of the Island, and exploration for oil and gas is taking place in the offshore areas.

#### 4.2 Labrador

Geological maps of Labrador are not available in the same detail as for the Island. There has, however, been a great deal of exploration carried out by the Geological Survey of Canada and mining companies in Labrador in the past 30 years, and the results are gradually becoming available.

Two separate geological provinces are recognized in Labrador, the Grenville Province in the south, and the Eastern Churchill Province in the north. Both geological provinces extend west of the Labrador-Quebec boundary.

In contrast to the Island where the majority of the rocks exposed are of Paleozoic age, the rocks of Labrador are nearly all of Pre-Cambrian age, the only known exceptions being two small areas of Cambrian sediment on the Strait of Belle Isle and some lavas further north may be Devonian or younger. Most of the Pre-Cambrian rocks are crystalline, but in some areas they are overlain by late Pre-Cambrian sedimentary and volcanic rocks that have undergone varying degrees of metamorphism. The most important of these latter rocks are those of the Labrador trough of which the southern extremity is within Labrador itself. This belt of rocks contains the major iron ore deposits that are mined at Schefferville and near the Carol Lake-Wabush area, the reserves of Wabush Mines alone being in excess of one billion tons of iron ore. Another area of similar rocks occurs northwest of Lake

Melville in the centre of Labrador, but only a limited amount of information is available at present.

Major basic and ultra-basic intrusions, composed largely of anorthosite and gabbro, occur south of Lake Melville, near Harp Lake, and in the coastal area near Nain and Nutak.

In addition to the iron ore deposits, a large number of uranium occurrences have been discovered over an area of 2500 square miles between Seal Lake and the seacoast, and it is possible that mining of uranium in Labrador will commence during the next few years. Other exploration programs in Labrador have discovered deposits of beryllium and molybdenum in significant amounts. In addition, numerous small occurrences of base metals and other minerals have been discovered but no commercial deposits have yet been reported.



LEGEND

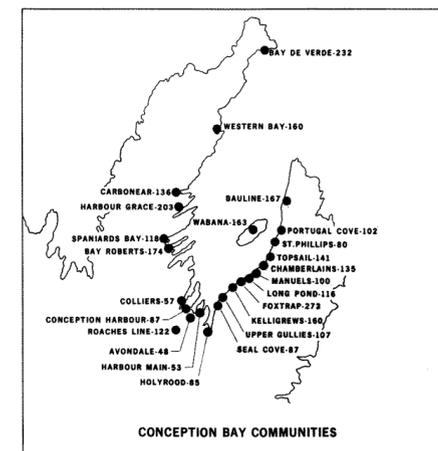
UNITS ARRANGED IN APPROXIMATE ORDER OF GROUND WATER POTENTIAL

UNITS	GROUND WATER POTENTIAL	ROCK TYPE
R1	LOW	MAJOR IGNEOUS INTRUSIONS
R2	LOW	MAIN PRECAMBRIAN SEDIMENTS
R3	LOW	PRECAMBRIAN VOLCANICS
R4	LOW	PALEOZOIC METAMORPHICS
R5	LOW	PALEOZOIC VOLCANICS
R6	LOW	PALEOZOIC SEDIMENTS
R7	LOW TO MODERATE	CARBONIFEROUS SEDIMENTS
R8	LOW TO MODERATE	SERIES WITH DOMINANT LIMESTONE AND DOLOMITE
R9	LOW TO MODERATE	ST. LAWRENCE GRANITE
---	MODERATE TO HIGH	FAULT OR MAJOR LINEAMENT

● ST. JOHN'S - 128. AVERAGE DEPTH OF WELL IN FEET

NOTE:  
THE HYDROGEOLOGIC UNITS WERE DEVELOPED FROM PUBLISHED AND UNPUBLISHED MAPS AND REPORTS BY THE GEOLOGICAL SURVEY OF CANADA, THE DEPARTMENT OF MINES, AGRICULTURE AND RESOURCES, NEWFOUNDLAND, AND AVAILABLE DATA ON WATER WELLS AND MINE Dewatering.

DISTRIBUTION OF UNITS ARE GENERALISED.



NEWFOUNDLAND  
BEDROCK HYDROGEOLOGY



ENLARGED COPIES OF THIS FIGURE MAY BE OBTAINED FROM THE CONSULTANTS UPON REQUEST.

5 SURFICIAL GEOLOGY

5.1 Island of Newfoundland

Two surficial hydrogeological maps are presented (Figure 5-1 and Figure 5-2)\* which consist of surficial geological maps of the Island of Newfoundland and the Avalon Peninsula with the surficial units grouped to show their relative groundwater potentials.

During the Wisconsin glaciation, the ice that blanketed the Province stripped off the pre-existing cover of unconsolidated material, and eroded fresh material from the rock beneath. As the ice retreated at the end of the glacial period, it left behind bare rock in some areas, while in others it left up to 100 feet or more of debris.

More than half of the Island is covered by material of glacial origin. The glacial materials can be divided into those which were deposited directly from the ice over very large areas, the moraines; those which were modified by the melt waters, the eskers and kames; and those deposited by the melt water behind the retreating ice, the outwash fans and deltas.

The other materials shown on the figures are only indirectly glacial in origin. These are the marine deposits and raised beaches that were laid down when the elevation of the sea relative to the land was higher than at present. There are post-glacial alluvial deposits, but these are generally formed in areas where glacial outwash material or kame deposits are available to be eroded and redeposited, as there is little other source material available for alluvial transport. The marsh and swamp deposits are also indirectly caused by the glaciation, as they develop where surface drainage over the glacial material is poor.

5.2 Labrador

A map showing the surficial geology of Labrador is included as Figure 5-3\*. The map is presented in the same way as the surficial map of the Island, with the materials grouped with reference to their groundwater potential.

\* For a discussion of groundwater potential see Volume Two B, Part VII, Section 35.4.

The northern part of Labrador and the region along the seacoast are almost completely free of surficial materials. The area immediately to the north of Lake Melville and the southern part of Labrador have a surficial cover over about half their area, while the western area is almost entirely covered.

Much of the surficial material consists of ground moraine which is often fairly thin, between 5 or 20 feet in depth, and ribbed moraine occurs quite frequently in the southern part of Labrador. In some areas there are numerous boulders or boulder fields on the surface of the till and extensive boulder fields may also exist on top of bedrock in some areas. Felsenmeer has developed widely on the mountain tops and elevated plateaus, and there are scree slopes on the steep hillsides.

There are extensive alluvial and fluvio-glacial deposits in the southern part of Labrador, and also a few in the north, but they are lacking in the western part. A large number of eskers, however, occur in the western part of the area as well as in the south. Some of the eskers can be traced for more than fifty miles with only minor interruptions and there are also many small eskers which are too small to show on Figure 5-3.

The major areas of swamp and bog are shown on Figure 5-3, but there are innumerable smaller swampy areas that are not indicated because of the scale of the mapping. Even greater areas of Labrador are covered by bog than on the Island of Newfoundland.

Much of the surficial geology of Labrador has been mapped in recent years by mining companies on a far more detailed level than shown here. Unfortunately it was not possible to obtain permission to use these maps for this compilation.

LEGEND

DIVISION OF SURFICIAL MATERIALS ARRANGED TO SHOW VARIATION  
IN GROUND WATER POTENTIAL AND MATERIAL TYPE

SURFICIAL HYDROGEOLOGICAL UNIT	GROUND WATER POTENTIAL	TYPE OF MATERIAL
 S1	LOW	THIN PATCHY MORaine OR BEDROCK
 S2	MODERATE TO LOW	GROUND, ABLATION AND SOME END MORaine
 S3	LOW MODERATE	RIBBED MORaine
 S4	HIGH TO MODERATE	ESKERS, KAMES, OUTWASH, BEACHES, RECENT ALLUVIUM
 S5	POOR QUALITY	MARSH AND BOG (HATCHING FOR UNDERLYING UNITS ALSO SHOWN ON MAP)
 S6	VARIABLE	MARINE CLAYS MAY OVERLIE WATER BEARING MATERIAL
		ESKER (DIRECTION OF STREAM FLOW NOT NECESSARILY IMPLIED)
		LINE OF END MORaine

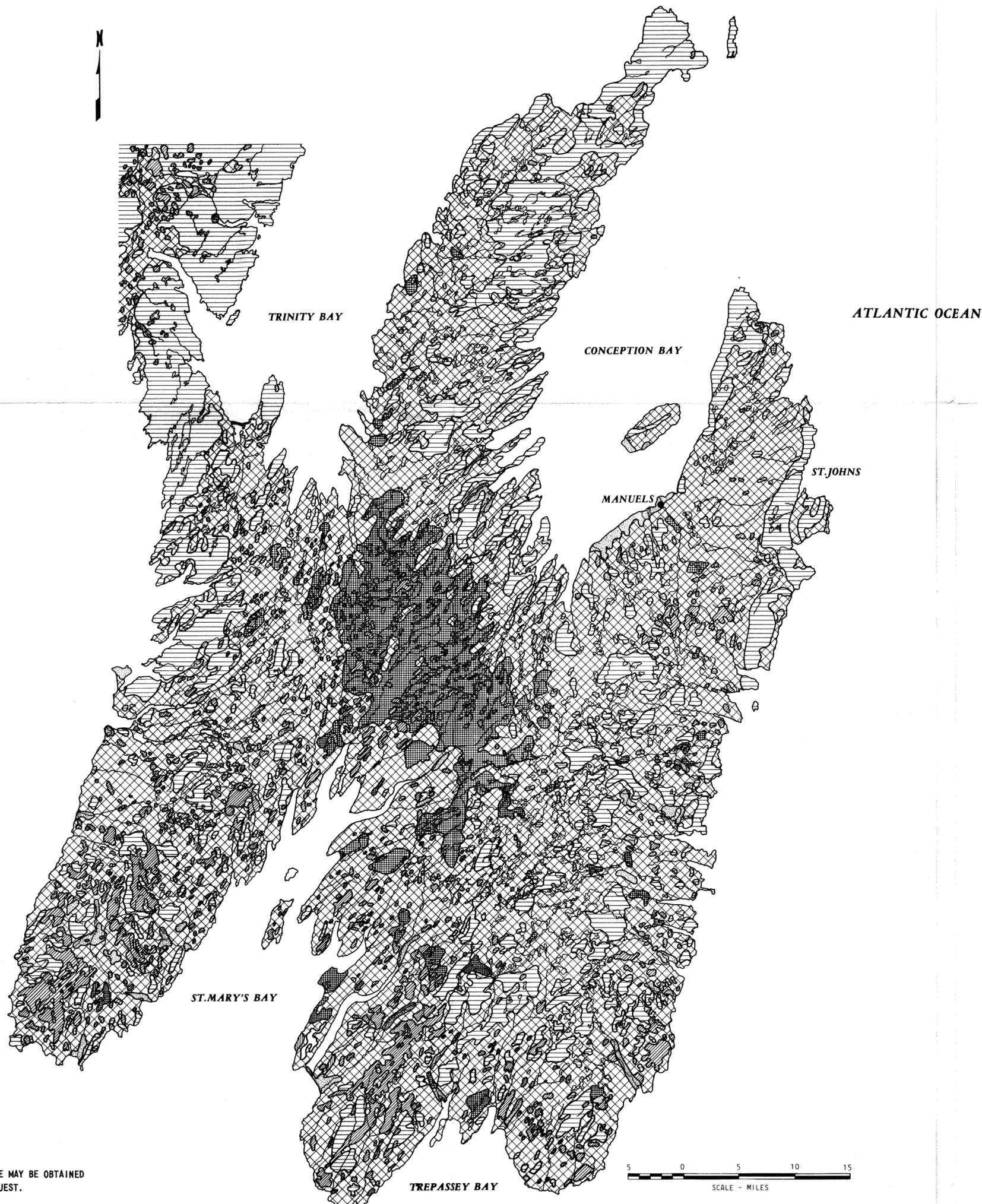
NOTE:

THE HYDROGEOLOGICAL UNITS WERE DEVELOPED FROM PUBLISHED AND UNPUBLISHED MAPS AND REPORTS BY THE GEOLOGICAL SURVEY OF CANADA, THE DEPARTMENT OF MINES, AGRICULTURE AND RESOURCES, NEWFOUNDLAND AND THE AVAILABLE DATA ON SURFICIAL MATERIALS AND GROUND WATER.  
DISTRIBUTION OF UNITS IS GENERALISED. MANY AREAS ARE TOO SMALL TO BE SHOWN AT THIS SCALE.



NEWFOUNDLAND  
SURFICIAL HYDROGEOLOGY  
(EXCLUDING THE AVALON PENINSULA)

ENLARGED COPIES OF THIS FIGURE MAY BE OBTAINED  
FROM THE CONSULTANTS UPON REQUEST.



LEGEND

DIVISION OF SURFICIAL MATERIALS ARRANGED TO SHOW VARIATION IN GROUND WATER POTENTIAL & MATERIAL TYPE

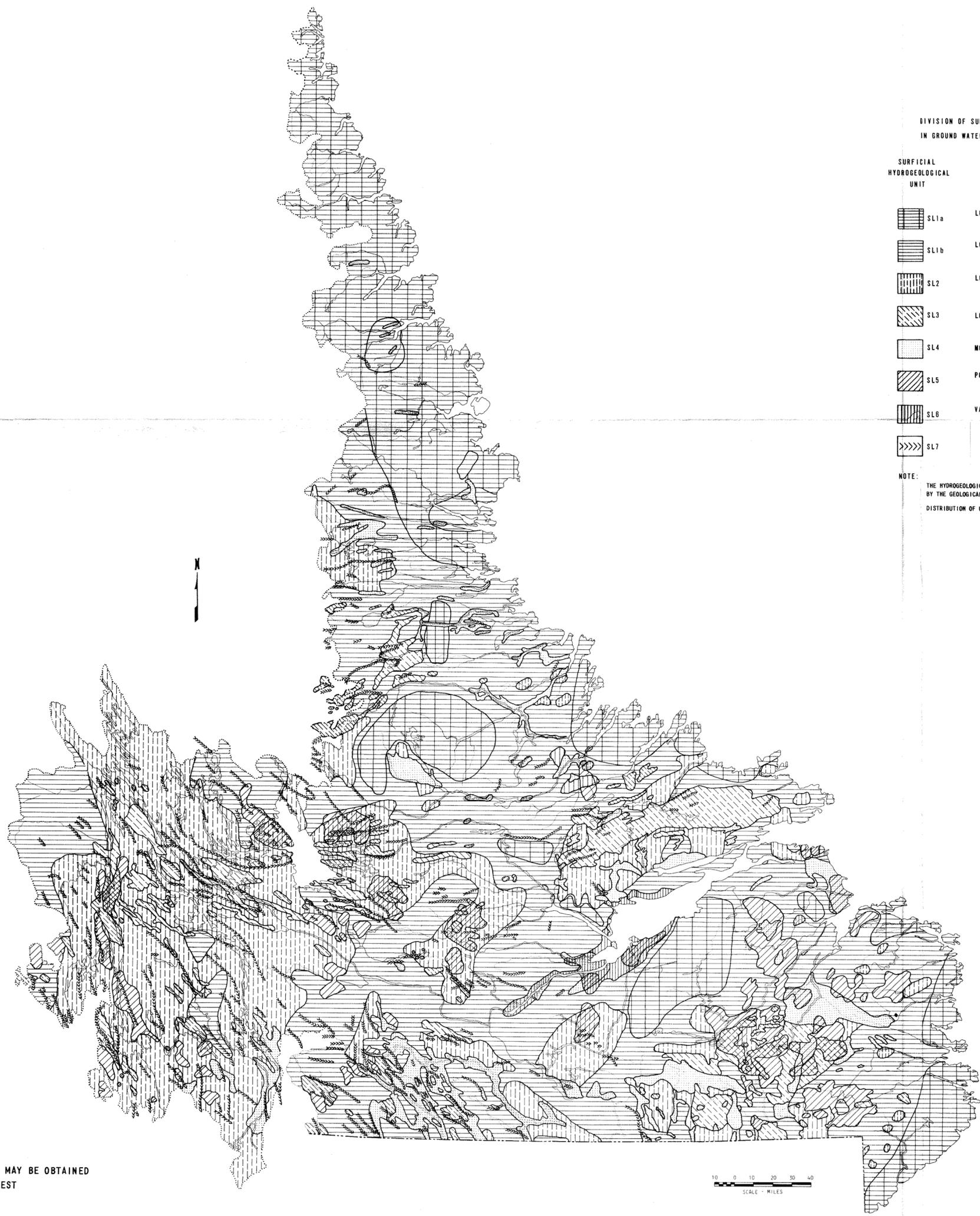
UNIT	GROUND WATER POTENTIAL	TYPE OF MATERIAL
S1	LOW	BED ROCK OR THIN PATCHY MORaine
SA2	MODERATE TO LOW	GROUND, HUMMOCKY AND ABLATION MORAINES
SA3	LOW TO MODERATE	END MORaine
S4	HIGH TO MODERATE	ESKERS, KAMES, OUTWASH, BEACHES, RECENT ALLUVIUM
S5	POOR QUALITY	MARSH AND BOG

NOTE:

THE HYDROGEOLOGICAL UNITS WERE DEVELOPED FROM PUBLISHED AND UNPUBLISHED MAPS AND REPORTS BY THE GEOLOGICAL SURVEY OF CANADA, AND AVAILABLE DATA ON SURFICIAL MATERIALS AND GROUND WATER. DISTRIBUTION OF UNITS IS GENERALISED, MANY AREAS ARE TOO SMALL TO BE SHOWN AT THIS SCALE.

ENLARGED COPIES OF THIS FIGURE MAY BE OBTAINED FROM THE CONSULTANTS UPON REQUEST.

AVALON PENINSULA  
SURFICIAL HYDROGEOLOGY



LEGEND

DIVISION OF SURFICIAL MATERIALS ARRANGED TO SHOW VARIATION  
IN GROUND WATER POTENTIAL AND MATERIAL TYPE

SURFICIAL HYDROGEOLOGICAL UNIT	GROUND WATER POTENTIAL	TYPE OF MATERIAL
SL1a	LOW	AREAS OF EXPOSED ROCK WITH FAIRLY CONTINUOUS OUTCROP
SL1b	LOW	AREAS OF EXPOSED ROCK, OUTCROPS FREQUENT BUT NOT CONTINUOUS
SL2	LOW TO MODERATE	GROUND, MORaine AND UNCLASSIFIED DRIFT AREAS
SL3	LOW TO MODERATE	MAINLY RIBBED MORaine
SL4	MODERATE TO HIGH	ALLUVIUM
SL5	POOR QUALITY	MARSH AND BOG (HATCHING FOR UNDERLYING UNITS ALSO SHOWN ON MAP)
SL6	VARIABLE	AREA OF MAXIMUM MARINE OVERLAP, PRE-EXISTING DEPOSITS REWORKED, AT LEAST NEAR THE SURFACE
SL7		ESKER; DIRECTION OF ORIGINAL STREAM FLOW NOT NECESSARILY IMPLIED

NOTE:  
THE HYDROGEOLOGICAL UNITS WERE DEVELOPED FROM PUBLISHED AND UNPUBLISHED MAPS AND REPORTS  
BY THE GEOLOGICAL SURVEY OF CANADA, AND AVAILABLE DATA ON SURFICIAL MATERIALS AND GROUND WATER.  
DISTRIBUTION OF UNITS IS GENERALISED. MANY AREAS ARE TOO SMALL TO BE SHOWN AT THIS SCALE.

ENLARGED COPIES OF THIS FIGURE MAY BE OBTAINED  
FROM THE CONSULTANT UPON REQUEST

10 0 10 20 30 40  
SCALE - MILES

LABRADOR  
SURFICIAL HYDROGEOLOGY

6 SOILS

6.1 General

The soils of the Province were formed largely by the action of weathering on the surface of material laid down by glaciers. Most of this material was coarse and stony, with fragments of rock in a sandy, silty, or clayey matrix and, under the climatic conditions that have prevailed in the relatively short time (about 7500 years) since the end of the glaciation, there has been little breaking down of the parent material in the formation of the soil profile. For this reason most soils are coarse and stony and contain boulders, except where they are formed on alluvial and organic materials, and in areas of relatively soft bedrock, such as shale, where the fragments have been more broken down by weathering.

6.2 Island of Newfoundland

The only comprehensive classification of soils in the Island was prepared for The Royal Commission on Agriculture by Mollard and Munn<sup>1</sup> in 1955 and was based on the nature of the surface geology as determined from air photographs. For each of their divisions of surface geology they described the corresponding relationship of the soil to the surficial material and topography and also gave the land use-capability. Most soils were classified as coarse textured podzols, with gleysols developed in the poorer drained areas.

The classification of surficial materials developed in this report is based on essentially the same divisions as those used by Mollard and Munn; but the distribution of the different types have been modified by additional information which was not available at the time of The Royal Commission on Agriculture, but which has been incorporated in the surficial hydrogeologic maps (Figures 5-1 and 5-2).

The present classification should be used with reservations for several reasons. The scale of the mapping, 1:500,000 in 5-1 and 1:250,000 in 5-2, is such that detail must be omitted and the classification is essentially regional. Later work by Wells<sup>2</sup> and Damman<sup>3</sup> also has shown that the moisture regime of the soil together with the aspect and steepness of the slope on which it is situated can be at least as important as the nature of the parent material.

Table 6-1 summarizes the classification used by Mollard and Munn, and relates their divisions of surface geology to the surficial units on the maps presented in this report, Figures 5-1 and 5-2. The most favourable bedrock units for each soil type are also shown on Table 6-1 since the quality of the soil is also affected by the rock fragments within the surficial material which will break down under weathering more or less rapidly depending on their composition. In addition, the chemical composition of the bedrock material in the soil parent materials will affect the composition of the soil produced; for example, limestone will help neutralize the characteristic acidity of the soils of the Island. As most of the bedrock material in the surficial materials is locally derived, the soil will be affected by the bedrock beneath it.

Practically all of the soils occurring in the Island are coarse textured, leached, and acid. The only more detailed available information on the composition of soils is in reports prepared by Wells<sup>2</sup> and Damman<sup>3</sup>.

Wells carried out a soils survey of the Gander and Gambo map sheets which covered an area including several different types of surficial and bedrock material. The results of his work are discussed here as they illustrate both the deficiencies of the type gross classification given above, and the characteristics of soils in a typical area of the Island, showing the difference between soil composition in Newfoundland and other parts of Canada.

The soil types are divided into Podzols (soils with a light coloured eluviated A horizon, underlain by an illuvial B horizon in which iron and aluminum oxides and organic matter are the main accumulation products) and Gleysols (soils which have poor drainage and cannot develop into Podzols). In Table 6-2 Wells' soil classification has been summarized and is shown in relation to the surficial hydrogeologic and hydropetrologic units developed for the present report. Wells' classification includes the drainage characteristics of individual soil types, the pH in the different horizons and the soil capability class. (Following the procedure of the Canada Land Inventory, Soil Capability Classification for Agriculture<sup>4</sup>.) As a further illustration of the characteristics of the Island's soils, the size distribution at two sample sites are shown graphically on Figures 6-1A and 6-1B.

Although the data presented are from a restricted area, they are believed to illustrate fairly well typical Newfoundland soil conditions.

### 6.3 Labrador

Although no overall classification of the soils of Labrador has been made, it is possible to subdivide them on a similar basis to that described above for the Island. Table 6-1 shows the surficial units mapped in Labrador

The reservations that apply to the classification and mapping of the Island are even more applicable to Labrador, where the mapping is on a very much smaller scale. None of the bedrock units favourable to good soil development is widely developed in Labrador, hence no attempt can be made to relate soil quality to bedrock in this part of the Province.

No detailed information is available on the composition of the soils of Labrador, but some general information has appeared in various reports of the Geological Survey of Canada.

In the cool climate of Labrador, with abundant moisture and thick surface vegetation, the development of Podzolic soils is also favoured. Although growth is slow, the decay of organic matter is also slow, allowing the accumulation of humus and the formation of the acid environment that produces the leached lower A horizon typical of a Podzol.

Where there is a cover of spruce-lichen, an A horizon develops with a humus rich horizon 1 to 2 inches deep on top of a grey leached zone. Where only lichen covers the ground, the vegetation may directly overlie the leached zone. Some B horizons are high in iron and may be indurated, forming hardpan. The low fertility of the Podzols contributes to the slow growth of the forest cover.

On the exposed uplands, particularly in the north, frost churning and solifluction mixes the soils, bringing deeper lying materials to the surface and making differentiation into horizons difficult. The upland soils are similar to tundra soils which develop over permafrost.

### 6.4 Permafrost

The permafrost region is defined on the basis of the temperature within the ground. The minimum definition of a permafrost zone is that the temperature in the ground remains below 32 deg F for a period of at least one full year.

There are two zones within the permafrost region, a continuous and a discontinuous zone. The boundary between the two is taken at the 23 deg F isotherm of mean annual ground temperature, measured immediately below the zone of seasonal variation in the ground.

The Island of Newfoundland lies to the south of the 23 deg F isotherm. A substantial part of Labrador, however, lies within the region of discontinuous permafrost. The accompanying Figure 6-2 is taken from Geological Survey of Canada, Map 1246A - 1967, Permafrost in Canada, and shows the projected distribution of permafrost in Labrador. In the absence of information about ground temperatures, the boundaries have been based on the 25 deg F and 30 deg F mean annual air temperature isotherms.

As part of the study of the climatic conditions in the Province, Section 8, a set of mean annual air temperature figures were obtained for 10 kilometer grid squares in Labrador, using a correlation between temperature data at meteorologic stations and the physiographic characteristics. On Figure 6-3, the 25 degree and 30 degree isotherms have been drawn in to indicate how the limits of permafrost would fall using this data. In Labrador in the southern part of the discontinuous permafrost zone, permafrost patches will occur in the better drained portions of bogs and peatlands; while in the northern part of Labrador it is more widespread and may also occur in the bedrock. At Schefferville, drilling in the iron ore deposits encountered patches of permafrost at depths of 20 to 40 feet, at a level well below that which would be affected by the modern climate. These are relics of a period of colder climate when the permanent permafrost belt extended this far south, and it is probable that similar relics exist elsewhere.

Patches of frozen material are quite often encountered outside the permafrost zone where digging takes place in summer, but these probably represent in the main the basal part of the previous winter's annual frost layer and would normally melt before the end of the season. A phenomenon sometimes observed in Labrador is the sudden lowering of the water level, and even complete drainage of upland ponds and small lakes in August. This is probably due to the late thawing of the previous winter's frost in the bottoms of these ponds and lakes.

On the Island itself, there are some areas on the Northern Peninsula where the estimated annual mean air temperature of individual 10 km grid squares is below 35 deg F, see Figure 8-6.

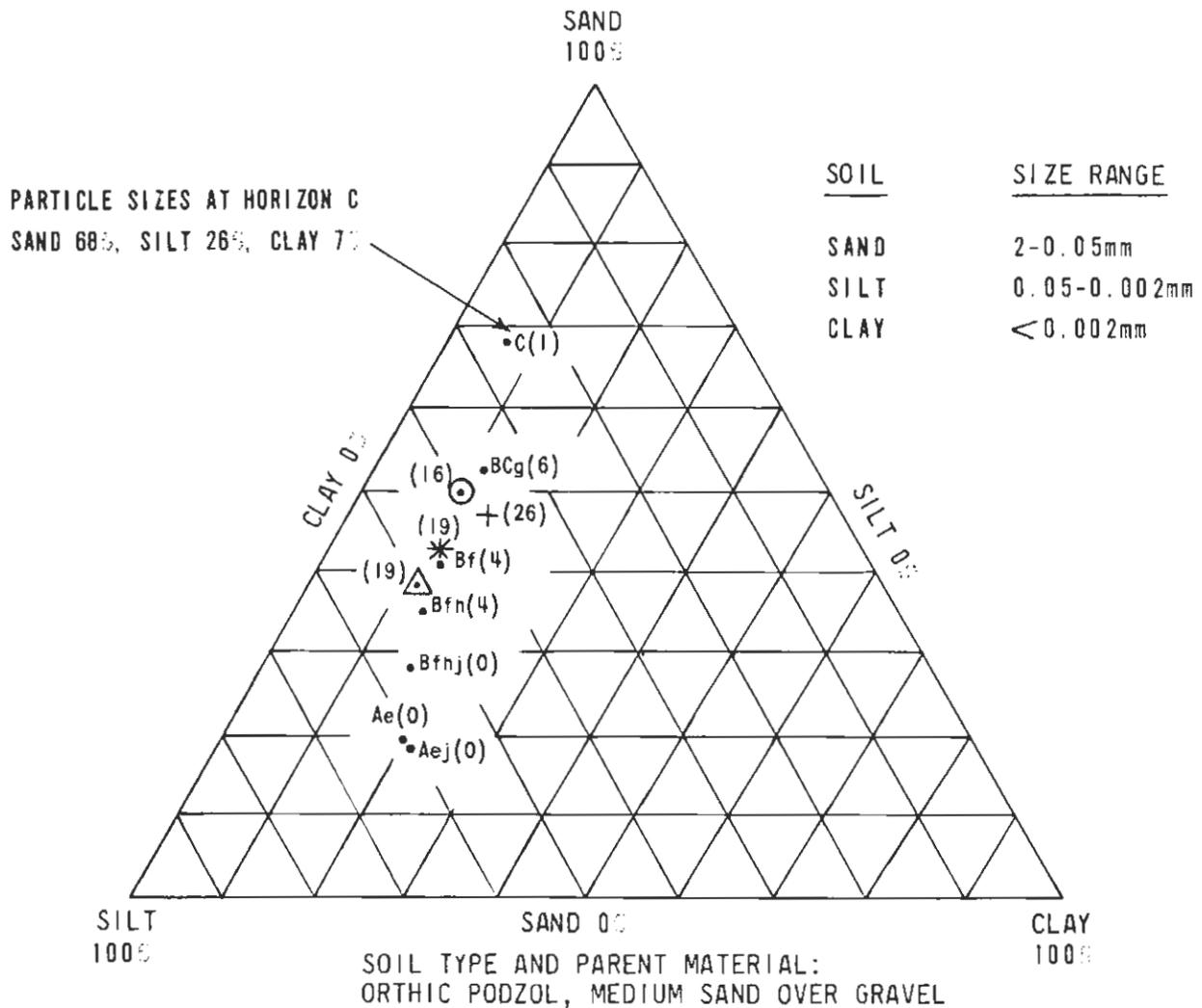
In these areas, it is probable that some patches of permafrost will exist on slopes with a northerly aspect. Additional evidence to suggest the existence of permafrost in this area is the presence of polygonal stone patterns adjacent to bulged stony slopes.

In areas of permafrost, the development of groundwater or the introduction or reduction of surface water storage will result in a change in the temperature regime in the ground. This in turn can result in changes in ground conditions that could lead to increased permeability where the temperature has risen and the permafrost melted, or decreased permeability where the temperature has fallen, allowing the formation of permafrost. The site of structures in areas where permafrost may exist, as indicated in Figures 6-2 and 6-3, should be carefully investigated.

REFERENCES

- 1 Mollard, J. D., and Munn, L. C. Report on Classes of Land in Newfoundland. Appendix I in Report of the Newfoundland Royal Commission on Agriculture 1955. St. John's, Queen's Printer, 1956.
- 2 Wells, R. Soils of the Gambo Map Area. (Unpublished manuscript). 1966.
- 3 Damman, A. W. H. Some Forest Types of Central Newfoundland and Their Relation to Environmental Factors. Forest Research Board Contribution No. 596. 1964.

NEWFOUNDLAND  
SOIL PARTICLE SIZE DISTRIBUTION DIAGRAM  
AT TWO SAMPLE SITES IN THE  
GANDER AND GAMBO MAP SHEETS

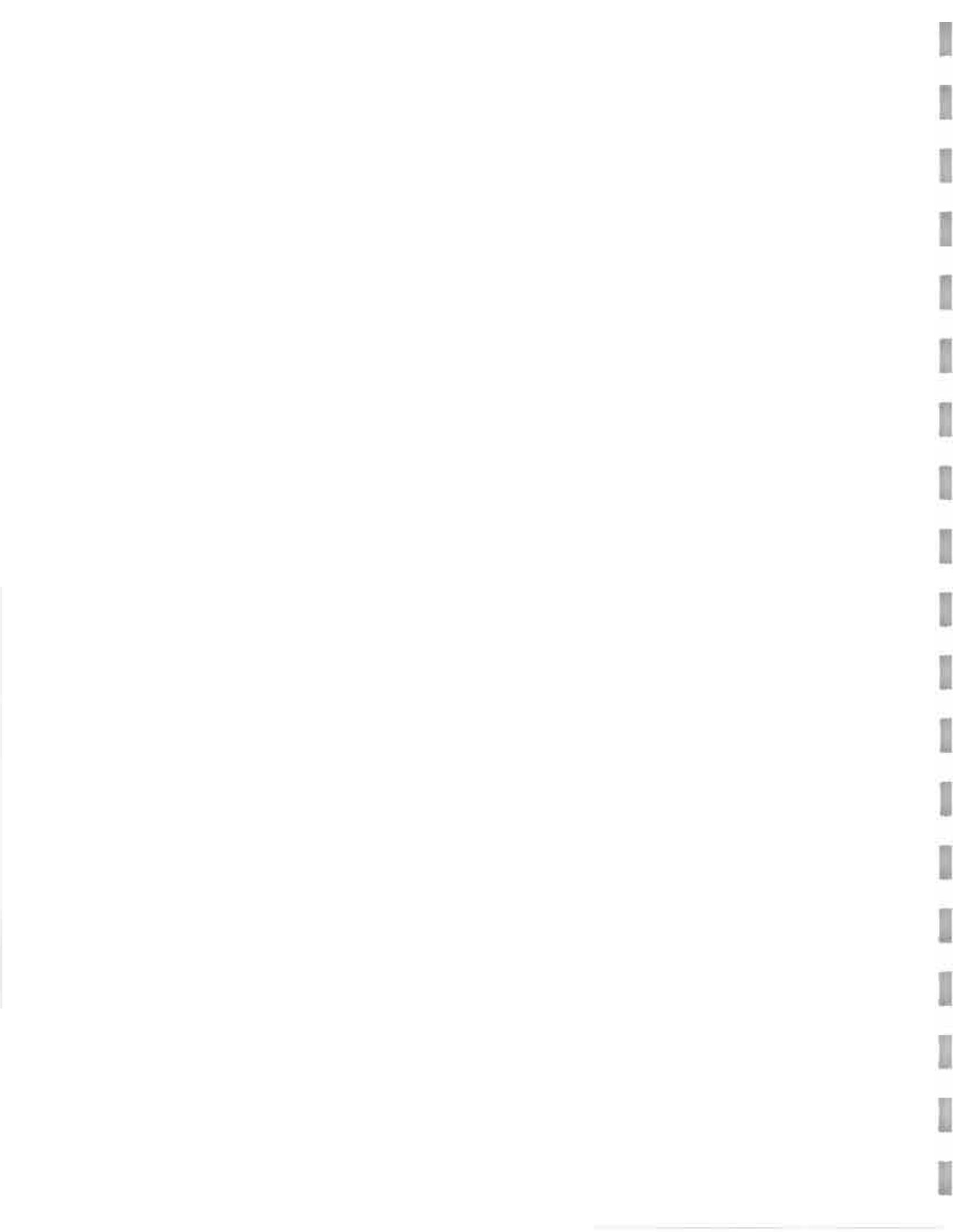


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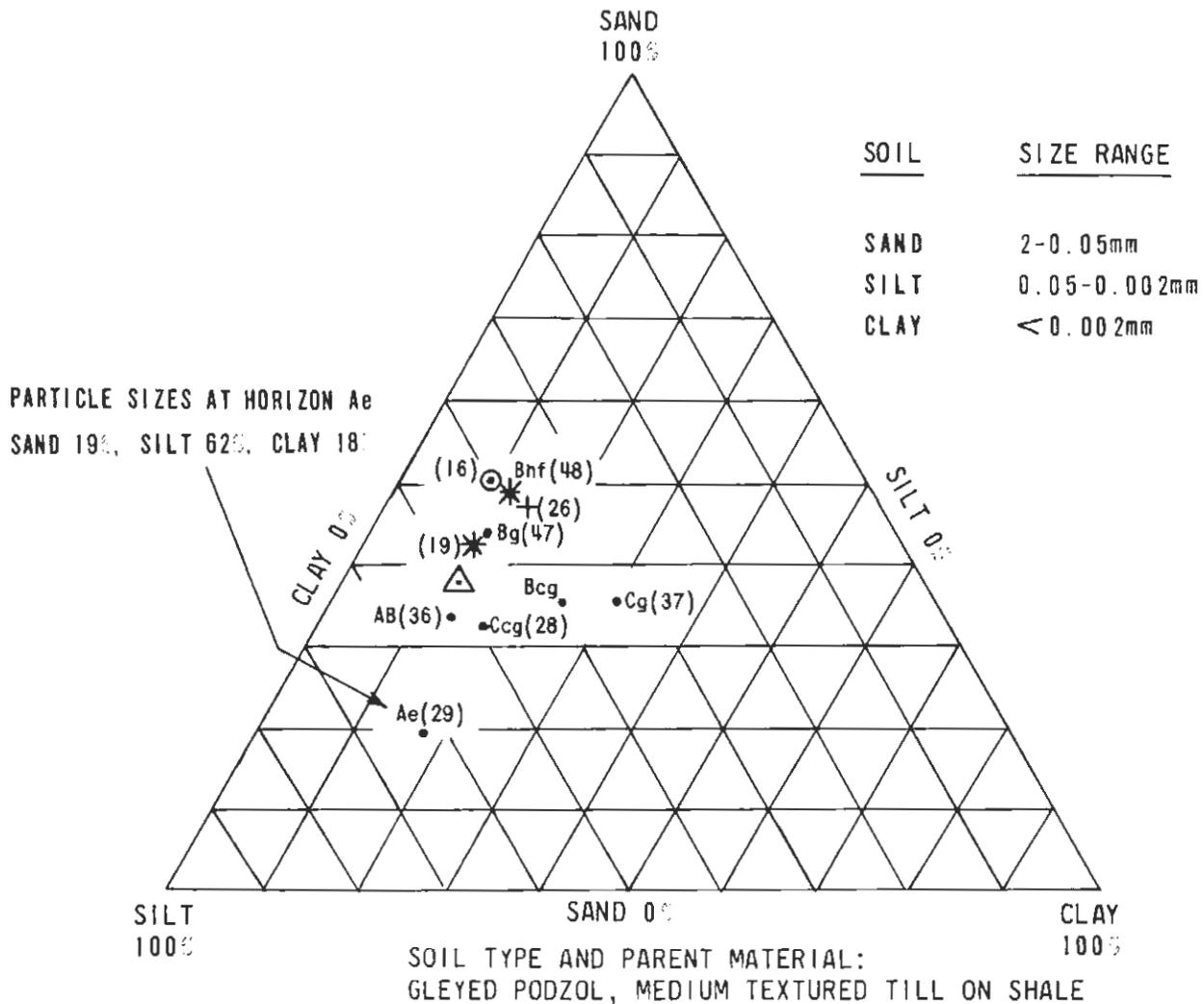
HORIZON	DEPTH IN INCHES		
Aej	0-2	•	INDICATED HORIZON
Bfnj	2-10	△	MEAN ALL A HORIZONS
Ae	10-13	⊙	MEAN ALL B HORIZONS
Bfn	13-18	+	MEAN ALL C HORIZONS
Bf	18-25	*	WEIGHTED MEAN ALL HORIZONS
Bcg	25-32	(4)	PERCENTAGE OF GRAVEL IN HORIZON
C	32-36		

SOURCE: WELLS, R. SOILS OF THE GAMBO MAP AREA  
UNPUBLISHED MANUSCRIPT 1966

FIGURE 6-1A



NEWFOUNDLAND  
SOIL PARTICLE SIZE DISTRIBUTION DIAGRAM  
AT TWO SAMPLE SITES IN THE  
GANDER AND GAMBO MAP SHEETS



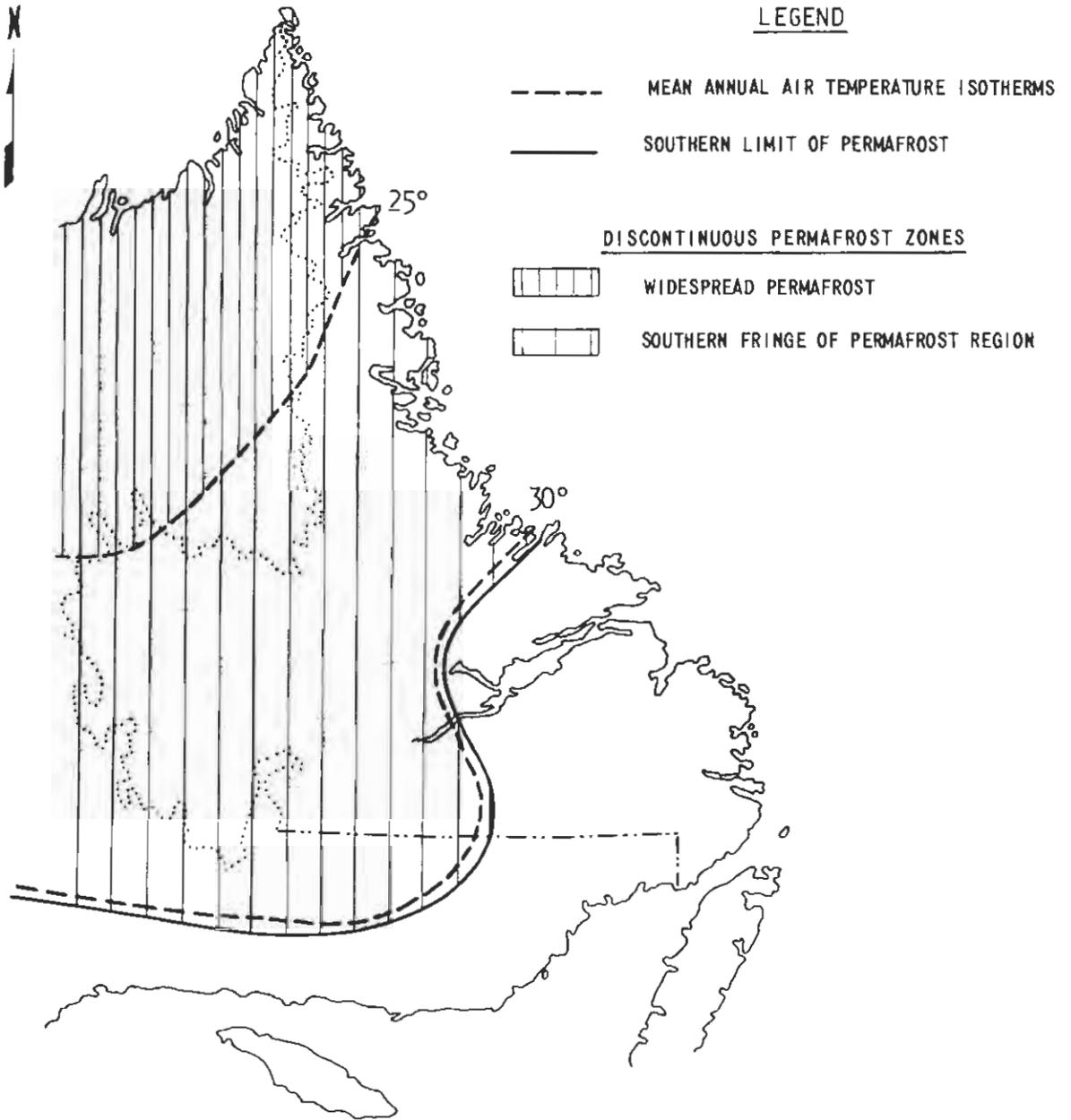
LEGEND

HORIZON	DEPTH IN INCHES	Symbol	Description
Ae	0-3	•	INDICATED HORIZON
AB	3-5	△	MEAN ALL A HORIZONS
Bnf	5-7	⊙	MEAN ALL B HORIZONS
Bg	7-10	+	MEAN ALL C HORIZONS
Bcg	10-18	*	WEIGHTED MEAN, ALL HORIZONS
Cg	18-24	(16)	PERCENTAGE OF GRAVEL IN HORIZON
Ccg	24+		

SOURCE: WELLS, R. SOILS OF THE GAMBO MAP AREA  
UNPUBLISHED MANUSCRIPT 1966

FIGURE 6-1B

### LABRADOR PERMAFROST MAP



SOURCE: PERMAFROST IN CANADA, MAP 1246A  
GEOLOGICAL SURVEY OF CANADA, IN  
CO-OPERATION WITH THE NATIONAL RESEARCH  
COUNCIL

FIGURE 6-2





RELATION BETWEEN  
 SURFACE GEOLOGY DIVISIONS OF MOLLARD AND MUNN  
 AND  
 SURFICIAL HYDROGEOLOGIC AND HYDROPETROLOGIC UNITS  
 DEVELOPED FOR THIS REPORT

<u>SURFACE MATERIAL</u>	<u>SURFACE GEOLOGY DIVISIONS</u> (Mollard and Munn 1955)	-----UNITS DEVELOPED IN PRESENT REPORT-----			<u>BEDROCK UNITS MOST FAVOURABLE FOR GOOD SOIL DEVELOPMENT</u> (Figure 4-2)
		<u>NEWFOUNDLAND</u> (Figure 5-1)	<u>AVALON PENINSULA</u> (Figure 5-2)	<u>LABRADOR</u> (Figure 3-3)	
Rock	Largely exposed rock	S1	S1	SL1	
Organic deposits	Peat bogs, muck lowlands, and ponds	S5	S5	SL5	R8, R7
Mineral soils	Ground moraine	S2	SA2		R8, R7, R6, R5
	End moraine	S3 some S2	SA3	SL2 SL3	R8, R7, R6, R5
	Glaciofluvium Recent alluvium	S4	S4	SL4 some SL7	R8, R7
	Marine sediments	S6	Absent	SL6	R8, R7, R6, R5



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PARENT MATERIAL				SUMMARY OF SOIL CHARACTERISTICS (Wells - 1966)					
Surficial (Wells)	Surficial Hydrogeologic Unit (Figure 5-1)		Hydropetrologic Unit (Figure 4-2)	PODZOLS			GLEYSOILS		
	Hydrogeologic Unit (Figure 5-1)	Bedrock (Wells)		Orthic	Orstein	Gleyed	Orthic	Rogo	Fera
Moderately stony medium textured glacial till	S2	Grey to black shale	R6	Moderately well drained Class 3 pH 4.5-4.9-5.2		Imperfectly drained Class 3 pH 4.1-4.6-4.7	Poorly drained Class 5 pH 5.4-6.7-6.9	Poorly drained Class 4 pH 4.6-5.2-5.5	
Stony medium textured glacial till	S2	Grey to black shale, siltstone and sandstone	R6	Well drained Class 5 pH 4.1-5.6-5.8		Imperfectly drained Class 5 pH 3.8-4.8-5.0			Poorly drained Class 7 pH 5.0-5.6-6.7
Stony, moderately coarse textured glacial till	S3	Medium grained grey to pink granite, plus shale, siltstone and sandstone	R1 R6	Moderately well drained Class 7 pH 4.3-5.3-5.6				Poorly drained Class 7 pH 5.2-5.5-5.6	
Stony, coarse textured glacial till	S3	Medium grained grey to pink granite	R1		Rapidly drained Class 7 pH 3.9-5.4-5.3	Imperfectly drained Class 7 pH 4.2-5.2-5.4			
Stony, coarse textured glacial till	S3	Medium grained granite, grano-diorite and diorite	R1		Well drained Class 7 pH 3.6-4.7-4.8	Imperfectly drained Class 7 pH 3.7-4.6-5.0			
Moderately fine textured, glacially modified residual shale	S1	Grey to black shale	R6	Well drained Class 7 pH 4.0-5.6-6.3					
Coarse, well stratified sands and gravel	S4	Various			Rapidly drained Class 7 pH 3.7-5.3-5.0				
Medium sands over gravel	S4	Various		Imperfectly drained Class 4 pH 4.2-4.6-5.0					

Class 3 = Moderately severe limitations for crop production  
 Class 4 = Marginal for sustained production of cultivated crops  
 Class 5 = Suitable for pasture only  
 Class 7 = Incapable of use for permanent pasture or arable culture  
 pH 4.2-5.6-4.8 = A horizon pH 4.2, B horizon pH 5.6, C horizon pH 4.8

RELATION BETWEEN WELLS' SOIL CLASSIFICATION AND SURFICIAL, HYDROGEOLOGIC AND HYDROPETROLOGIC UNITS

7      VEGETATION

Vegetation in the Province can be divided into four broad groups: forests, bogs and swamps, barrens, and agricultural crops.

7.1      Forests

The areal distribution of forests by square grid obtained from 1:250,000 scale maps is shown on Figures 7-1 and 7-2. It should be emphasized that the forest area indicated on these figures includes a large amount of bush and arctic forest which has no economic significance, but is classified topographically as forest. In the hydrologic computations the area of forest was included as shown by the topographic maps. As shown in Figures 7-1 and 7-2, the forests cover most of the northern half of the Island and the southern part of Labrador. A large part of the Avalon Peninsula is also forested. The total area of forests on the Island is 21,000 square miles and in southern Labrador (south of 56 degrees - 30 minutes north latitude), according to the available maps, there are about 88,000 square miles of forest, a good deal of which should no doubt be called scrub.

According to Ralph and Monro<sup>1</sup>, ". . .the forests of Newfoundland are composed of three main species: black spruce, balsam fir, and white birch. Also present in smaller quantities are yellow birch, aspen, white pine, red pine, larch, and white spruce".

The type of forest is closely related to the type of soil, humidity, forest exploitation, occurrence of forest fires, etc. The succession of different types of forest in undisturbed areas, after logging and after forest fires, has been studied by Damman<sup>2</sup> in relation to the type of soil and the moisture regime. His conclusions are summarized in Figure 7-3.

The same work contains an interesting relationship between the type of forest and soil moisture regime which is reproduced in Figure 7-4 because of its application from the viewpoint of water resources. Indeed using the indications included in Figure 7-4 if an areal delineation of forests according to the types indicated in the figure were available, some conclusions about the soil moisture conditions could be drawn.

The influence of forests on the hydrologic regime is discussed in different sections of Part IV. Further details about forests from the economic viewpoint can be found in Volume Three A, Section 8.

## 7.2 Bogs and Swamps (Marshes)

There is not yet a consensus about the definition of bogs and swamps in scientific literature. In this study, the definitions suggested by Damman<sup>3</sup> were accepted. According to this author a bog is ". . . a wet, extremely nutrient - poor organic site with a vegetation in which sphagnum species play a very important role, and the remains of which make up a major part of the organic horizon", and a marsh is ". . . a rich site covered with a vegetation of sedges and grasses, a vegetation of periodically flooded alluvial soil or shore vegetation of nutrient rich ponds and lakes".

Although there is a basic difference between bogs and marshes, it appears that an accurate delineation of these two formations cannot be obtained from the available 1:250,000 scale maps. Since the effects of bogs and marshes on the hydrologic regime may be assumed to be similar, the areas occupied by these two formations in river basins were considered together in hydrologic computations. The areas occupied by bogs and marshes in different portions of the Island and in Labrador are indicated on Figures 7-5 and 7-6. The total area of bogs and marshes in Newfoundland is 2700 square miles and in Labrador, south of 56 degrees - 30 minutes north latitude, 4200 square miles. Since bogs have a definite economic potential, whereas marshes are less important from this viewpoint, bogs are discussed in Volume Three A, Section 9.

Vegetation formations found in bogs are characterized mainly by a mass of white moss, heather, and scattered brushwood together with some types of sedge. More details about the plant species can be found in a report by Loddesol<sup>4</sup>. Details of the botanical characteristics of the marshes can be found in the two papers by Damman<sup>2, 3</sup>.

The influence of bogs and marshes on the hydrologic regime was difficult to determine in the Province's conditions, since the statistical indications obtained (see Part IV) are either not significant or are contradictory.

It is interesting to note that the degree of humification of a bog is closely related to its moisture content, the amount of humus being higher with the decrease in humidity. A mapping of the bog areas according to their degree of humification could therefore be helpful in estimating the moisture of the corresponding organic soil.

Bog drainage for agricultural purposes may have a local influence on the water body receiving the drainage water. Eolian soil erosion following bog drainage is also a possibility in Newfoundland's conditions.

### 7.3 Barrens

The area which is unoccupied by forest, lakes, bogs and marshes, or farmland is given the general name of barrens, and may include a large variety of geologic and vegetation formations, from bare rock outcrops to a mixture of grass, brush, scattered trees, and small bog areas.

The barrens are probably a result of the interplay of geologic, topographic, and climatic conditions, better drainage conditions being probably the main reason that an area is a barren rather than a bog. It appears that some of the earlier forests were transformed into barrens because of repeated forest fires and consequent erosion, because they were used for agriculture and then abandoned, or finally because of overcutting for fuel wood in areas close to populated centres.

The area of barrens was not included in the physiographic characteristics as such, as it represents approximately the difference between the total river basin area and the areas of lakes, forest, bogs, and marshes. The approximate distribution of barrens on the Island is shown on Figure 7-7.

### 7.4 Farmland

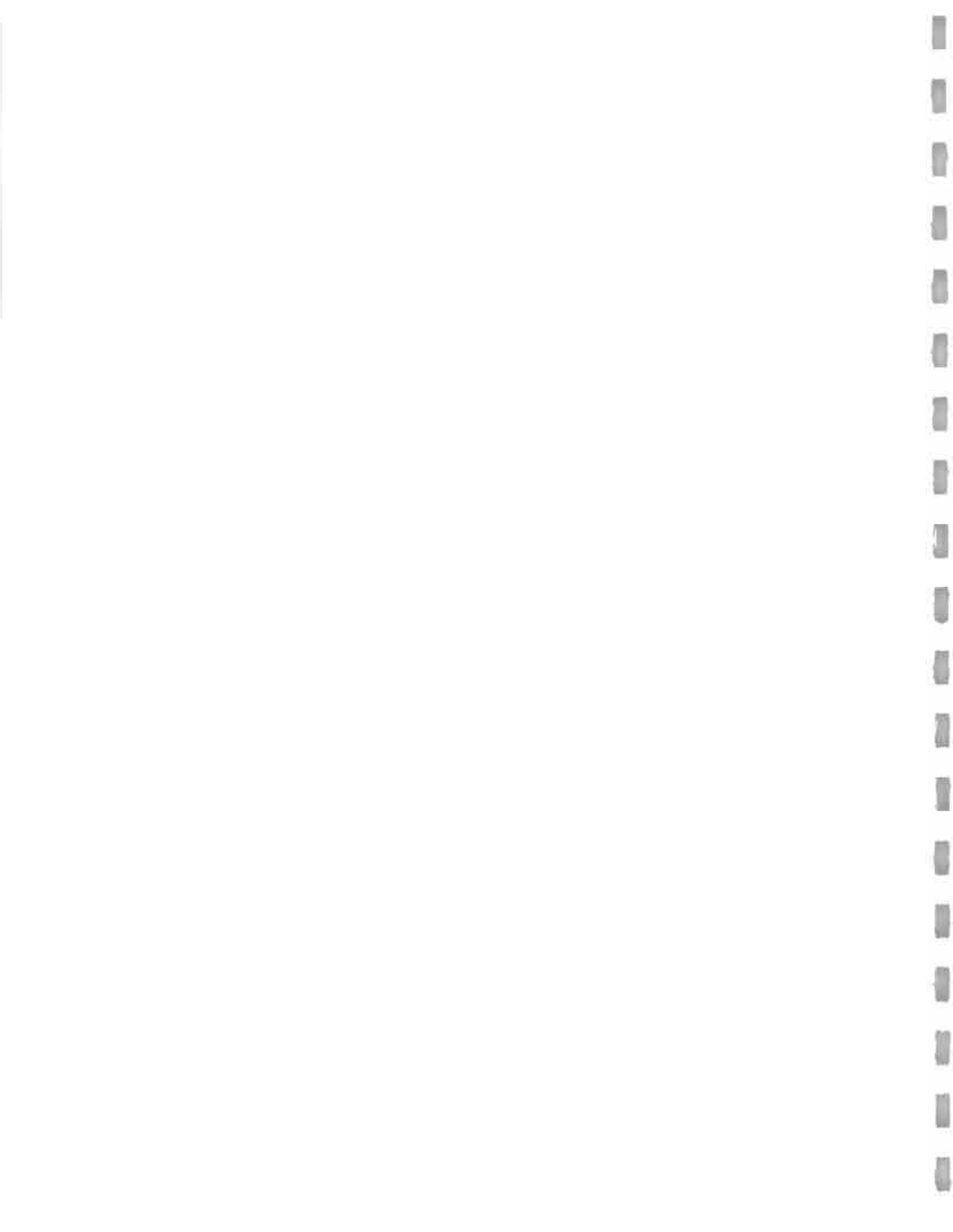
Farming is practiced only on the Island and the total farmland area is very small, namely 49,500 acres of which only 20,600 acres are improved land.

The areas where agriculture activity is more significant today are indicated on Figure 7-8. Details on the types of crops produced in these areas are given in Volume Three A, Section 9.

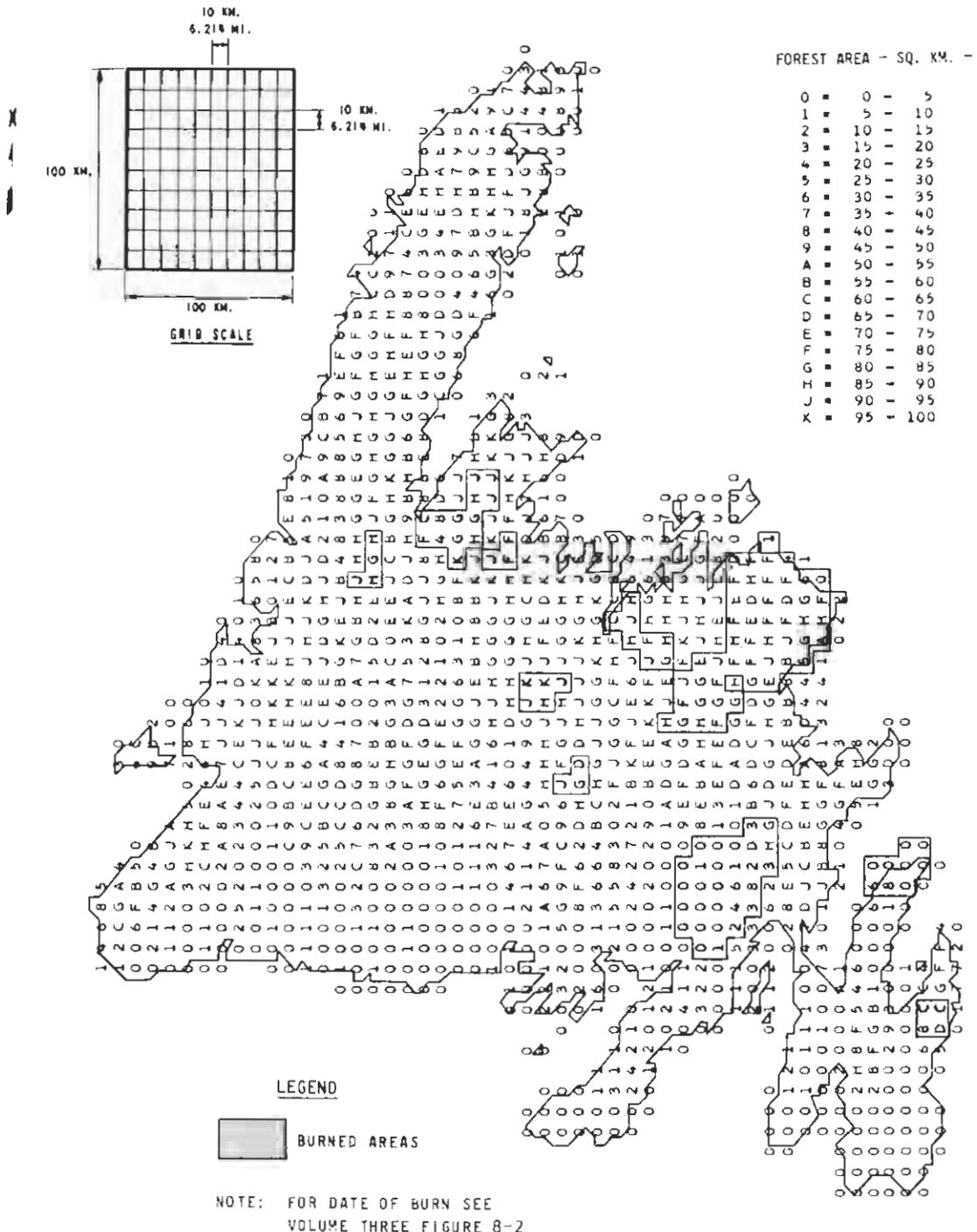
The influence of farmland on the hydrologic regime has only a local character. The most significant effect consists in increased soil erosion and sediment load. Bog drainage can also be a factor in this context, as mentioned in Section 7.2.

REFERENCES

- 1 Ralph, E. B., and Monro, J. The Forest Industries. In The First Fifteen Years of Confederation. Edited by R. I. McAllister. St. John's, Dicks & Co.
- 2 Damman, A. W. H. Some Forest Types of Central Newfoundland and Their Relation to Environmental Factors. Forest Science Monograph No. 8. Ottawa, Canada. Department of Forestry, 1964.
- 3 Damman, A. W. H. Key to Carex Species of Newfoundland. Publication No. 1017. Ottawa, Canada. Department of Forestry, 1964.
- 4 Løddestøl, A. Investigation and Utilization of the Bogs of Newfoundland. (Unpublished), 1955



# NEWFOUNDLAND SQUARE GRID DISTRIBUTION OF FOREST AREA AND MAJOR BURNED AREAS



LABRADOR  
 SQUARE GRID DISTRIBUTION  
 OF FOREST AREA

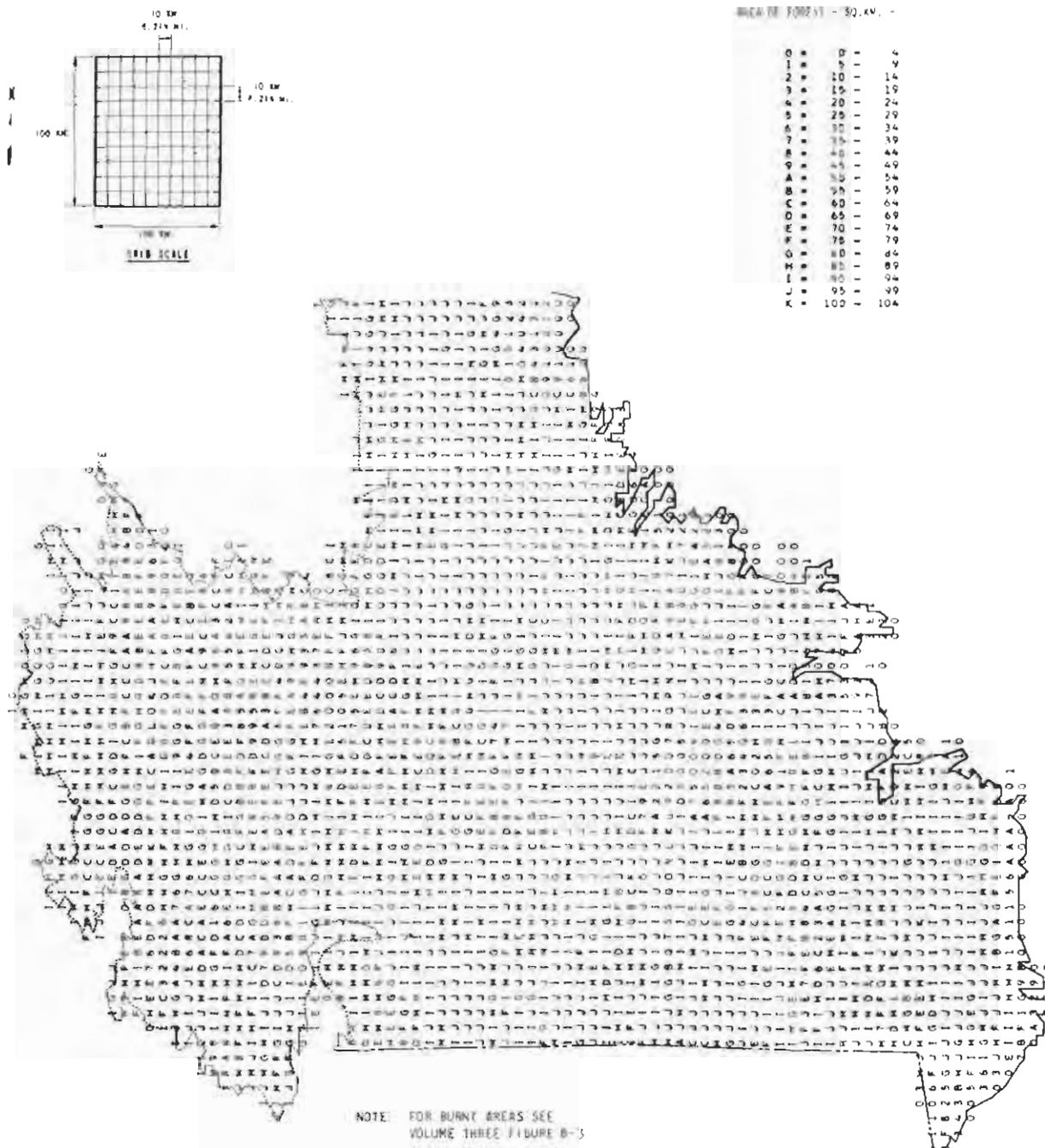
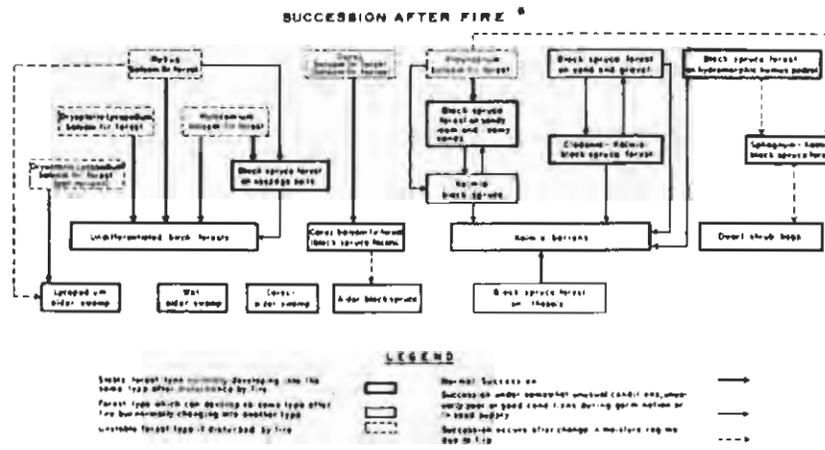
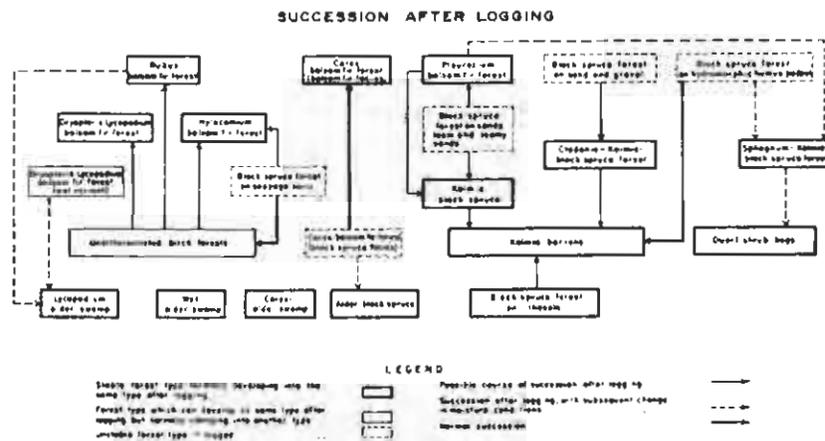
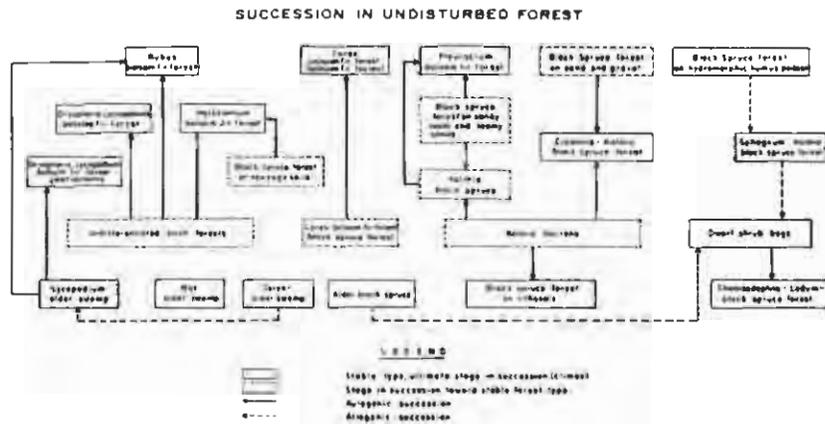


FIGURE 7-2

# NEWFOUNDLAND

## SUCCESSION OF FOREST TYPES IN UNDISTURBED, CUT, AND BURNT FOREST AREAS

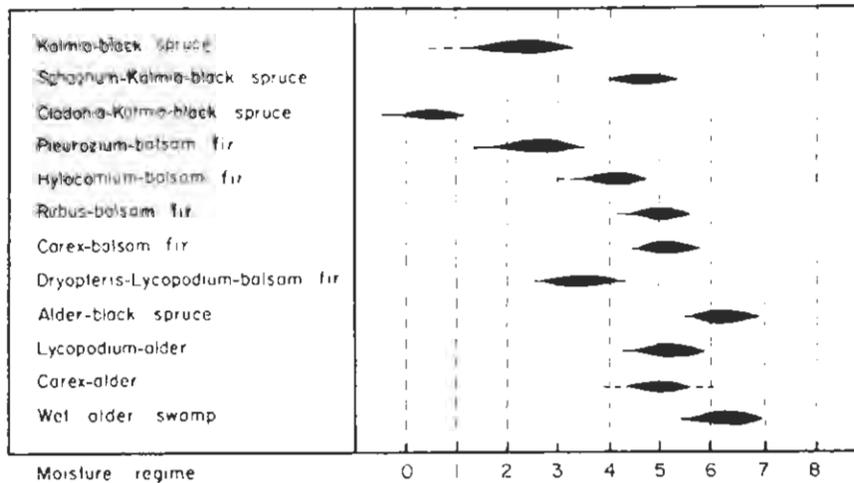


<sup>B</sup> Any 1 up of the year except after a fire in the fall of before the seed year

SOURCE: SOME FOREST TYPES OF CENTRAL NEWFOUNDLAND AND THEIR RELATION TO ENVIRONMENTAL FACTORS BY: A.W.H. DAMMAN

FIGURE 7-3

NEWFOUNDLAND  
ECOLOGICAL POSITION OF THE FOREST TYPES  
AS A FUNCTION OF THE MOISTURE REGIME



ECOLOGICAL POSITION OF THE FOREST TYPES

**Appendix I: The Moisture Regime Scale**

**Characteristic Soils of the Moisture Regime Classes**

- Extremely dry: steep eroding sands, rock piles, gravel. Lithosols, sandy and eroded regosols.
- 0—Very dry: medium and coarse sands; shallow soils. Lichen podzol (Tamm 1920), iron humus podzol (Kubiěna 1953).
- 1—Dry: deep silty sands and loamy sands. Iron humus podzol (Kubiěna 1953) and iron podzol (Tamm 1920, Kubiěna 1953).
- 2 Well-drained: deep sandy loams and loams. Iron podzol and "rich" podzol (Appendix III).
- 3—Somewhat moist: loams and sandy loams with mottling in lower part of B or C horizon. Moist variants of zonal soil types.
- 4—Moist: soil surface above the maximum water level; normal soil profile development hampered because of imperfect drainage. On mineral soils a severely mottled to homogeneous brown horizon (color B) is present. Occurs also on heavy textured soils with stagnating rain water and on dry deep peat layers. Seepage gleysoilic soils, molken podzol (Kubiěna 1953), dry peat soil.
- 5 Somewhat wet: maximum water level at or close to the soil surface. Mottling to soil surface on mineral soils. Gleysol (NSSC 1958), peat soil, peat podzol (Kubiěna 1953).
- 6—Wet: water level at soil surface for most of vegetative season. Reduced gley layer up to mineral soil surface on mineral soils; mottling usually absent or insignificant. Organic soil, (peat and muck soil), gleysol.
- 7—Very wet: water level above soil surface for most part of vegetative season. Minimum water level approximately at soil surface. Organic soil (peat and muck soil).
- 8—Permanently inundated: minimum water level above soil surface, soils permanently inundated. Sapropel, dy and gyttja soils (Kubiěna 1953).

Seepage moisture regimes are underlined, (for instance 4) whereas the moisture regimes of ombrogenous organic soils have a bar over the moisture regime figures (for instance 5).

NEWFOUNDLAND  
 SQUARE GRID DISTRIBUTION OF  
 BOGS AND SWAMPS

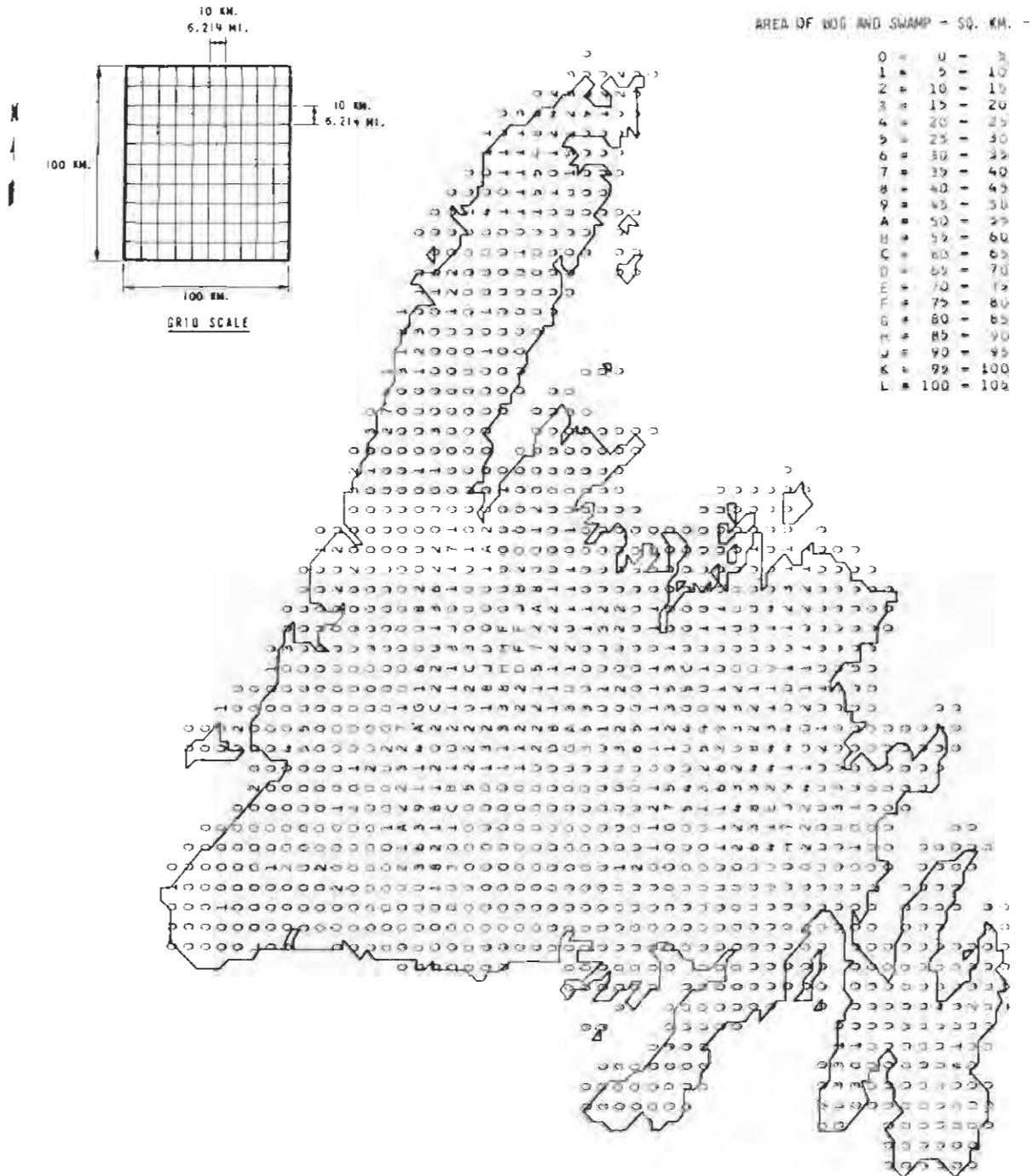


FIGURE 7-5

LABRADOR  
 SQUARE GRID DISTRIBUTION OF  
 BOGS AND SWAMPS

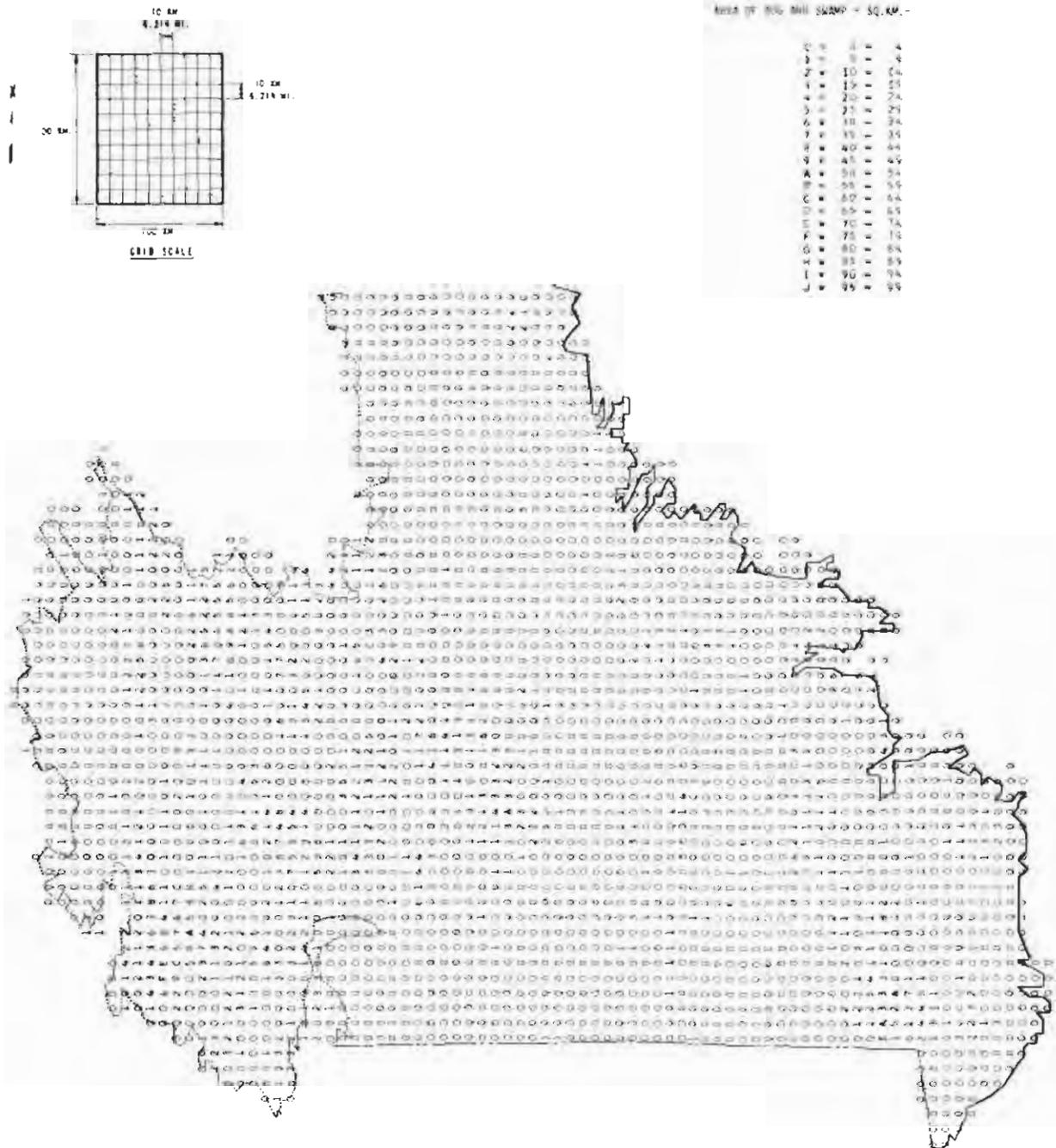
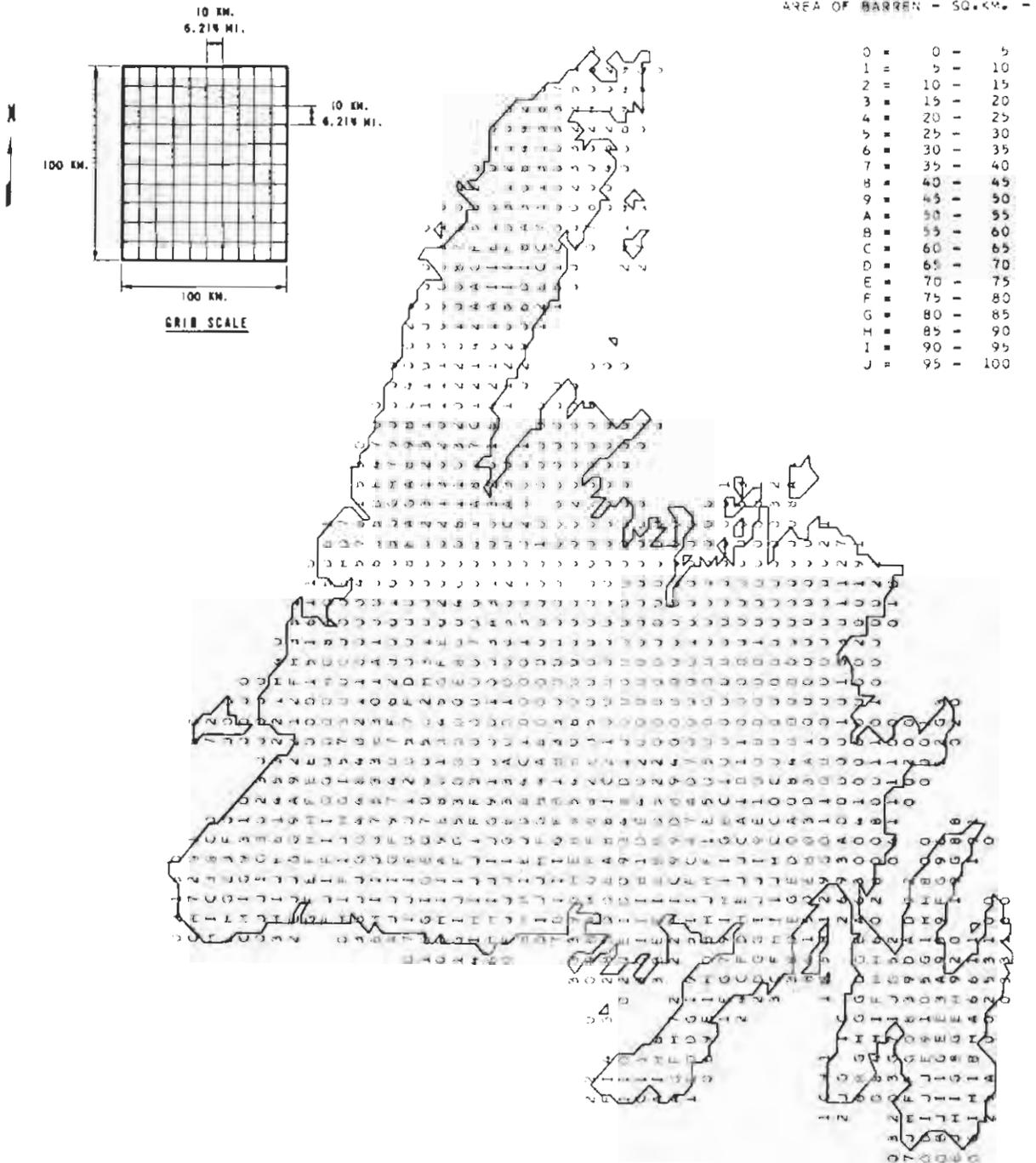


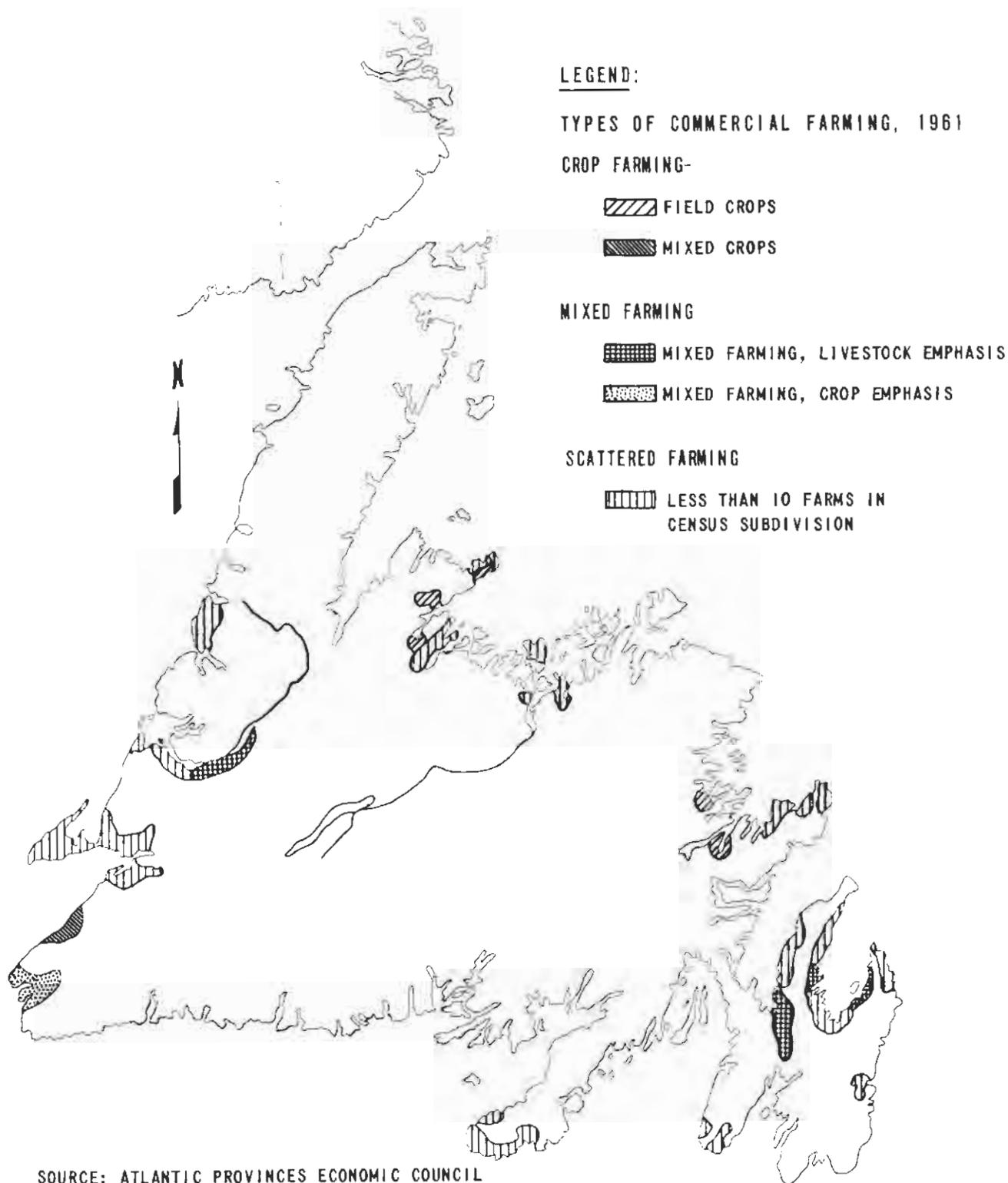
FIGURE 7-6

NEWFOUNDLAND  
 SQUARE GRID DISTRIBUTION OF  
 AREA OF BARRENS



# NEWFOUNDLAND

## AREAS WITH COMMERCIAL FARMING



SOURCE: ATLANTIC PROVINCES ECONOMIC COUNCIL

NOTE: BASED ON 1961 DEFINITION, A COMMERCIAL FARM IS A CENSUS FARM WITH ANNUAL SALES OF AGRICULTURAL PRODUCTS OF \$1,200 OR MORE

FIGURE 7-8

8 CLIMATE

Since climate has a decisive influence on other natural conditions, primarily on hydrology and hydrogeology as well as on economic activity, special attention has been paid to it in the framework of this study.

Climatic studies were based to a large extent on studies made by different agencies, especially the Meteorological Branch of the Canada Department of Transport. These studies were complemented where necessary by further investigations by the project team or the Meteorological Branch on the basis of a special agreement with this agency. This refers especially to studies on maximized storm precipitation and seasonal snowfall, and critical spring temperatures for the computation of snowmelt.

The distribution of mean annual temperature and precipitation has been investigated in more detail than other climatic characteristics in connection with the runoff distribution for the whole Province. A rough estimate of actual evaporation has also been obtained. Other climatic characteristics were studied in more depth for the Island than for Labrador because of lack of data for the latter area. However, even for the Island, most of the data are incomplete and the conclusions and generalizations included in this study are considered to be preliminary.

Whenever possible data were computed over a climatological study period selected to coincide with the hydrological study period which is, for reasons indicated in Section 15, October 1939 to September 1966.

8.1 Climatologic Network

The first climatological gauging stations in Newfoundland date back to 1871 when four stations were installed at Belle Isle, Forteau, Harbour Grace, and St. John's. In 1967 there were 57\* stations operating in the Province as a part of the Canadian climatologic network, of which only ten were in Labrador (Figures 8-1 and 8-2, Table 8-1). This represents an average of one station per 2800 square miles for the whole Province, one station per 915 square miles in the Island, and one station per 11,200 square miles in Labrador compared with an average of one station per 1500 square miles for the whole Canadian network. According to the World Meteorological Organization guidelines<sup>1</sup>, the norms of gauging stations tolerated under difficult conditions for an island with very irregular precipitation and a very dense hydrographic network (a situation which closely approximates the Island's conditions) indicate a minimum density of one station in about 370 square miles (1000 square kilometers). Under very difficult conditions this may be extended to 750 square miles (2000 square kilometers). For arid and polar zones the minimum density recommended is one station in about 3700 square miles (10,000 square kilometers). This indicates that both the Island and Labrador are lacking a bare minimum of climatological stations. The situation is actually worse than that indicated by the density figures, because of the concentration of the stations in coastal areas.

The density of the climatologic network of the Province has increased very slowly in the last three decades, and its position compared to the overall Canadian network has deteriorated during this period, as shown in the following table<sup>2</sup>.

\* According to the information available, in addition to the main network operated by the DOT Meteorological Branch, there are four additional stations operated by different companies. Only some data from these stations were included because the data were not in a readily usable form. However, data from the station at Corner Brook Lake, kindly provided by the Bowaters Pulp and Paper Company, were used to check data at other stations and results obtained from the general precipitation analysis. Snow course data were also available as shown in Table 8-17. Most useful in the analysis were data on snow courses carried out by the Bowater Power Company.

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Year	Climatological Stations		Percent in Canadian Network $100 \times (3)/(2)$
	Canada (total)	Newfoundland and Labrador	
(1)	(2)	(3)	(4)
1867	12		0
1877	105	8	7.6
1887	301	4	1.3
1897	313	7	2.2
1907	339	7	2.1
1917	605	9	1.5
1927	804	11	1.4
1937	955	41	4.3
1947	979	35	3.6
1957	1741	50	2.9
1967	2385	56	2.3

Table 8-1 contains a list of the climatological stations with their geographic position, elevation, and observing program, as well as the periods of record. Many stations of the earlier years of settlement have long been abandoned and their records are short. According to Potter<sup>2</sup> the following table summarizes the length of record at stations operating at the end of 1966 for the different types of observations.

Type of <u>Observation</u>	Number of Stations		Period of Record (years) Newfoundland-Labrador			
	<u>Canada</u> Dec 1966	<u>Nfld &amp; Lab</u> <u>Dec 1966</u>	<u>10</u>	<u>30</u>	<u>60</u>	<u>90</u>
Temperature Extremes	1704	45	42	15	3	1
Precipitation	2266	52	46	15	3	1
Rainfall Intensity	299	4	1			
Soil Temperature	41	2				
Evaporation	72	0				
Sunshine	203	7				
Radiation	27	2				
Upper Air	34	3				
Snow Survey*	82	3				

In addition, at the end of 1966 at 18 stations in the Province, observations of pressure, humidity, cloud cover, visibility, and wind were also obtained.

## 8.2 Analysis of Available Information

The climatologic information presently available is inadequate for a complete analysis of the climatic conditions of the Island as required for a comprehensive water resources study. The data are not adequate either from the quantity or quality aspect. The quantitative aspects were discussed in Section 8.1.

\* A complete list of snow course stations is included in Table 8-17 for Newfoundland and Labrador.

From the qualitative viewpoint the difficulties are related to:

- a) Inadequate distribution of stations, which results in lack of information in the interior of the Province and especially at higher elevations.
- b) Incorrect observations over long periods at some stations (see excerpts from the Department of Transport letter of August 18, 1967, at the end of this section).
- c) Approximations in the determination of precipitation during the winter by measuring snow depth and assuming a snow density of 0.1.

Since this last problem affects all stations of the Province (although measures to correct the situation at some stations were initiated in the early sixties), this deserves further discussion.

As indicated by Thomas<sup>3</sup>, "... depth of snow observations cannot be reliable since this meteorological parameter is perhaps one of the most difficult to measure. The quality of fresh snowfall varies widely from fluffy and light to wet and heavy. If snow occurs with quiet, calm conditions, the amount of fall is relatively easy to measure by taking several sample probes and averaging the results. More often, however, there is blowing and drifting and the observer has to average out the depth in drifts with the wind-swept bare spots. In blizzards there is always a question of whether snow is actually falling or is merely being transported horizontally along the ground by the wind, and there are also the days when the snowfall melts soon after it falls, perhaps before the observer can make the proper measurements. "

Besides the difficulty of measuring the snow depth, there is a serious error in assuming a snow density of 0.1. While this value might be correct on the average, it is obvious that it varies greatly in time and space. It can be assumed that the density is larger than 0.1 in more humid areas, as is the case of the Island. An illustration of the effect of the approximation made in estimating snow density is given in Figure 8-3, which is reproduced from a paper by Potter<sup>9</sup>. The figure indicates that, according to the preliminary investigation of this problem, the Province of Newfoundland and Labrador was the area in which the largest underestimation of the water content of snow occurred in the past.

Because of the circumstances described above, a special technique was developed to obtain more reasonable and Province-wide estimates for at least the main meteorological characteristics, as shown in Section 8. 6.

The meteorologic data used in this study were made available by the DOT, Meteorological Branch<sup>4</sup>. This information was supplied in two forms: as partially published data and on punch cards.

A description of the information included in these cards is given in the DOT, Meteorological Branch card library<sup>5</sup>. The data included in the cards were screened for errors. Additional checks were done for this study by means of correlations and double-mass techniques only for the stations indicated by the Meteorological Branch as having possible erroneous data. As a result of these checks some of the data were completely discarded (precipitation data at Gull Pond and Rattling Brook Norris Arm), and others were used only partially to the extent to which the checks did not indicate significant errors.

Because of the inadequacy of the climatologic data available, a significant improvement of the network is considered necessary. Recommendations on this subject are included in Section 8. 9.

The results of the evaluation of the quality of data of the stations with doubtful records is included in the following excerpt from a letter of the Department of Transport of August 18, 1967:

"Baie Verte - There was a change in location at this station in 1963 with a move of approximately three miles and a change in elevation at the site from 15 to 362 feet. The first site was near a pulp and paper mill\* and the present site is at the Advocate Mines. Different members of the staff apparently take observations as part of their duties and the result has been a variable record depending on the interest of the individual on duty. Thus throughout the record there are many months where the precipitation is incomplete due to poor observers missing observations.

"Colinet Peatbog CDA - This is a sub-station of the Canada Department of Agriculture Experimental Farm at St. John's West. Since 1962 it has been run as a summer program with observations normally only for the period June to October. The observations of rainfall have been generally fair to good, but should be used with some caution as our records indicate that the observers have made many errors in reading the thermometers.

\* The site referred to as a pulp and paper mill was actually a shipping depot.

"Goose Rawinsonde - At Goose Airport the sites of the surface observations and the upper air observations are at a considerable distance, and formerly the surface observations were taken by Canadian personnel and the upper air observations by the U. S. Air Force. In our catalogue these have been carried as two separate sites. You will notice that no surface temperatures or precipitation are available from Goose Rawinsonde.

"Gull Pond - This station was established on the property of the Gull Bridge Mines and the observations are taken by the mines' staff. During the operation there have been different observers each year and the data are quite variable with precipitation incomplete for many months due to missing observations.

"Hearts Content, New Chelsea, Rattling Brook Norris Arm, Seal Cove, Topsail and Westbrook St. Lawrence - All these stations were originally established by the Newfoundland Light and Power Company\* at their installations and reported to their St. John's office. Originally arrangements were made through their Head Office for the observers to also furnish reports of their observations to the Meteorological Branch. In most cases it was found in the early reports that the observers were either not measuring snowfall or reporting very low amounts, and tended to disregard small amounts of precipitation. Thus in the published record and punched cards for these stations there will be months when the totals are incomplete or all the precipitation data for a month were not transferred to punched cards and published. In this group of stations the more reliable data are likely available for Rattling Brook Norris Arm and New Chelsea, and the least reliable from Topsail. "

### 8.3 Radiation and Temperature

Radiation data are useful for estimating indirectly potential and actual evaporation. In the Province's conditions this is difficult since solar radiation measurements are made only at St. John's West CDA and Goose Airport and only since June 1966. Table 8-2 gives a summary of the results of these measurements.

Radiation can be estimated well enough, however, from data on cloud cover as shown in Figure 8-4. The formula indicated in the figure could be used to expand radiation data at stations where cloud cover records expand over a longer period. This can be very helpful in estimating radiation in the Province, since at present there are 18 stations recording cloud data.

\* With the exception of Rattling Brook Norris Arm, these stations were established by United Towns Electric, a predecessor company.

Data on temperature were available at 112 stations, 88 stations on the Island and 24 in Labrador (Table 8-1). Out of these, 33 stations with reliable data and a reasonable length of record period were selected on the Island and 13 in Labrador for further reference. These stations are given in Table 8-3, and their location is shown in Figures 8-1 and 8-2. Missing records were synthesized for the hydro-meteorological study period (1939/40 to 1965/66) by correlations established on the basis of monthly averages. The mean monthly temperature correlations at two stations even when located many miles apart are generally very good (Figure 8-5).

The long term mean annual temperature is a climatic characteristic of special significance in hydrologic computations since it is one of the factors influencing evaporation. In the hydrologic computations, these data are required in their areal distribution and, to obtain them without introducing the possible bias involved in tracing isotherms on the basis of data at stations only, the following approach was used:

- a) The mean annual temperature for the hydro-meteorologic study period was computed at each selected station (Table 8-3).
- b) For the Island, a correlation was established between the physiographic characteristics at each station and the corresponding mean annual temperature (Table 8-4). The coefficient of correlation is 0.86 which, for the number of data (30) and variables (5), is significant at 1 percent level. The coefficients of the variables included in the correlation have the sign corresponding to their possible physical influence on the mean annual temperature, and are statistically significant at the 1 percent level.
- c) For Labrador, a similar procedure was used but, because of the scarcity of data, the correlation was based not only on the Labrador stations but also on the isotherms traced by the DOT and included in a working paper (Figure 8-7a), which were used as data having a weighting factor 100 times lower than the station records. The correlation between temperature and physiographic characteristics for Labrador is shown in Table 8-5.
- d) The above correlations were used with the data file on grid physiographic characteristics (see Volume Eight, Appendix A) to estimate the mean annual temperature in each grid square. The results of the computation are shown in Figures 8-6b and 8-7b.

The mean annual isotherms derived recently by the DOT, Meteorological Branch are shown on Figures 8-6a and 8-7a. By comparing the two sets of figures, it becomes obvious that there is a similar pattern in regions without too varied a topography. However, in the more rugged regions, in the Long Range Mountains area especially, a more detailed relationship with the topographic features can be obtained by the suggested approach.

Average, minimum and maximum mean monthly and annual temperatures at different stations of the Province for which data were available for the study period (1939/40 to 1965/66) are given in Table 8-5.

Boughner and Thomas<sup>6</sup> characterize the temperature variation in the Province in the following way:

"Winter temperatures in Newfoundland are noteworthy for the coldness of the interior, the mildness of the coasts, and the variability of the day-to-day temperatures. January mean temperatures vary between 15 and 20 deg F in the interior and increase to 25 deg F on the southeastern coasts. Following a late spring, summer is usually brief but pleasant. July mean temperatures are above 60 deg F in the interior but the cool Labrador Current holds the mean temperature to slightly in excess of 55 deg F along the southern and eastern coasts. Hot spells occur occasionally during the summer and maxima of 85 deg F are not unusual along the railway belt across the interior. Temperatures decline rapidly in autumn, falling more quickly in the north than in the south, thus ending the anomalous flat distribution of temperature across the Island typical of summer. The Long Peninsula presents a remarkable gradation in climate. At the southern end temperatures are representative of the central interior but at Belle Isle the mean July temperature is only 49 deg F as a result of the cold Labrador Current which is often ice-laden even in mid-summer.

The climate of all Labrador is severe, the yearly mean temperature for the whole area being below freezing. Along the coast January mean temperatures range from zero in the north to 10 deg F in the south and are lower than - 10 deg F in the most westerly part of the interior. Summer temperatures are cool along the coast owing to the influence of cold offshore waters, ranging from 45 deg F to 50 deg F in July, but are 5 and 10 deg F warmer in the interior. Goose Airport with a mean July temperature of 61 deg F has recorded an extreme summer maximum of 100 deg F and an extreme winter low temperature of -38 deg F."

If separation of the year into seasons was made, according to the temperature data, the length of the four seasons would be as follows:

<u>Season</u>	<u>Temperature Limits</u> (mean daily temperature)	<u>The Island</u>	<u>Labrador</u>
Winter	below 32 deg F	Dec, Jan, Feb, March	Nov, Dec, Jan, Feb, Mar, Apr.
Spring	between 32 and 42 deg F	April, May	May
Summer	above 42 deg F	June, July, Aug, Sept, Oct.	June, July, Aug, Sept.
Autumn	between 42 and 32 deg F	Nov.	Oct.

This unequal season duration was not used in the study since it makes comparisons with other regions difficult.

The mean duration of the frost-free season varies widely in the Province. In the Island, along the south seacoast, the frost-free season ranges from 140 to 150 days with the Burin Peninsula the most favoured area. On the Avalon Peninsula, the frost-free interval ranges from 110 to 140 days. In the interior of the Island, the season averages 100 days or less. The average fall frosts occur in the middle of October and the last frosts in early June. In Labrador, along the seacoast, the frost-free period extends to almost 100 days in the south, gradually decreasing to 40 days in the north. Goose Bay has an average frost-free period of 96 days. In the interior, Sandgirt Lake has an average frost-free period of 84 days based on a short record. The average fall frosts occur in the middle of September and the last frosts in the middle of June.

The computation of snowmelt for flood estimates requires the assessment of maximum temperature sequences during the spring. Although an accurate computation would require applying associate probability data to these sequences, since estimates of maximum sequences were already obtained by the DOT as envelopes of maximum recorded data<sup>7, 8</sup>, these results were accepted in the study (Figure 8-8).

#### 8.4 Air Pressure and Winds

Atmospheric pressure is of little climatic significance in itself, but it controls the movements of the atmosphere and thereby most of the climatic characteristics of an area. The mean, monthly and annual sea level pressures at 14 stations in the Province having data for recording the period 1952 to 1965 have been used to estimate the average annual and seasonal isobars (Figure 8-9). The winter and spring sea level pressures are lower than the average and present a complicated pattern related to the influence of the mass of land and the ocean. The summer and fall pattern is more definite indicating a gradual decrease in the pressure from south to north, leading to the conclusion that the main air movements originate from the southeast and southwest. This is also indicated by the mean annual variation of sea level pressure.

Mean, maximum, and minimum monthly and annual sea level pressure at 25 stations in the Province for the period of record are shown in Table 8-7.

A summary of wind data at one station is shown in Table 8-8. These data include monthly and annual peak wind velocity and direction, average peak wind velocity, and most frequent direction of peak winds for the period of record. Data on wind characteristics for three stations in the Province, St. John's-Torbay Airport, Gander Airport, and Goose Airport are included in Reference 16. The reference provides long term (30 years) monthly average data on the direction and percentage of most prevalent winds, and on the wind velocity. If these latter data were characteristics for the whole Province, it could be inferred that the prevailing winds across the Island are from the west in the winter and from the southwest in the warmer part of the year. However, air pressure indications are that winds from the southeast can also be prevalent in some areas. The mean wind speed varies between 11 and 19 miles per hour. In Labrador, the prevailing winds are westerly from September to February, northeasterly from March to June, and southwesterly from July to August. Average wind speeds are between 8 and 11 miles per hour. However winds with a velocity up to 120 mph have been recorded on the Island.

## 8.5 Humidity

Humidity is generally very high both in the Island and in Labrador. Table 8-9 shows the average, maximum, and minimum mean monthly relative humidity at 17 stations in Newfoundland and 9 stations in Labrador. It indicates that the annual average relative humidity does not reach values lower than 82 percent in the Island and 80 percent in Labrador. The minimum mean monthly humidity does not go lower than 64 percent in the Island and 56 percent in Labrador for the whole period of record. The relative humidity decreases slightly in summer in the interior, but this is obviously only a reflection of higher temperatures rather than of lower absolute humidities. On the seacoast the relative humidity varies little.

Figure 8-10 shows the approximate variation of the average annual relative humidity (at 8:00 a. m. ) in the Province. The little variation indicated by the map reflects the influence of the ocean and land on relative humidity, as well as of the many bodies of water scattered all over the Province.

Because of the high humidity and rapid drops in temperature, rime deposition is heavy and frequent.

## 8.6 Precipitation

This is the most significant climatic characteristic from the viewpoint of water resources. Average precipitation is the most important factor determining runoff. Variation of precipitation within an area gives an indication of storage requirements. Differences in precipitation in neighbouring areas might indicate the advantages of diversions. Storm precipitation and snow accumulation are important factors determining the peak flow and volume of floods. Finally, the drought duration is the main factor determining minimum flows.

### 8.6.1 Mean Annual Precipitation

Data on precipitation were available at 120 stations - 97 in the Island and 23 in Labrador (Table 8-1). Of these, 46 stations with more reliable data and a reasonable record period were selected for further reference, 35 in Newfoundland and 11 in Labrador (Table 8-3).

Checks for reliability and synthesis of missing data by correlation were done when considered necessary in the same way as for temperature data (Section 8.3). It should be emphasized, however, that correlation of monthly precipitation at two stations which are even less than forty miles apart is generally weak (Figure 8-11). However,

the correlation coefficient of all correlations used was significant, at least at the 5 percent level. Whenever required, the data at one station were correlated with the data at two or more neighbouring stations. Correlations were used mainly to complete long term averages. Their use for completing missing monthly records should be made very cautiously, and it is obviously out of the question to complete the daily precipitations by correlations.

The correlations were used to complete the mean annual precipitation at the 46 stations - 35 in the Island and 11 in Labrador (Table 8-3).

The distribution of the mean annual precipitation, an important meteorologic characteristic, was recently (1967) plotted by the DOT, Meteorological Branch, for the whole country. The portion of the map covering the Province is shown in Figure 8-12a. Since the isohyets drawn on this map are too general for the purpose of this study, and because of lack of consistency between the precipitation and runoff data (Section 16), it was decided to attempt a more accurate and consistent distribution. For this purpose the following approach was used:

- a) For the Island, a preliminary correlation was established between the mean annual precipitation at stations and a series of physiographic characteristics (Table 8-10). The coefficient of correlation is 0.89, which, for the number of data (33) and variables (7), is significant at the 1 percent level. The coefficients of the variables included in the correlation have the sign corresponding to their probable physical influence on the mean annual precipitation. All the coefficients are significant at the 1 percent level except distance to the sea in a southwest direction which was nevertheless maintained in the correlation because the general pattern of air mass circulation indicates that many storms on the Island come from this direction.
- b) For Labrador, a similar approach was used to obtain a preliminary relationship between precipitation and physiographic characteristics. However, because of the scarcity of data, in addition to the data recorded at the Labrador stations, the indications from the preliminary isohyets contained in the maps prepared by the DOT were also used in Figure 8-13a, Map B. The latter were considered with a weighting factor 100 times smaller than the actual records. The equation of the correlation between precipitation and physiographic characteristics is shown in Table 8-11. The results obtained in this way for Labrador are less reliable than those obtained for the Island.

- c) The above correlations were used with the data file on grid physiographic characteristics to make the preliminary estimate of the mean annual precipitation in each grid square. The results of the computation are shown in Figures 8-12B, Map C and 8-13B, Map C.
- d) Comparison of Figures 8-12B, Map C and 8-13B, Map C with runoff data shows a better consistency than Figures 8-12A, Map B and 8-13A, Map B. However, since this consistency is not completely satisfactory, further investigation was done using a special approach of combining hydrologic and meteorologic information described in Section 16. As a result of these investigations, three correlation equations (for the western and eastern regions of the Island and for Labrador) have been established relating the mean annual precipitation to the physiographic characteristics (Tables 8-12, 8-13 and 8-14). These correlations have been used with the file on grid physiographic characteristics to produce the mean annual precipitation shown in Figures 8-12B and 8-13B.

Although the very high precipitation around 100 inches, obtained at very high elevations, around 2000 feet, appear justified by rapid increases of precipitation in certain areas with similar topography, a check by direct gauging stations installed at high elevations is considered necessary.

#### 8.6.2 Annual Precipitation Variation

The variation of annual precipitation at four selected stations in the Island and two selected stations in Labrador is shown in Figure 8-14A. The figure indicates significant variations of the annual precipitation around the mean during the period of record (from 68.5 percent up to 135 percent at St. John's, and from 74 percent up to 141 percent at Cartwright). It also shows that the minimum and maximum annual precipitations do not generally coincide at various stations, indicating the possible usefulness of interconnected systems in drought periods. Figure 8-14B represents the empirical probability curves of the annual precipitation for the same stations. The figure indicates that it can be assumed that the annual precipitation has a log normal distribution. Annual precipitations with different probabilities can be read directly from Figure 8-14B.

### 8. 6. 3 Monthly Precipitation Variation

A summary of recorded monthly precipitation in the Province is given in Table 8-15. It shows that the precipitation variation in a month around the mean is large, making predictions based on a seasonal pattern very unreliable. The average distribution of the mean monthly precipitation at selected stations in the Province, based on the records available, is shown on Figure 8-15. It indicates that the largest monthly precipitation occurs on most of the Island in November (exceptionally in October or December), while the minimum occurs in spring or summer as follows: in June (exceptionally July) in the Avalon and Burin Peninsulas; in April (exceptionally in May) on the northeast seacoast; in March-April on the west and southwest seacoast and to a large extent also in Labrador. This again points out the possibility of obtaining advantages from the proper operation of interconnected electrical systems using water resources.

### 8. 6. 4. Storm Precipitation

A summary of storm precipitation data in the Province is given in Table 8-16. An attempt was made to produce storm precipitation - frequency - duration - area relationships. However, due to the scarcity of data, this attempt was limited to estimates of maximum in 24-hour point precipitation for frequencies up to 1/20 years (Figure 8-16). Maximum storms for flood computations required for this study have been based on a series of storm maximization studies done by the DOT, Meterological Branch<sup>7, 8</sup>.

On the basis of these studies, maximized storm precipitation - area - duration curves have been established in eight regions of the Province, six in the Island and two in Labrador. The results of these studies are shown in Figure 8-17. A rough comparison of the storm precipitation values obtained from frequency analysis with those shown on Figure 8-17 indicates that the maximum storms obtained by the maximization studies represent roughly 1.4 - 1.5 of the precipitation 1/10,000 years for the maximum 24-hour precipitations. Nevertheless, further investigations of the problem of storm precipitation - frequency - duration - area relationships are recommended, after data at higher elevations are obtained.

8. 6. 5 Snow and Maximum Possible Seasonal Snowfall

As indicated in Section 8. 2, the measurement of snow depth and water equivalent is affected by errors which were partially reduced beginning in 1960 with the introduction of snow gauges into the DOT meteorologic network. However, as data at most of these gauges only date back to 1963, it is still too early to estimate the actual values of snowfall. A study by Potter<sup>9</sup> has concluded on the basis of relatively short period of observations that the density is approximately 0. 1 in the average for southern Newfoundland and western Labrador, but that in northern Newfoundland and eastern Labrador it is 0. 12 in the average as shown in Figure 8-5. Potter<sup>9</sup> also indicates that during this short period of record (October 1956 - January 1959) the density of snow at St. John's-Torbay Airport station varied between 0.04 and 0. 28 for snowfalls larger than 1 inch in depth.

A complete analysis of snowfall conditions, including maps of earliest, median, and latest dates of first snow cover; earliest, median, and latest date of last snow cover; minimum, median, and greatest number of days with snow cover; least, median, and greatest maximum snow cover, and median depth of snow cover at the end of each winter month are also given by Potter<sup>10</sup>. Figure 8-18 reproduces from Potter's work the snow cover frequency for the winter months at four meteorological stations in Newfoundland and two stations in Labrador. It indicates particularly that in Newfoundland the snow cover starts in November and ends in April, whereas in Labrador it starts in October and ends in May. The snow cover in Newfoundland reaches up to 50 inches in February (possibly more in the higher areas), and is almost double in Labrador.

In addition to the data obtained by the meteorological stations there is valuable information included in the river basin snow course data, consolidated and published by the DOT, Meteorological Branch<sup>11</sup> carried out in Newfoundland essentially by the Department of Energy, Mines and Resources, Inland Waters Branch; the Department of Transport, Meteorological Branch; and the Bowater Power Company Limited, and listed in Table 8-17. As indicated in the table, the record of the longest number of years for the river basin snow course is from Bowater Power Company Limited (Green<sup>12</sup>). The results of these snow surveys expressed in inches of water equivalent average for the Humber River basins above Deer Lake power plant, around the middle of March, are shown in Figure 8-19. The figure indicates that the average snow depth is about 10 inches of water equivalent, reaching 18 inches, within a period of 40 years. The limited records available at the other stations tend to indicate that this average value is

characteristic for the Island with smaller values to the south and larger in higher and more northern areas. Values higher by 20 to 30 percent can be expected in Labrador. The fact that the average water equivalent of snow at the middle of March has a value which is not significantly lower than the average water equivalent of the total snowfall over the whole period as estimated, for example by Thomas<sup>3</sup>, again substantiates the conclusion that the current estimates of average snowfall are lower than the actual average snowfall.

Extensive studies conducted recently by the Meteorological Branch<sup>7, 8</sup> have resulted in recommended values for the "maximized" seasonal snowfall which would represent between 190 and 280 percent of the average seasonal snowfall (Figure 8-20). Significantly the results of these studies indicate, for the average seasonal snowfall, values much larger than those previously indicated in the available literature (Thomas<sup>3</sup>). According to these data, the maximum seasonal snowfall would vary approximately between 32 and 45 inches of water equivalent. Preliminary investigation of the probability distribution of seasonal snow depth indicates that these values correspond to 1.3 - 1.4 times the seasonal snow depth with a probability of 1/10,000 years. The probability that the total of this snow cover accumulates and is available at the end of the winter for melting is much lower.

#### 8.6.6 Drought Frequency and Duration

Assuming conventionally a drought to be a period of at least five consecutive days without total precipitation of at least 0.1 inches, an attempt has been made to analyze the frequency and duration of drought from July to October. The basic data, including records from 17 stations in Newfoundland and 3 stations in Labrador, are summarized in Table 8-18. The results of this analysis are shown in Figure 8-21 which gives estimated isolines of drought durations for the probability of 1/2.33 years, 1/5 years, and 1/20 years. The results should be considered as preliminary, especially in Labrador, because of the small number of data. The variation of the average drought duration is small (from 10 days in the Corner Brook area to 14 days in the Gander area). For the 1/20 year probability the variation is relatively smaller (from 18 days in the St. John's area to 21 days in the Buchans area in Newfoundland, and from 17 days in the Goose area to 21 days in the Hopedale area in Labrador). From the hydrological viewpoint, the drought could be actually larger since precipitations of 0.1 inches or more may be stored in the soil or evaporated over a period of five days. Further discussion of the problem of hydrological drought is included in Section 19.

## 8.7 Evaporation

From the hydrologic viewpoint it is important to distinguish between potential and actual evaporation. Potential evaporation, as defined, is the evaporation from a moist surface so small that the evaporation has no appreciable influence on the air passing over it. Under this definition, potential evaporation is directly related to regional climatological conditions, and is influenced indirectly only by the amount of water available for evaporation.

Potential evaporation was computed by Bruce and Weissmann<sup>13</sup> for two stations on the Island - St. John's and Gander, and one in Labrador - Goose, using Penman's formula. Solar radiation observations were used in the formula for the St. John's and Goose stations, whereas at Gander the solar radiation was estimated from data on actual sunshine.

Using pan evaporation data in conjunction with computed (from solar radiation) potential evaporation and a correlation between small lake evaporation to potential evaporation, Bruce and Weissmann<sup>13</sup> have established mean annual and monthly evaporation isolines (isopleths) from small bodies of water for Canada. The relevant portion of the mean annual isopleths map is shown in Figures 8-22 and 8-23.

Actual evaporation is the real evaporation (including transpiration) which occurs from a certain area, and from the hydrological viewpoint represents the difference between precipitation and runoff. Actual evaporation also depends on the climatic conditions, but is heavily dependent on the amount of water available for evaporation.

Bouchet<sup>14</sup> has shown that in humid regions potential and actual evaporation is of the same order of magnitude and does not differ much from small water bodies' actual evaporation. Actual evaporation for the Province was estimated by using Turc's formula<sup>15</sup> which relates actual evaporation to precipitation and temperature by means of the grid data on precipitation and temperature shown in Figures 8-6B, 8-7B, 8-12C, and 8-13C. The results of these computations are shown in Figures 8-22 and 8-23. The comparison shows that, as expected, the two methods of computation lead to results which are not very different, actual evaporation being, as expected, lower however by 15 to 25 percent than potential evaporation. This indicates that, in the very humid conditions of the study area, Turc's formula is applicable for rough preliminary estimates of actual evaporation.

It should be kept in mind that the values of evapotranspiration and actual evaporation vary from one year to another as a function of the variation of climatic conditions, including precipitation (magnitude and distribution in time). In very dry years, the potential evaporation probably may increase to as much as twice, whereas the actual evaporation decreases because of lack of water to be evaporated. Since lawn watering is usually done in a restricted area, it does not influence the climatic conditions to a significant extent, and the evaporation which determines the water used is closer to the potential evaporation rather than to the actual.

Preliminary computations indicate that, for the Province's conditions, potential evaporation is equal to about 55 percent of the net radiation and this in turn can be estimated from the solar radiation with an albedo varying between 0.5 (for years with a longer period of snow cover) to 0.4. Since radiation can be estimated well enough from data on cloud cover (Figure 8-4), this suggests a method of computing the annual variation of potential evaporation.

#### 8.8 Climatic Regions

The regional pattern delineated by the Meteorological Branch for their studies of storms and seasonal snowfall, which correspond to main physiographic subdivisions, has been accepted in this study as indicating a general delineation of climatic regions.

Accordingly, the Province is considered as consisting of eight climatic regions, six in the Island and two in Labrador (Figure 8-17A). Further, most of these regions have been divided into two or three sub-regions corresponding to internal variation of physiographical characteristics, where this was also indicated by the estimated variation of the climatic characteristics. The average climatic characteristics (mean annual precipitation, temperature, relative humidity, potential evaporation, maximized storm precipitation and seasonal snowfall, and average drought duration) for each climatic sub-region are given in Table 8-19.

Since these data are obtained from generalized maps which were based on little actual information in the inland regions, the use of these characteristics should be made with caution. Only further studies, some of which are indicated in the next section, will show if these generalizations are correct or what amendments have to be introduced.

8.9 Recommendations for Further Climatologic Studies

Most of the Province's areas lack climatologic information and the completion of the network will require additional stations located in the interior and at higher elevations. Figures 8-1 and 8-2 suggest the minimum number of additional stations required.

Most of the additional stations will have to be located in relatively inaccessible areas remote from centers of population. Because of this, the use of a telemetering system would be advisable. For some stations it may be possible to use existing cables, however, in most cases it will be necessary to transmit data by radio to the nearest population center. At the present time, battery-powered radio-telemetering units are capable of transmitting over distances of 30 to 40 miles.

The new stations should be designed to make observations on all significant climatologic characteristics. Data should be recorded for rain and snow precipitation, rime, temperature, humidity, solar radiation, wind and possibly evaporation. Consideration should also be given to expand programs at existing stations and to ensure at least the density recommended in Guide to Hydrometeorology, with gauging measuring key climatologic characteristics mentioned above.

In the expansion of the network, the co-operation of private companies and various government agencies should be sought. For example, advantage should be taken of the new hydro-electric developments at Churchill Falls and Bay D'Espoir. These areas are of economic significance and the introduction of meteorologic stations in the areas which are not yet gauged will be beneficial.

Since the co-operation of public and private bodies would result in the most efficient network, a plan should be developed to detail questions regarding responsibilities and schedules for the supply of equipment, its installation, operation and maintenance, and the obtaining, collection, and processing of the records.

Although the existing network is not complete, considerable data are available and have provided the basis of the work carried out in this report. The use of published precipitation data has led to the belief that re-examination of the data would result in its improvement. Specifically, the published data assume a constant ratio of snow density whereas, in fact, this is the function of a number of variables such as temperature, wind, and humidity. A sampling program to determine correlations between these factors and snow densities could be used as the basis for revised precipitation records.

Climatologic analysis carried out in this volume was based on historical records available up to and including 1966. The review of this analysis as new data become available from existing and new stations should be considered later (after four to five years of records at the new stations).

REFERENCES

- 1 World Meteorological Organization. Guide to Hydrometeorological Practices. WMO No. 168 TP 82. Geneva, 1965.
- 2 Potter, J. G. Canadian National Meteorological Networks. Ottawa, Canada. Department of Transport. Meteorological Branch, 1967.
- 3 Thomas, M. K. Snowfall in Canada. Meteorological Branch, Circular 3977, TEC 503. Ottawa, Canada. Department of Transport, 1964.
- 4 Canada. Department of Transport, Meteorological Branch. Meteorological Observations in Canada, Monthly Record.
- 5 Canada. Department of Transport, Meteorological Branch. Meteorological Branch Documentation Sheet No. 14-66. Climatological Division, Punched Card Library.
- 6 Boughner, S. S., and Thomas, M. K. The Climate of Newfoundland. Ottawa, Canada. Department of Transport. Meteorological Branch, 1964.
- 7 Canada. Department of Transport. Meteorological Branch. Estimates of Maximum Rainfall, Winter Seasonal Snowfall, Snow Depth, and Spring Temperature Sequences in Newfoundland.
- 8 Sparrow, D. M. Critical Meteorological Conditions for Maximum Inflow, Churchill Falls Development. 1968.

REFERENCES

- 9        Potter, J. G. Water Content of Freshly Fallen Snow. Meteorological Branch Circular 4232. Ottawa, Canada. Department of Transport, 1965.
  
- 10       Potter, J. G. Snow Cover. Ottawa, Canada. Department of Transport, Meteorological Branch, 1965.
  
- 11       Canada. Department of Transport. Meteorological Branch. Snow Cover Data



FLOW REPORTING HYDRO  
ELECTRIC PLANTS

NO.	NAME	OWNER	DRAINAGE AREA AS OUTLINED (SQ. MILES)	COMMENTS
I	DEER LAKE	BOWATERS	1,330 *	TOTAL 1,942 SQ. MILES
II	BAY D'ESPOIR	N.L.P.C.	321 *	TOTAL 1,415 SQ. MILES
III	RATTLING BROOK	N.L.P.C.L.	146	
IV	SANDY BROOK	N.L.P.C.L.	196	
V	GRAND FALLS	PRICE	3,024 *	TOTAL 3,650 SQ. MILES
VI	HEARTS CONTENT	N.L.P.C.L.	35	
VII	NEW CHELSEA	N.L.P.C.L.	28	
VIII	PETTY HARBOUR	N.L.P.C.L.	53	
IX	PIERRE'S BROOK	N.L.P.C.L.	45	
X	MOBILE RIVER	N.L.P.C.L.	43	
XI	SEAL COVE	N.L.P.C.L.	30	

NOTE: \* INCREMENTAL DRAINAGE AREAS BETWEEN MEASUREMENT POINTS

N.L.P.C. NEWFOUNDLAND AND LABRADOR POWER COMMISSION  
N.L.P.C.L. NEWFOUNDLAND LIGHT AND POWER COMPANY LIMITED

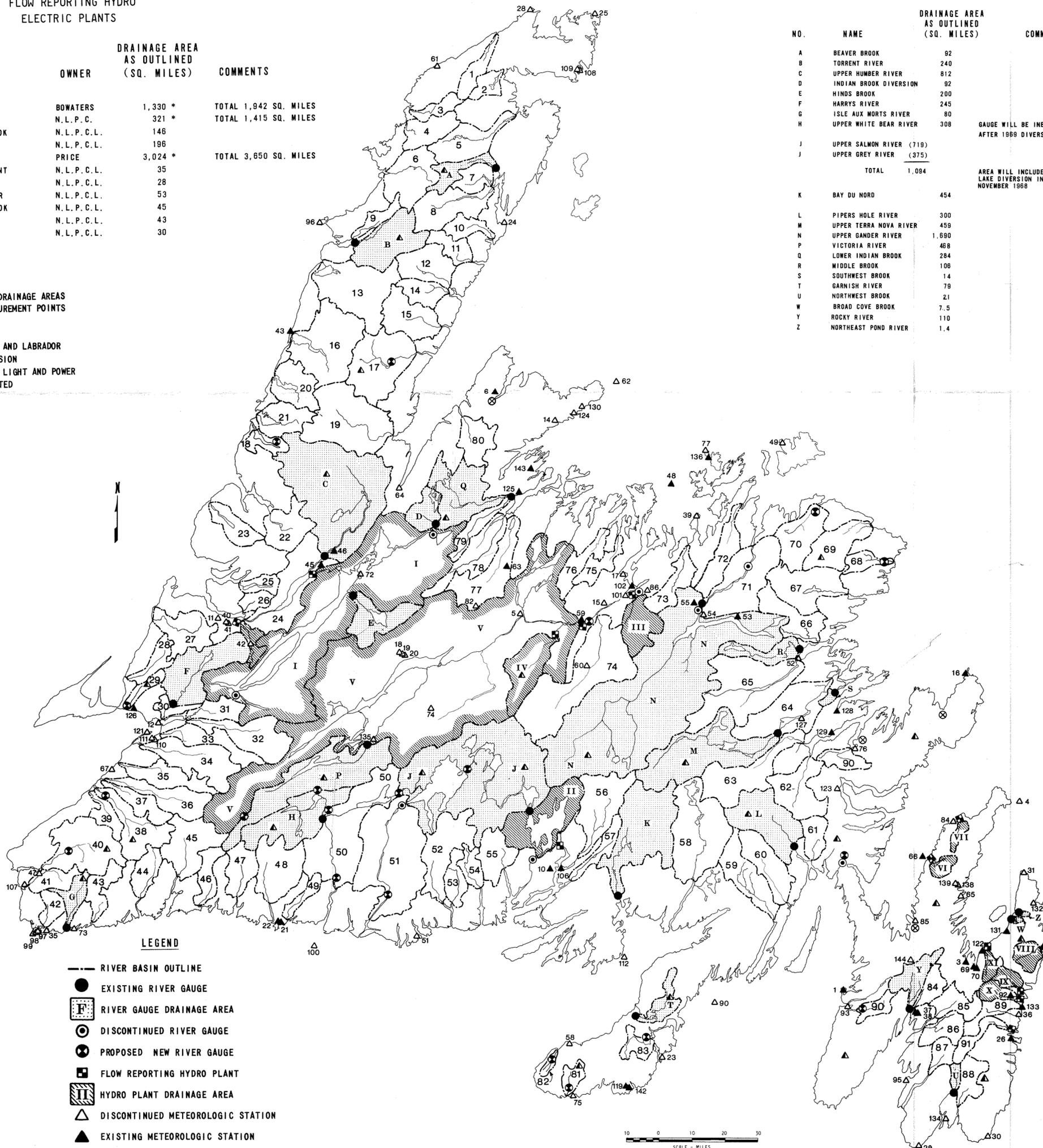
GAUGED RIVERS

NO.	NAME	DRAINAGE AREA AS OUTLINED (SQ. MILES)	COMMENTS
A	BEAVER BROOK	92	
B	TORRENT RIVER	240	
C	UPPER HUMBER RIVER	812	
D	INDIAN BROOK DIVERSION	92	
E	HINDS BROOK	200	
F	HARRYS RIVER	245	
G	ISLE AUX MORTS RIVER	80	
H	UPPER WHITE BEAR RIVER	308	GAUGE WILL BE INEFFECTIVE AFTER 1969 DIVERSION
J	UPPER SALMON RIVER (719)		
J	UPPER GREY RIVER (375)		
	TOTAL	1,094	AREA WILL INCLUDE GRANITE LAKE DIVERSION IN NOVEMBER 1968
K	BAY DU NORD	454	
L	PIPERS HOLE RIVER	300	
M	UPPER TERRA NOVA RIVER	459	
N	UPPER GANDER RIVER	1,690	
P	VICTORIA RIVER	468	
Q	LOWER INDIAN BROOK	284	
R	MIDDLE BROOK	106	
S	SOUTHWEST BROOK	14	
T	GARNISH RIVER	79	
U	NORTHWEST BROOK	21	
W	BROAD COVE BROOK	7.5	
Y	ROCKY RIVER	110	
Z	NORTHEAST POND RIVER	1.4	

UNGAUGED RIVERS \*

NO.	NAME	DRAINAGE AREA AS OUTLINED (SQ. MILES)	COMMENTS
1	BIG BROOK	78	
2	ROCKY COVE BROOK	59	
3	WEST RIVER	58	
4	TEN MILE LAKE	118	
5	SALMON RIVER	177	
6	CASTORS RIVER	211	
7	NORTHWEST RIVER	83	
8	CLOUD RIVER	186	
9	EAST RIVER	50	
10	UNNAMED RIVER	72	
11	UNNAMED RIVER	74	
12	SUFFLETS RIVER	157	
13	RIVER OF PONDS	340	
14	GREAT HARBOUR DEEP RIVER	83	
15	LITTLE HARBOUR DEEP RIVER	187	RIVER TO BE GAUGED
16	PORTLAND CREEK POND	372	FALL OF 1968
17	CAT ARM RIVER	60	GAUGE PROPOSED AT SMALL POND OUTLET IN UPPER AREA
18	WESTERN BROOK POND	390	
19	MAIN RIVER	153	
20	PARSONS POND	123	
21	ST. PAULS INLET	154	
22	LOMOND RIVER	89	
23	TROUT RIVER	323	
24	LOWER HARBOUR RIVER	81	
25	OLD HANS POND	51	
26	HUGHES BROOK	169	
27	SERPENTINE RIVER	71	
28	FOX ISLAND RIVER	77	GAUGE PROPOSED
29	ROMAINES BROOK	83	
30	LOWER HARRYS RIVER	229	
31	BOTTOM BROOK	138	
32	SOUTHWY BROOK	216	
33	LITTLE BARACHOIS BROOK	140	
34	FLAT BAY BROOK	165	
35	FISCHELLS BROOK	92	
36	ROBINSONS RIVER	204	GAUGE PROPOSED
37	BARACHOIS BROOK	66	
38	CRABBES BROOK	89	GAUGE PROPOSED
39	HIGHLAND RIVER	293	GAUGE PROPOSED
40	CODROY RIVER	89	
41	LITTLE CODROY RIVER	59	
42	GRAND BAY RIVER	107	
43	GRANBY'S BROOK	94	
44	GARIA BROOK	204	
45	LA POILE RIVER	82	
46	CIND CREEK	121	GRANITE LAKE AREA TO BE DIVERTED IN 1969 GAUGE PROPOSED NEAR RIVER MOUTH
47	UNNAMED RIVER	228	
48	GRANDY'S BROOK	51	
49	KINGS HARBOUR BROOK	464	
50	LOWER WHITE BEAR RIVER	572	GAUGE PROPOSED
51	AND GRAYE LAKE	238	
52	LOWER GREY RIVER	86	
53	DOLLAND BROOK	58	
54	MORGAN BROOK	113	
55	BOTTOM BROOK	239	
56	D'ESPOIR BROOK	390	
57	CONNIE RIVER	180	
58	LITTLE RIVER	184	
59	LONG HARBOUR RIVER	89	
60	PARADISE RIVER	185	
61	SANDY HARBOUR RIVER	285	
62	BLACK RIVER	279	
63	SOUTHWEST RIVER	443	
64	NORTHWEST RIVER	161	
65	LOWER TERRA NOVA RIVER	230	
66	GAMBO POND	187	GAUGE PROPOSED
67	TRAVERSE BROOK	173	GAUGE PROPOSED
68	INDIAN BAY BROOK	314	
69	POUND COVE BROOK	143	
70	DEADMAN'S BROOK	118	
71	RAGGED HARBOUR RIVER	583	
72	LOWER GANDER RIVER	84	
73	TEN MILE LAKE	101	
74	INDIAN ARM BROOK	244	
75	GREAT RATTLING BROOK	198	
76	NEW BAY RIVER	80	
77	WEST ARM BROOK	131	
78	SOUTH BROOK	45	GAUGE PROPOSED
79	BARNBY'S BROOK	187	GAUGE PROPOSED
80	BURNT BERRY BROOK	131	
81	MIDDLE ARM BROOK	45	
82	SALMONIER RIVER	58	GAUGE PROPOSED
83	FORTUNE BROOK	64	
84	FRESHWATER POND (UPSTREAM OF TIDES BROOK)	101	
85	COLONET RIVER	85	
86	SALMONIER RIVER	54	
87	LITTLE HARBOUR RIVER	84	
88	CROSSING PLACE RIVER	82	
89	BISCAY BAY BROOK	55	GAUGE PROPOSED
90	LA MANCHE	73	
91	SOUTHEAST RIVER		
	HORSE CHOPS RIVER		

\* RIVERS WITH DRAINAGE AREAS OF LESS THAN 50 SQ. MILES GENERALLY EXCLUDED



LEGEND

- RIVER BASIN OUTLINE
- EXISTING RIVER GAUGE
- RIVER GAUGE DRAINAGE AREA
- ⊙ DISCONTINUED RIVER GAUGE
- ⊗ PROPOSED NEW RIVER GAUGE
- FLOW REPORTING HYDRO PLANT
- ▨ HYDRO PLANT DRAINAGE AREA
- △ DISCONTINUED METEOROLOGIC STATION
- ▲ EXISTING METEOROLOGIC STATION
- ▲ PROPOSED METEOROLOGIC STATION
- ⊗ PROPOSED NEW RIVER GAUGE

NOTE: NUMBERS OF METEOROLOGIC STATIONS CORRESPOND TO NUMBERS IN TABLE 8-1

EXACT LOCATION  
UNDETERMINED



NEWFOUNDLAND  
CLIMATOLOGIC AND HYDROMETRIC NETWORK

LEGEND

- RIVER BASIN OUTLINE
- EXISTING RIVER GAUGE
- ⊙ RIVER GAUGE DRAINAGE AREA
- ⊙ DISCONTINUED RIVER GAUGE
- ⊗ PROPOSED NEW RIVER GAUGE
- FLOW REPORTING HYDRO PLANT
- ▨ HYDRO PLANT DRAINAGE AREA
- △ DISCONTINUED METEOROLOGIC STATION
- ▲ EXISTING METEOROLOGIC STATION
- ▲ PROPOSED METEOROLOGIC STATION } EXACT LOCATION
- ⊗ PROPOSED NEW RIVER GAUGE } UNDETERMINED

NOTE: NUMBERS OF METEOROLOGIC STATIONS  
CORRESPOND TO NUMBERS IN TABLE 8-1

GAUGED RIVERS

NO.	NAME	DRAINAGE AREA AS OUTLINED (SQ. MILES)	COMMENTS
A	CHURCHILL RIVER AT FLOUR LAKE	5,700	TOTAL 13,100 SQ. MILES
B	UNKNOWN RIVER AT LAKE 51	7,700	
C	CHURCHILL RIVER AT MUSKRAT FALLS	6,500	TOTAL 30,400 SQ. MILES
D	EAGLE RIVER ABOVE EAGLE FALLS	3,900	
E	NASKAUPI RIVER AT FREEMONT LAKE	3,470	

UNGAUGED RIVERS \*

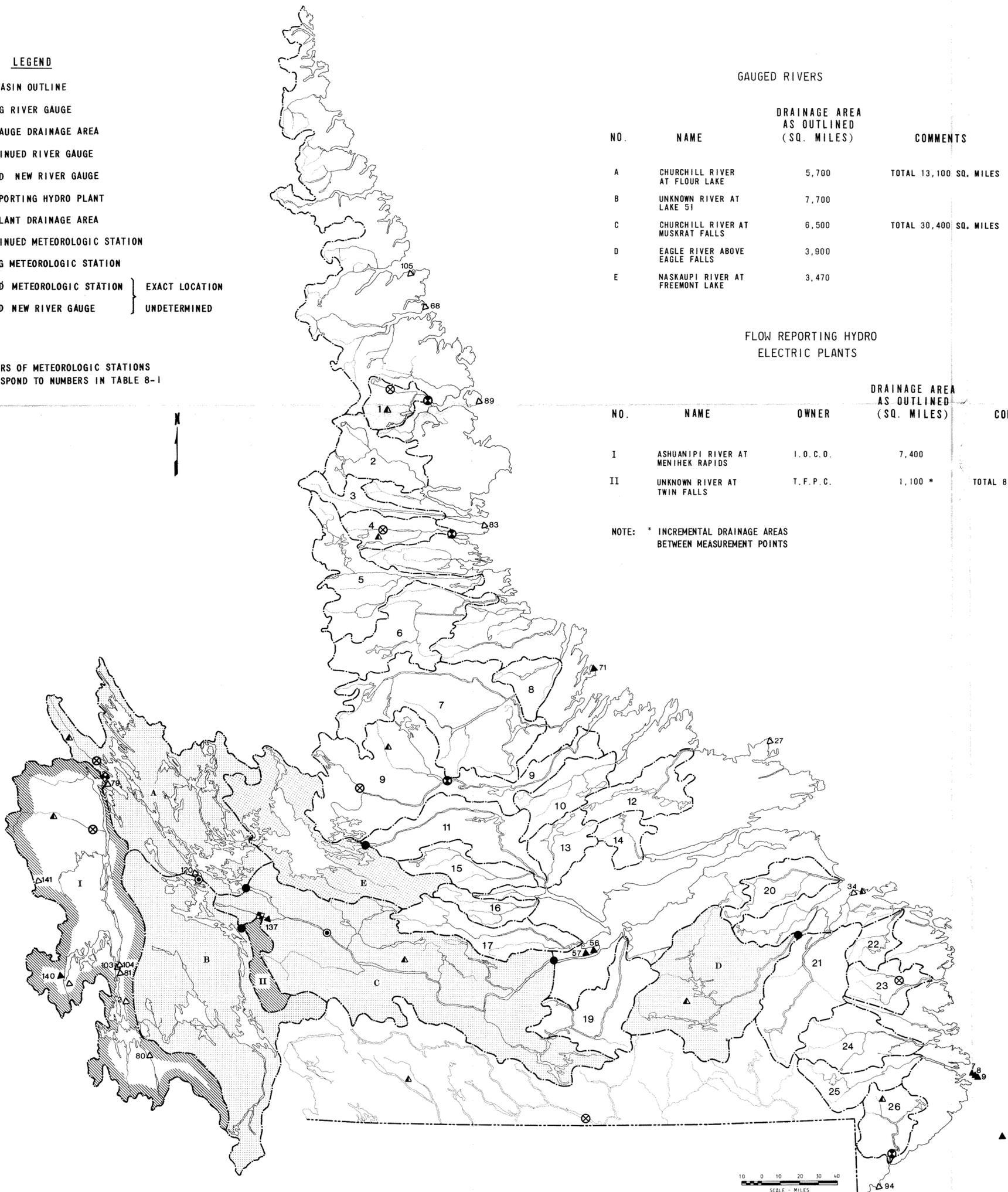
NO.	NAME	DRAINAGE AREA AS OUTLINED (SQ. MILES)
1	NORTH RIVER	630
2	KINGYRUTIK RIVER	1,410
3	FRASER RIVER	690
4	ANAKTALIK BROOK	690
5	KOGALUK RIVER	2,930
6	NOTAWANON RIVER	2,310
7	HARP LAKE	4,810
8	HUNT RIVER	660
9	CANAIKIKTOX RIVER	4,570
10	KAIPOK RIVER	1,090
11	LOWER NASKAUPI RIVER	2,490
12	BIG RIVER	1,160
13	CROOKED RIVER	860
14	UNNAMED RIVER	530
15	RED WINE RIVER	1,060
16	BEAVER RIVER	740
17	GOOSE RIVER	1,340
18		
19	KENAMU RIVER	1,700
20	NORTH RIVER	890
21	PARADISE RIVER	2,280
22	SAND HILL RIVER	500
23	HAWKE RIVER	690
24	ALEXIS RIVER	1,310
25	ST. LEWIS RIVER	950
26	PINWARE RIVER	970

FLOW REPORTING HYDRO  
ELECTRIC PLANTS

NO.	NAME	OWNER	DRAINAGE AREA AS OUTLINED (SQ. MILES)	COMMENTS
I	ASHUANUPI RIVER AT MENIHEK RAPIDS	I. O. C. O.	7,400	
II	UNKNOWN RIVER AT TWIN FALLS	T. F. P. C.	1,100 *	TOTAL 8,800 SQ. MILES

NOTE: \* INCREMENTAL DRAINAGE AREAS  
BETWEEN MEASUREMENT POINTS

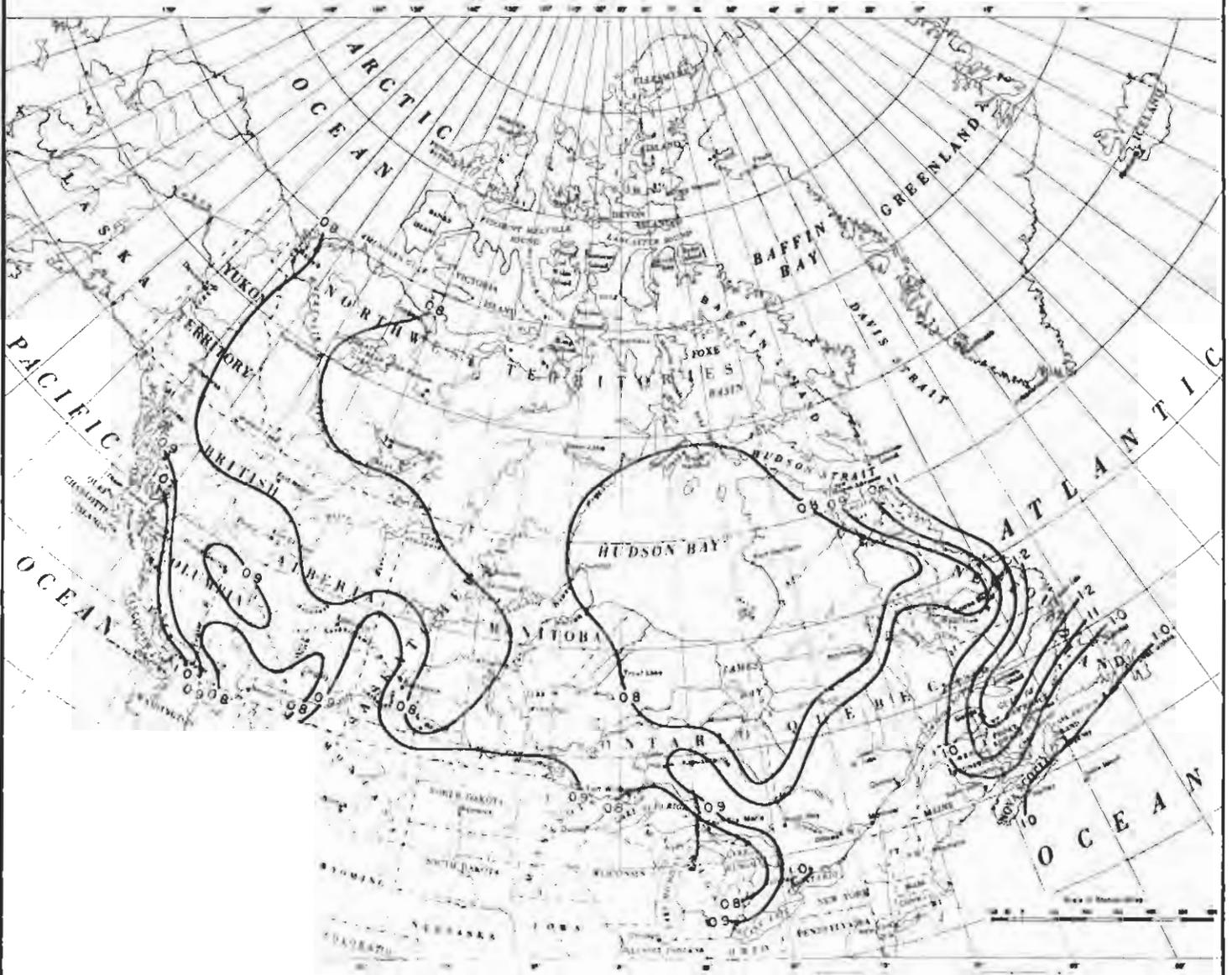
\* RIVERS WITH DRAINAGE AREAS OF LESS  
THAN 500 SQ. MILES GENERALLY EXCLUDED



LABRADOR  
CLIMATOLOGIC AND HYDROMETRIC NETWORK

CANADA

RATIO OF THE MEASURED WATER CONTENT OF SNOWFALL  
TO AN ESTIMATED WATER CONTENT USING 10 INCHES  
OF SNOWFALL AS EQUIVALENT TO 1 INCH OF WATER

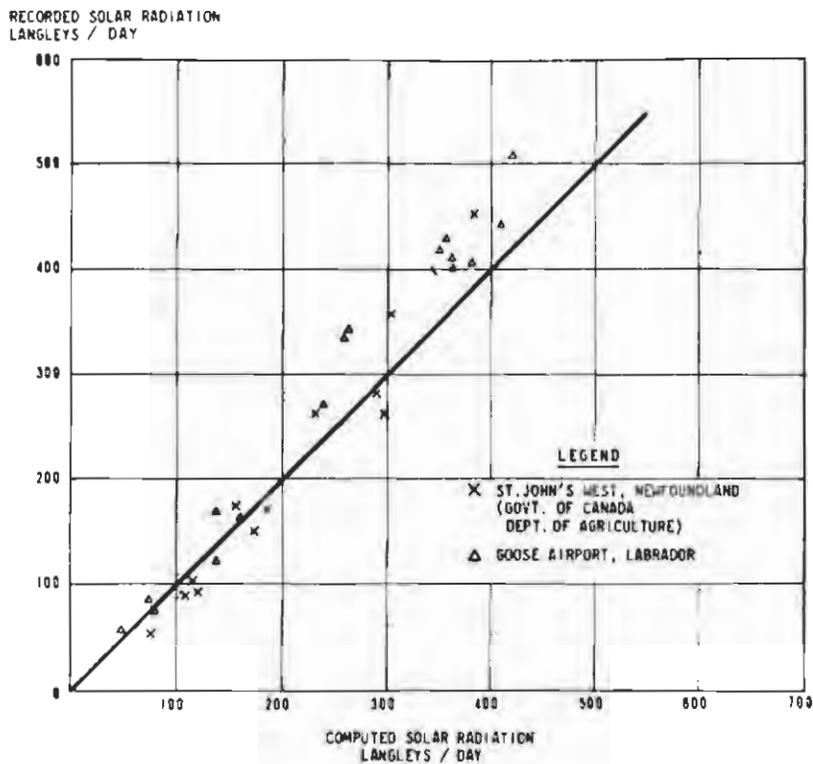


SOURCE: DEPARTMENT OF TRANSPORT  
METEOROLOGICAL BRANCH  
CIR. 4232 - TEC. 569, MAY 12, 1965.  
WATER CONTENT OF FRESHLY FALLEN SNOW  
BY J.G.POTTER

FIGURE 8-3

NEWFOUNDLAND AND LABRADOR

CORRELATION BETWEEN RECORDED RADIATION AND COMPUTED RADIATION FROM CLOUD COVER DATA



TOTAL SOLAR AND SKY RADIATION FOR CLOUDLESS SKIES EXPRESSED IN INCHES EVAPORATION EQUIVALENT

( $R_{80}$ )

LATITUDE $\phi_h$	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
60	1.1	2.6	6.4	10.3	13.9	14.9	14.4	10.9	7.0	4.1	1.7	0.8
55	2.0	3.7	7.7	11.1	14.3	15.1	14.7	11.8	8.2	5.1	2.7	1.5
50	3.1	5.0	9.0	11.9	14.7	15.3	15.0	12.5	9.5	6.4	3.9	2.5
45	4.4	6.3	10.3	12.7	15.1	15.5	15.3	13.4	10.7	7.7	5.1	3.8
40	5.8	7.7	11.3	13.3	15.3	15.7	15.5	14.1	11.7	8.9	6.5	5.1
35	7.2	9.1	12.3	14.0	15.3	15.7	15.5	14.5	12.5	10.1	7.9	6.4
30	8.5	10.1	13.0	14.4	15.3	15.7	15.5	14.8	13.2	11.0	9.1	7.6
25	9.5	11.0	13.5	14.5	15.3	15.6	15.4	14.9	13.7	11.7	10.0	8.7
20	10.3	11.7	13.9	14.5	15.1	15.3	15.1	14.8	14.0	12.3	10.9	9.7
15	11.1	12.2	14.0	14.4	14.7	14.8	14.7	14.5	14.1	12.8	11.5	10.5
10	11.6	12.7	14.0	14.2	14.1	14.1	14.1	14.1	14.1	13.1	12.0	11.1
5	12.0	13.0	13.9	13.9	13.6	13.2	13.4	13.7	13.9	13.3	12.4	11.5
0	12.3	13.2	13.6	13.5	12.8	12.0	12.5	13.1	13.6	13.3	12.7	12.0

MEAN ANNUAL VALUES OF  $k$   
LATITUDE (DEGREES)

0	5	10	15	20	25	30	35	40	45	50	55	60
$k = 0.35$	0.34	0.34	0.33	0.33	0.32	0.32	0.32	0.33	0.34	0.36	0.38	0.40

SOLAR RADIATION ( $R_g$ ) FOR THE CLOUDINESS  $N$

$$R_g = R_{80} \left[ 1 - (1 - k) \frac{N}{10} \right]$$

( $N = 0$  TO  $10$ )

FIGURE 8-4

CORRELATION BETWEEN MEAN  
MONTHLY TEMPERATURES AT  
GOOSE AIRPORT AND CARTWRIGHT  
(PRODUCED BY COMPUTER - PLOTTER)

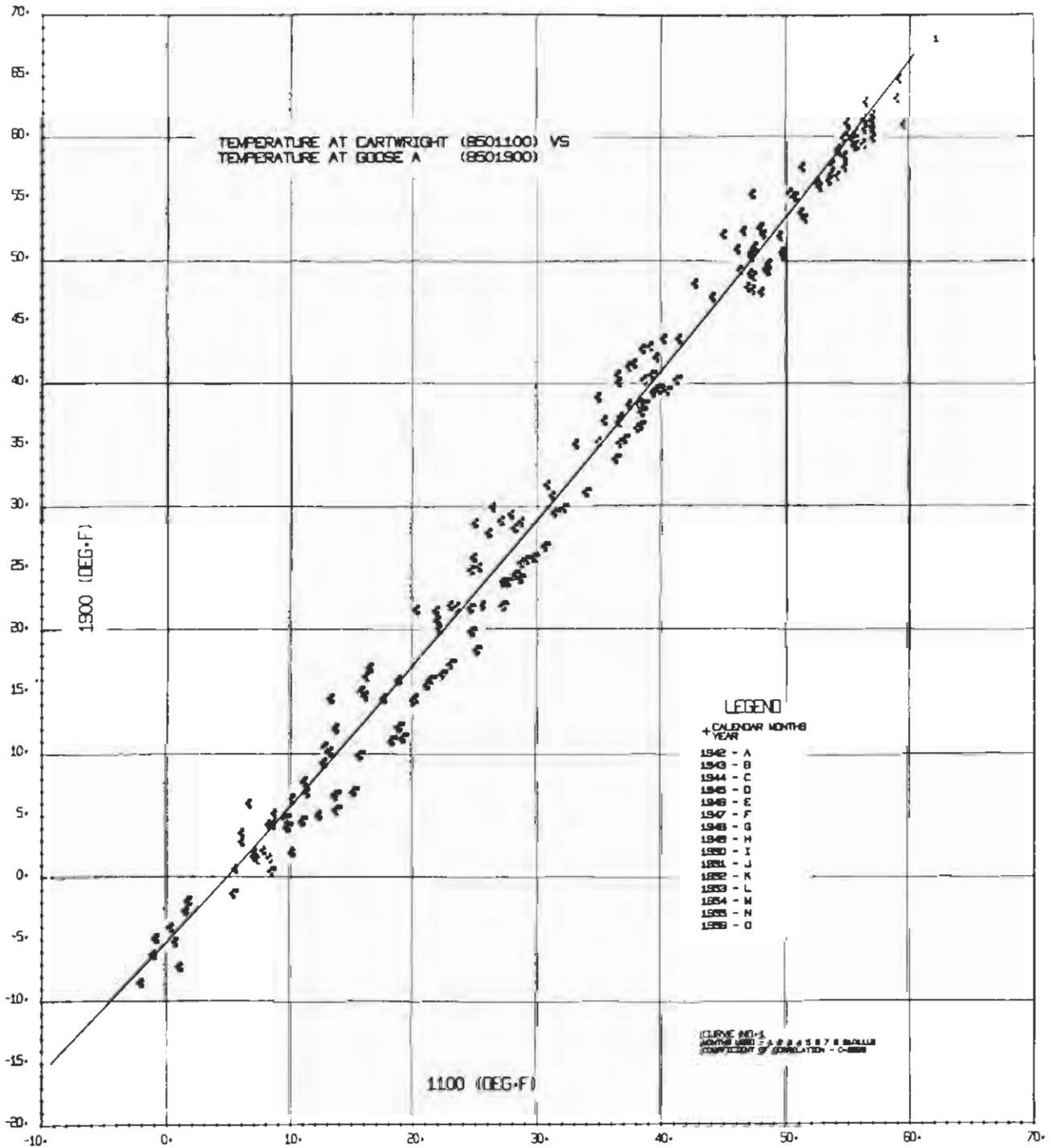
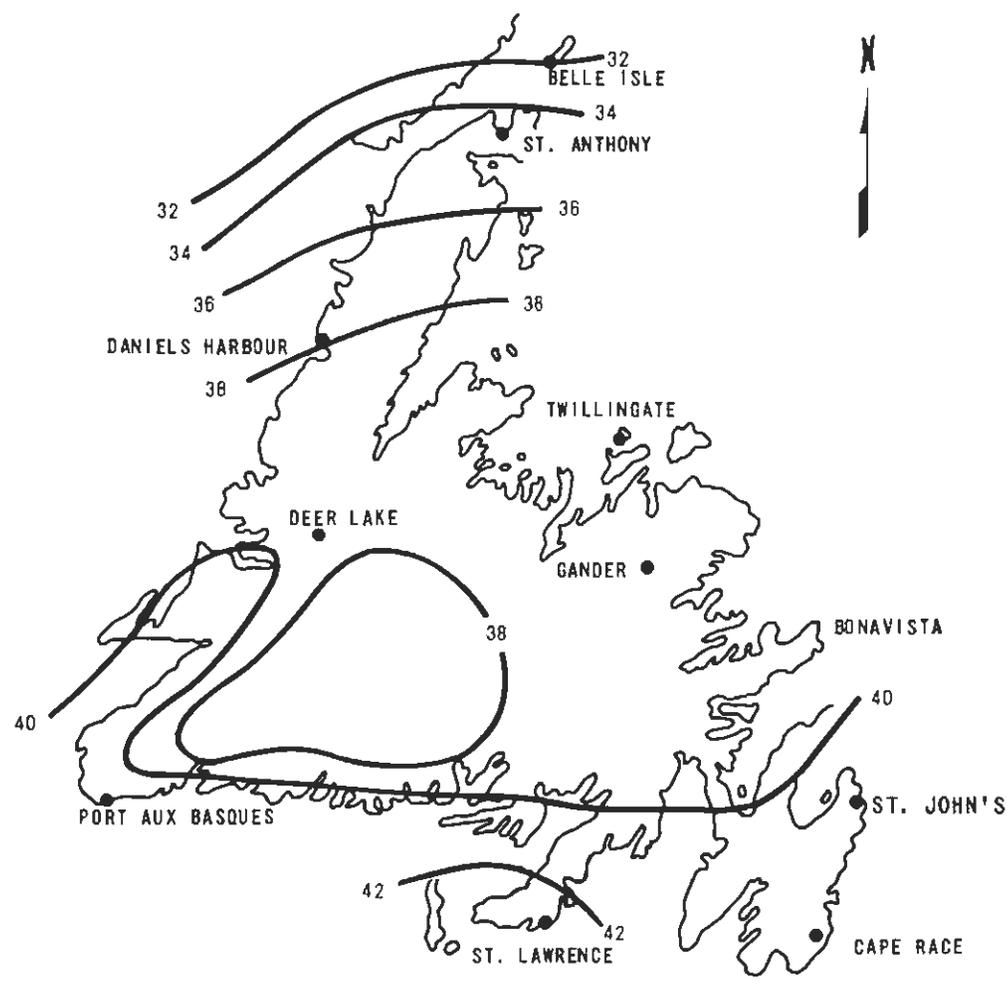


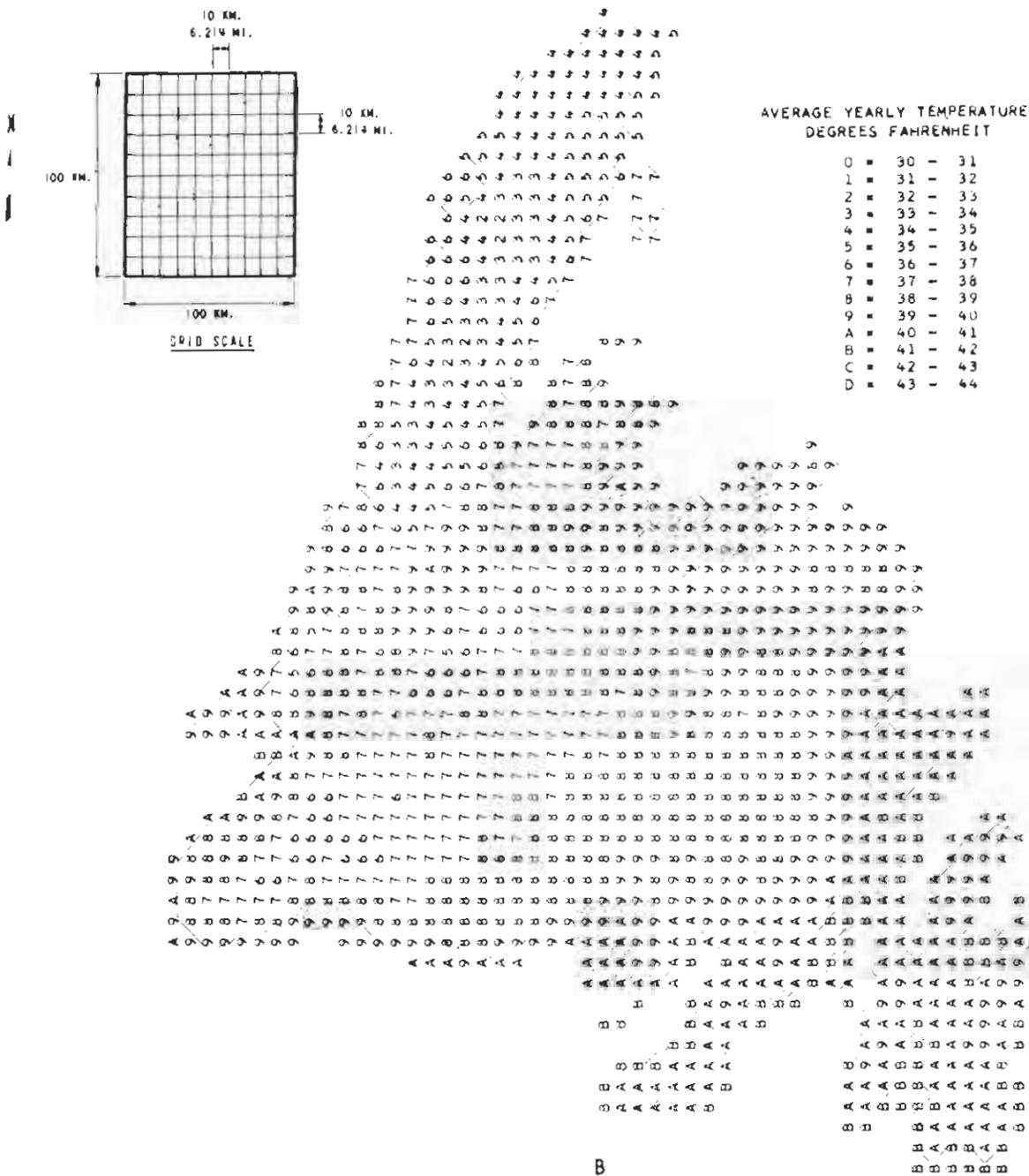
FIGURE 8-5

NEWFOUNDLAND  
MEAN ANNUAL TEMPERATURE DISTRIBUTION  
(°F)



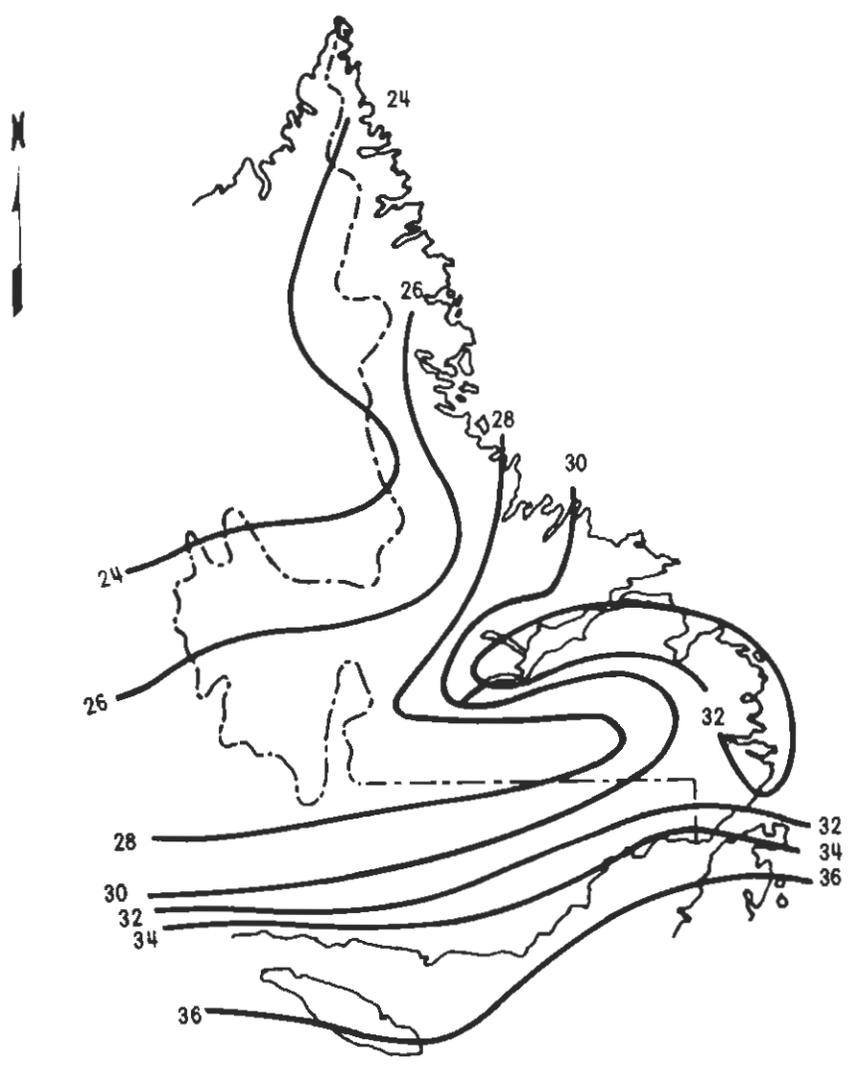
A  
MEAN ANNUAL ISOTHERMS  
(DEPARTMENT OF TRANSPORT -  
WORKING PAPER)

NEWFOUNDLAND  
 MEAN ANNUAL TEMPERATURE DISTRIBUTION



B  
 SQUARE GRID DISTRIBUTION OF  
 MEAN ANNUAL TEMPERATURE  
 OBTAINED FROM CORRELATION WITH  
 PHYSIOGRAPHIC CHARACTERISTICS

LABRADOR  
MEAN ANNUAL TEMPERATURE DISTRIBUTION  
(°F)



A  
MEAN ANNUAL ISOTHERMS  
(DEPARTMENT OF TRANSPORT-  
WORKING PAPER)

# LABRADOR MEAN ANNUAL TEMPERATURE DISTRIBUTION

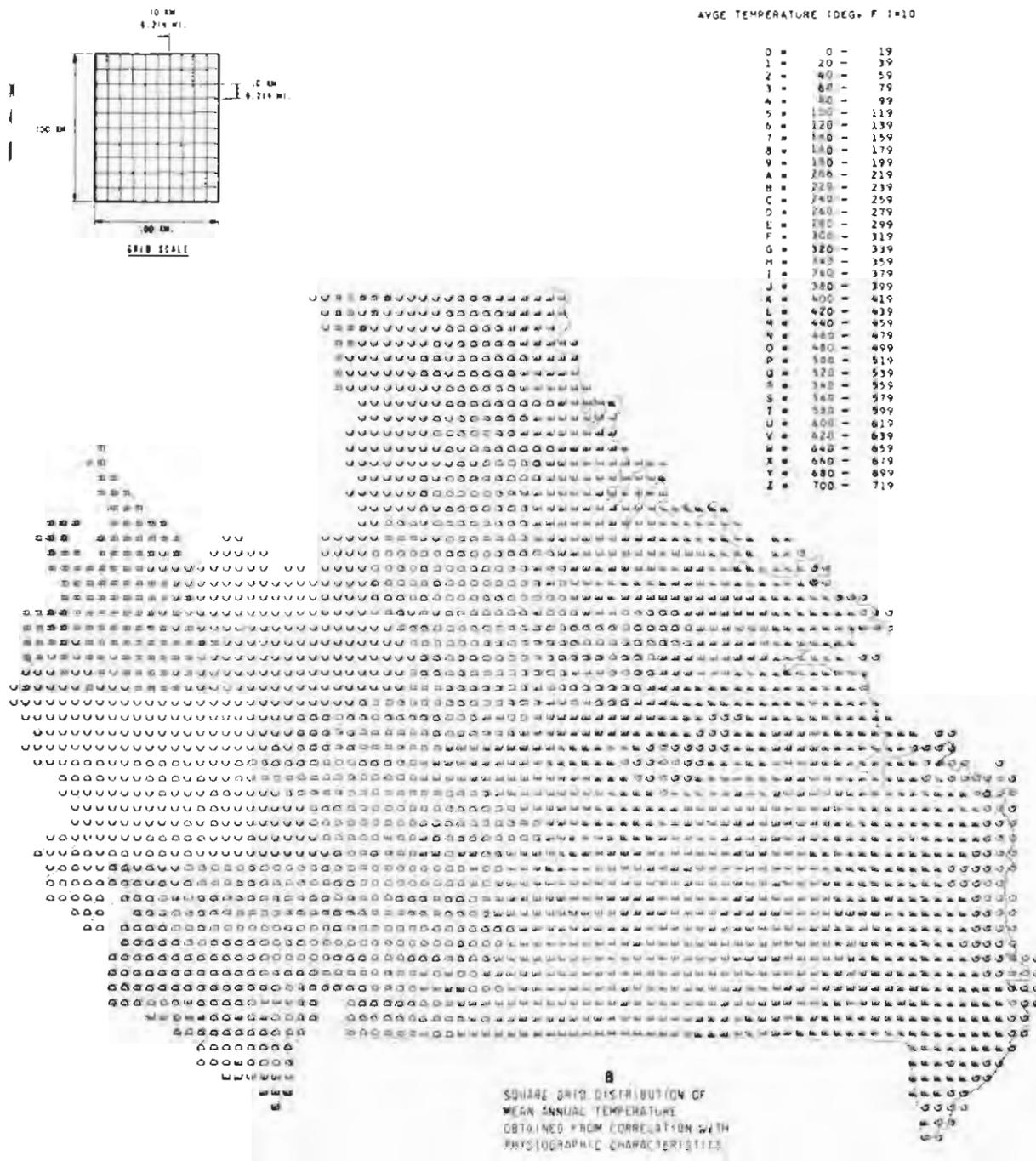


FIGURE 8-78

# NEWFOUNDLAND AND LABRADOR CRITICAL SPRING TEMPERATURE SEQUENCES

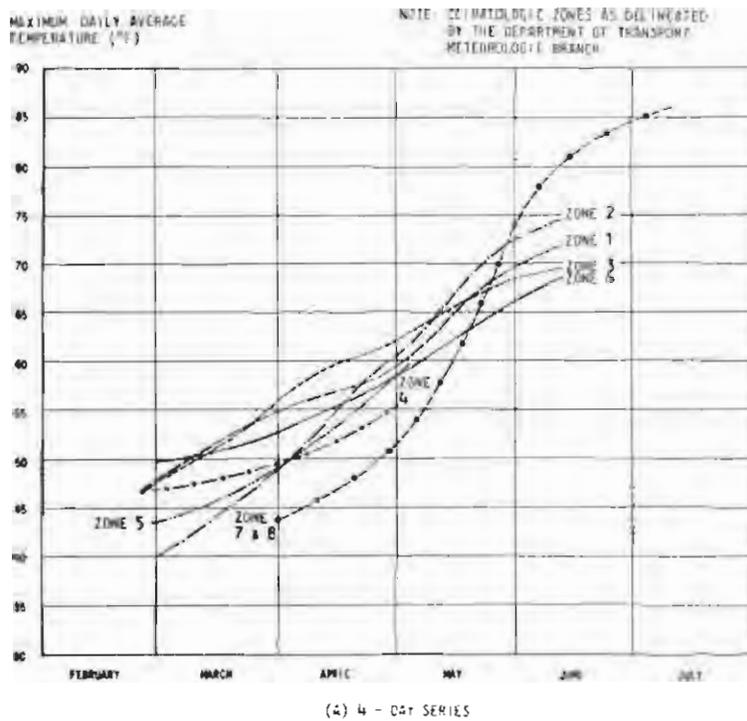
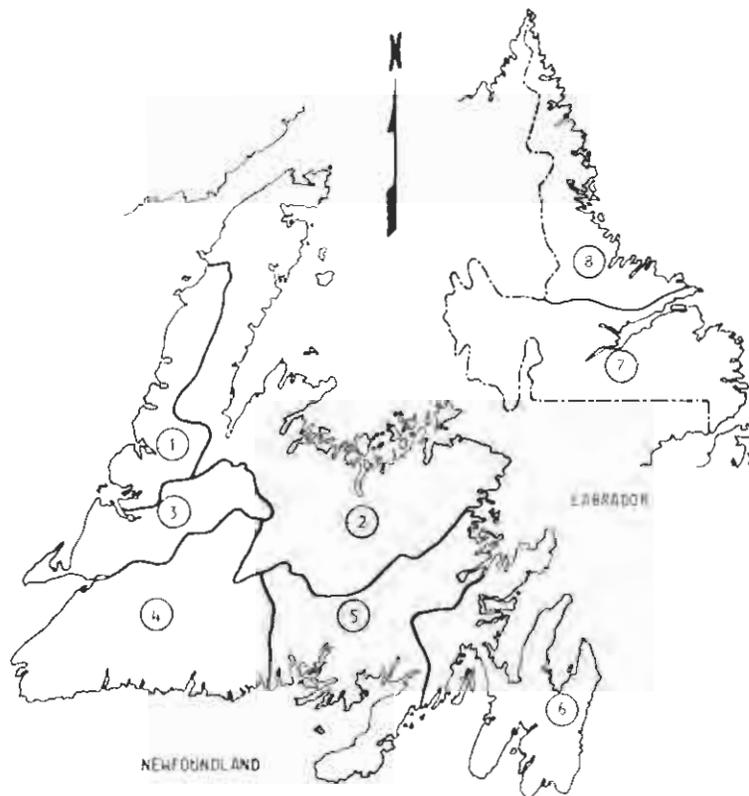
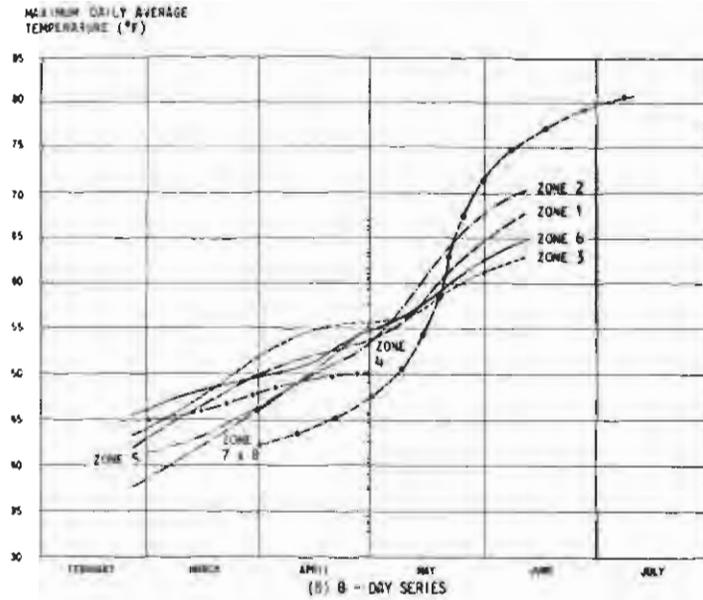
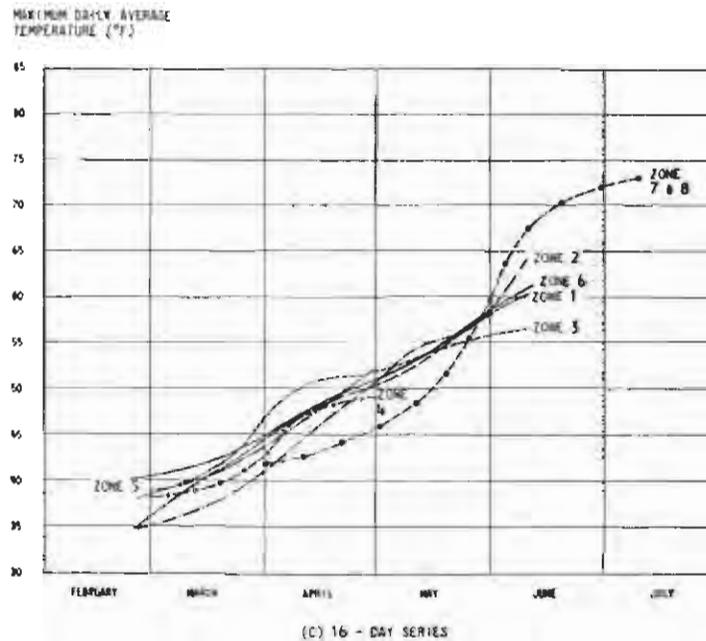


FIGURE 8-8A

## NEWFOUNDLAND AND LABRADOR CRITICAL SPRING TEMPERATURE SEQUENCES



SOURCE: DEPARTMENT OF TRANSPORT  
METEOROLOGICAL BRANCH WORKING DOCUMENT,  
ESTIMATES OF MAXIMUM STORM RAINFALL, WINTER SEASONAL SNOWFALL,  
SNOW DEPTHS, AND SPRING TEMPERATURE SEQUENCES, IN NEWFOUNDLAND.



### NEWFOUNDLAND AND LABRADOR MEAN ANNUAL AND SEASONAL ISOBARS

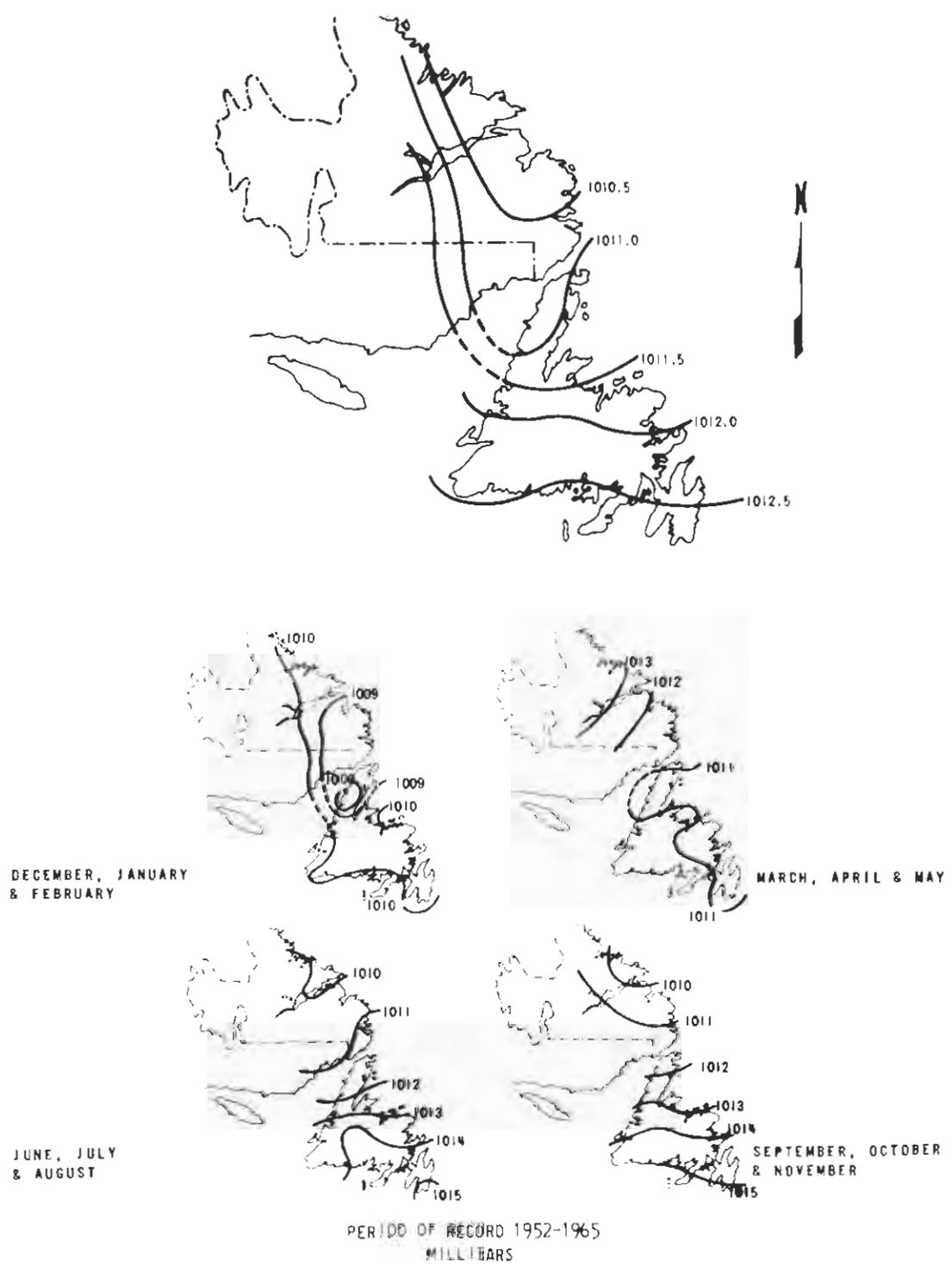
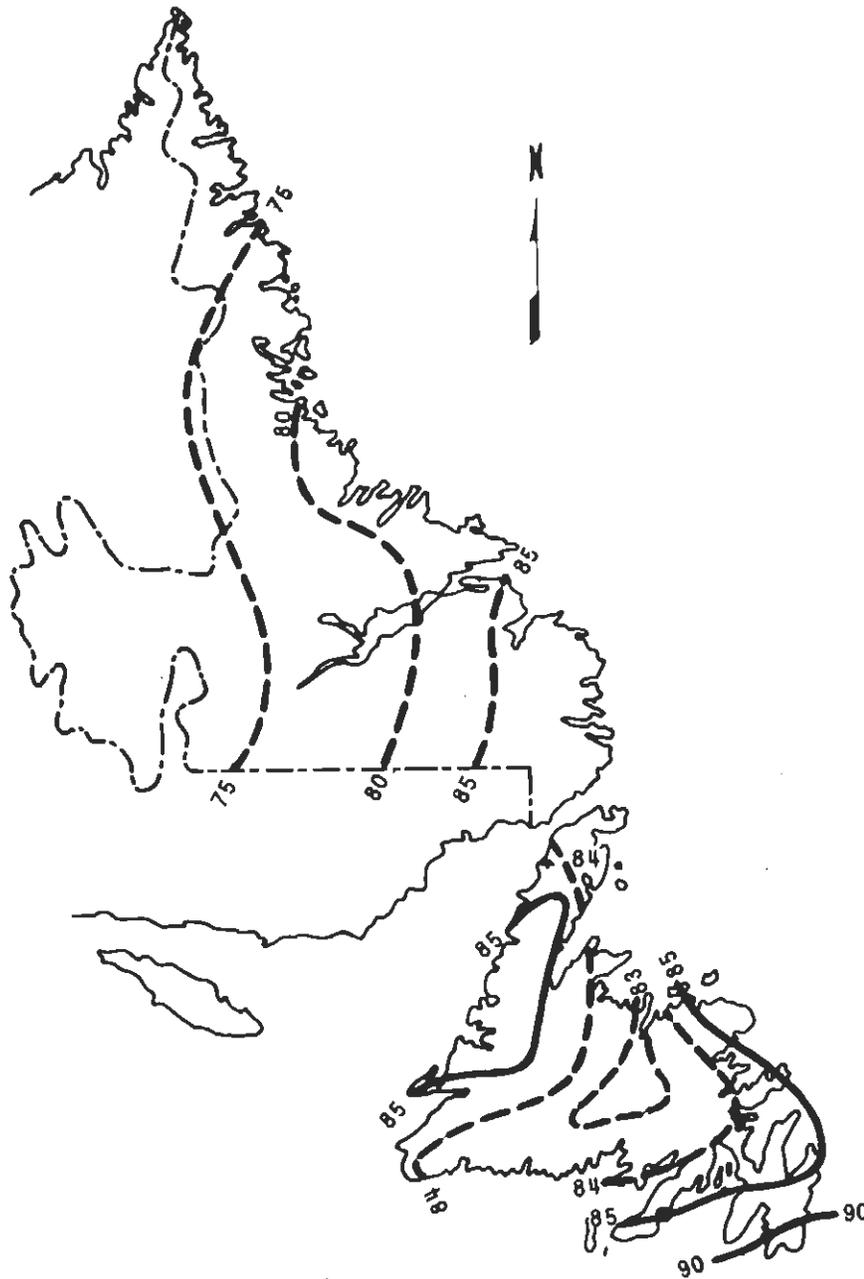


FIGURE 8-9

NEWFOUNDLAND AND LABRADOR  
MEAN ANNUAL HUMIDITY



MEAN ANNUAL RELATIVE HUMIDITY (AT 8 A.M.)  
RECORD PERIOD 1952-1965

CORRELATION OF MONTHLY PRECIPITATION AT  
 BELLE ISLE AND BATTLE HARBOUR LORAN  
 (PRODUCED BY COMPUTER - PLOTTER)

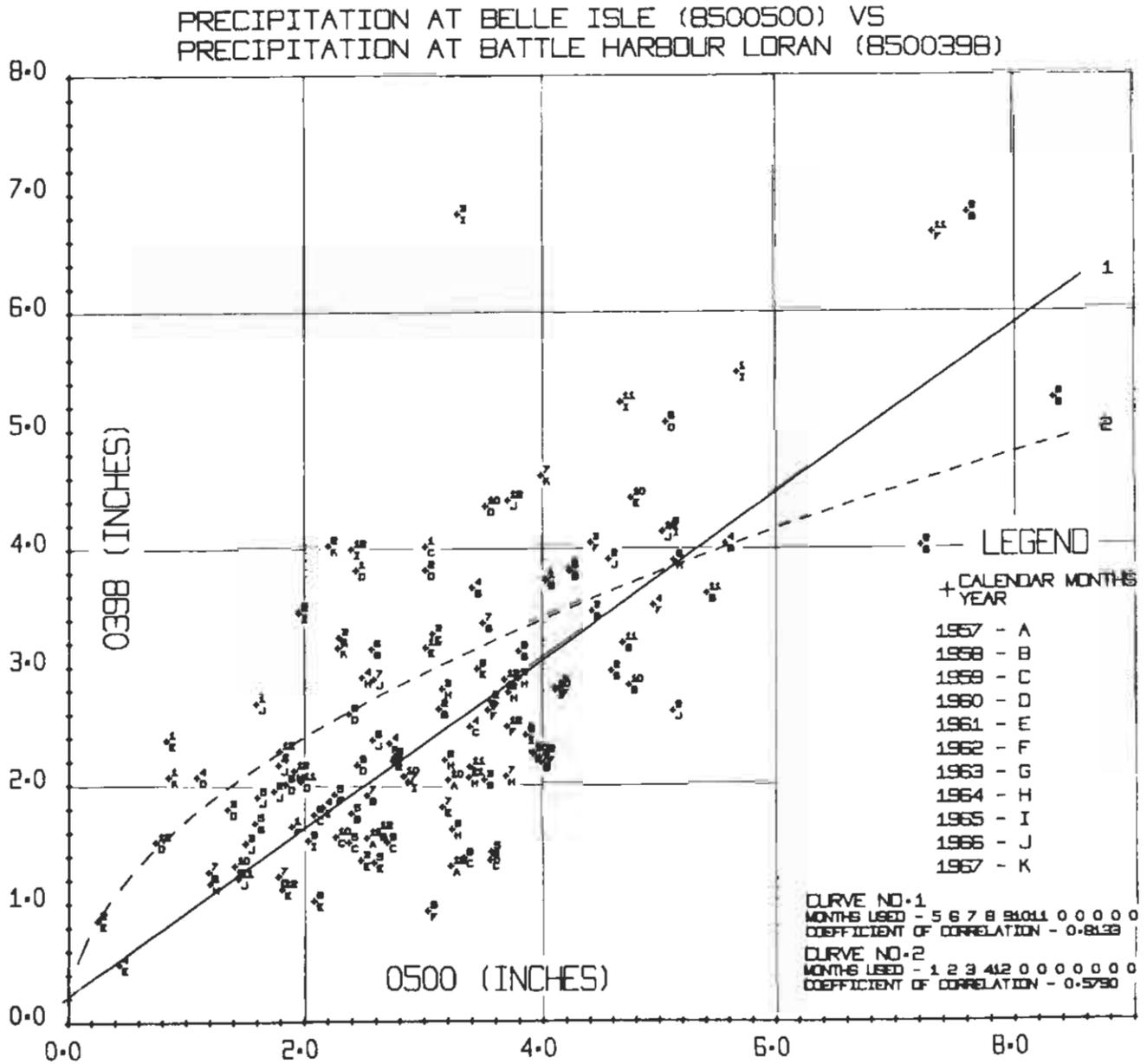
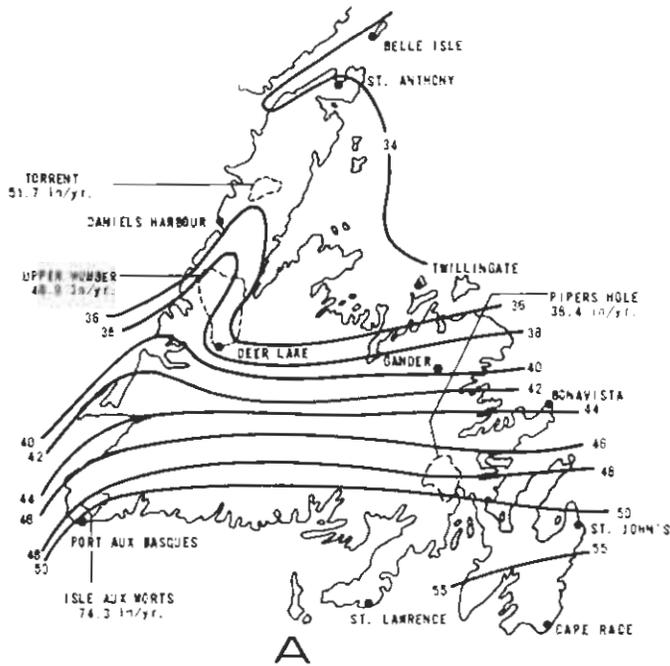
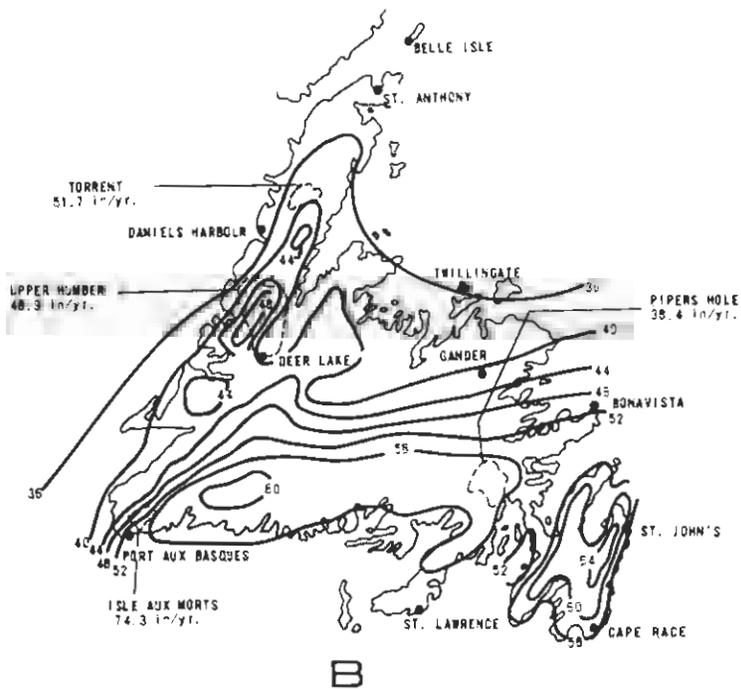


FIGURE 8-11

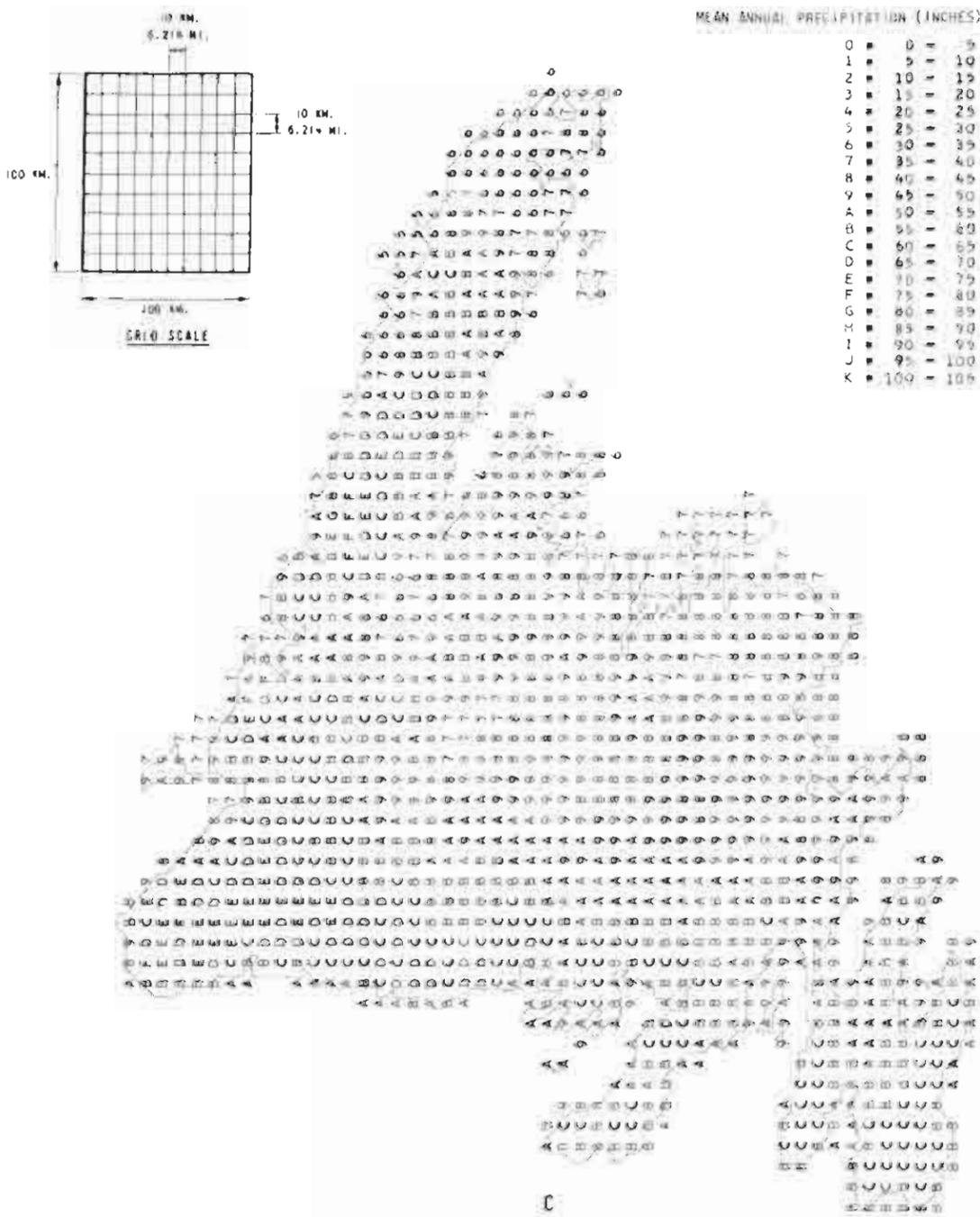
### NEWFOUNDLAND MEAN ANNUAL PRECIPITATION DISTRIBUTION



A  
ANNUAL PRECIPITATION DISTRIBUTION (INCHES)  
ACCORDING TO THE ATLAS OF CANADA  
(DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1957)



B  
REVISED ANNUAL PRECIPITATION DISTRIBUTION (INCHES)  
(DEPARTMENT OF TRANSPORT -  
METEOROLOGICAL BRANCH WORKING DOCUMENT)



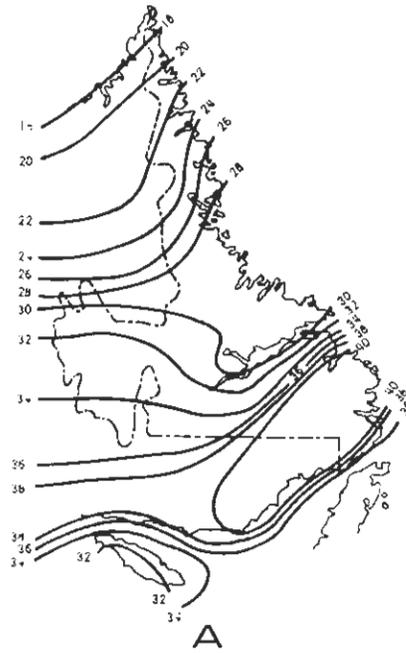
C  
PRELIMINARY ESTIMATE OF  
SQUARE GRID DISTRIBUTION OF ANNUAL PRECIPITATION  
(FROM CORRELATION WITH PHYSIOGRAPHIC FACTORS)



D  
FINAL ESTIMATE OF  
SQUARE GRID DISTRIBUTION OF ANNUAL PRECIPITATION  
(USING METEOROLOGIC AND HYDROLOGIC DATA)

NEWFOUNDLAND  
MEAN ANNUAL PRECIPITATION DISTRIBUTION

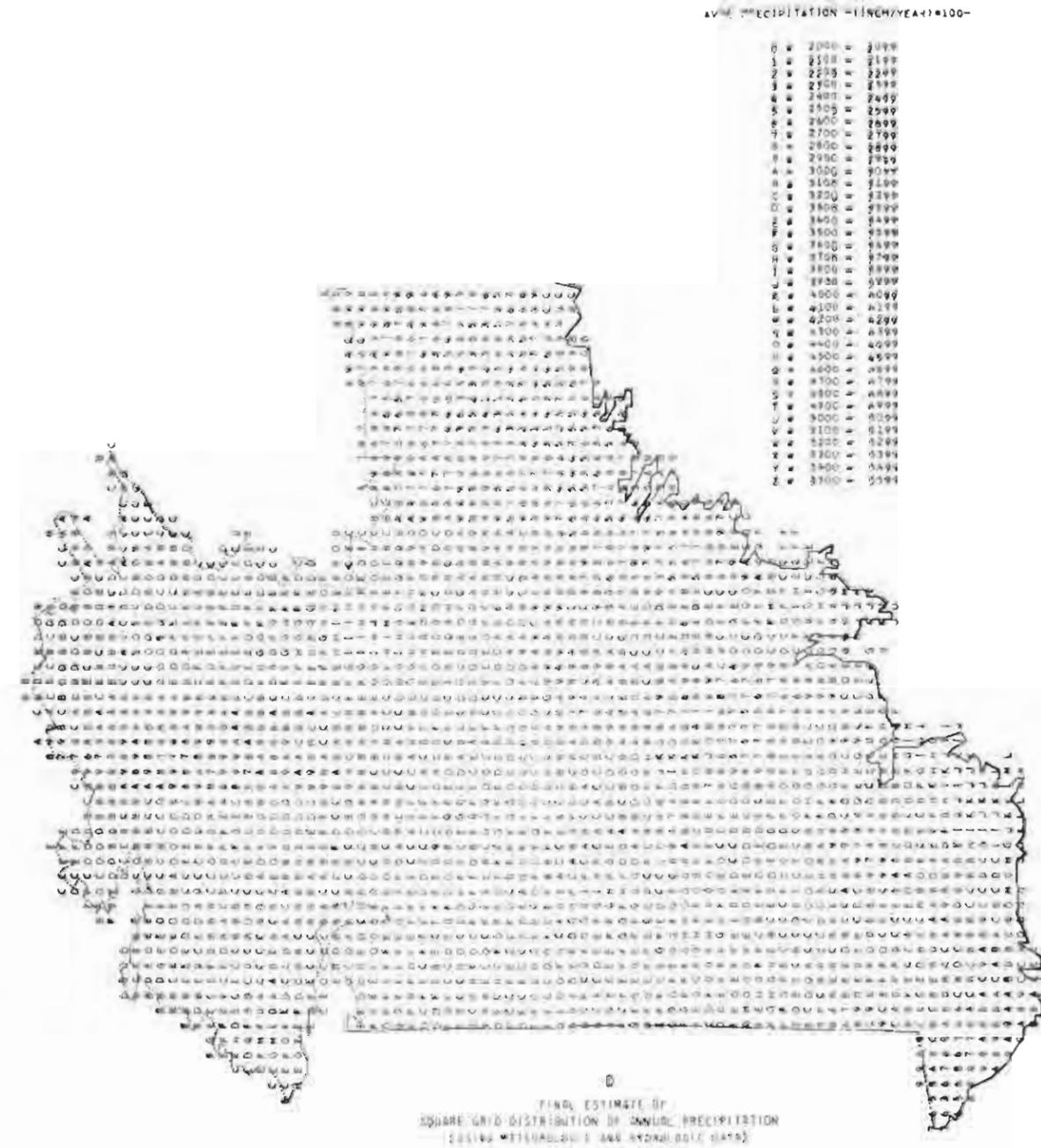
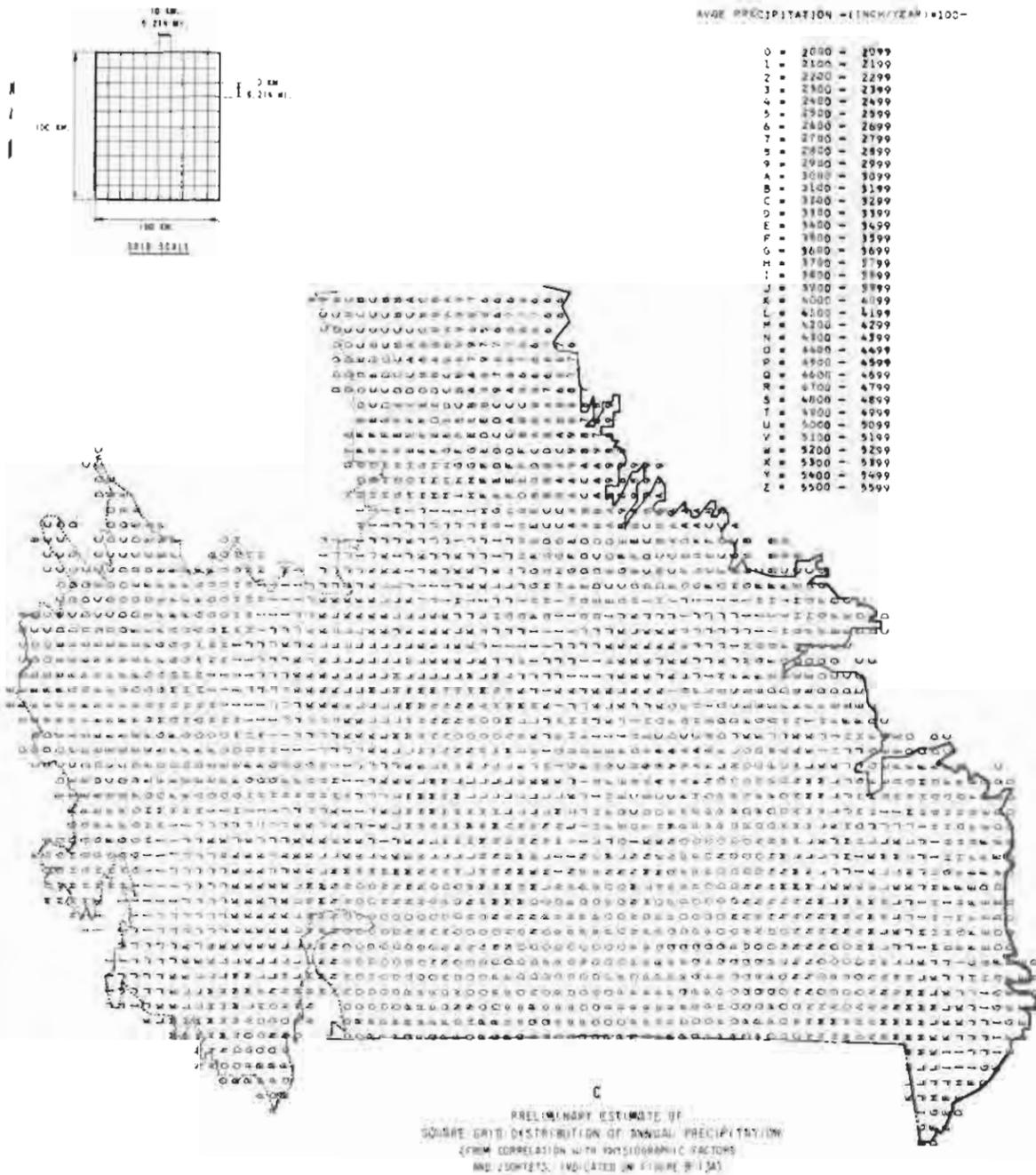
# LABRADOR MEAN ANNUAL PRECIPITATION DISTRIBUTION



ANNUAL PRECIPITATION DISTRIBUTION (INCHES)  
ACCORDING TO THE ATLAS OF CANADA  
(DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1957)



REVISED ANNUAL PRECIPITATION DISTRIBUTION (INCHES)  
(DEPARTMENT OF TRANSPORT  
METEOROLOGICAL BRANCH WORKING DOCUMENT)



LABRADOR  
MEAN ANNUAL PRECIPITATION DISTRIBUTION

NEWFOUNDLAND AND LABRADOR  
 VARIATION OF MEAN ANNUAL PRECIPITATION

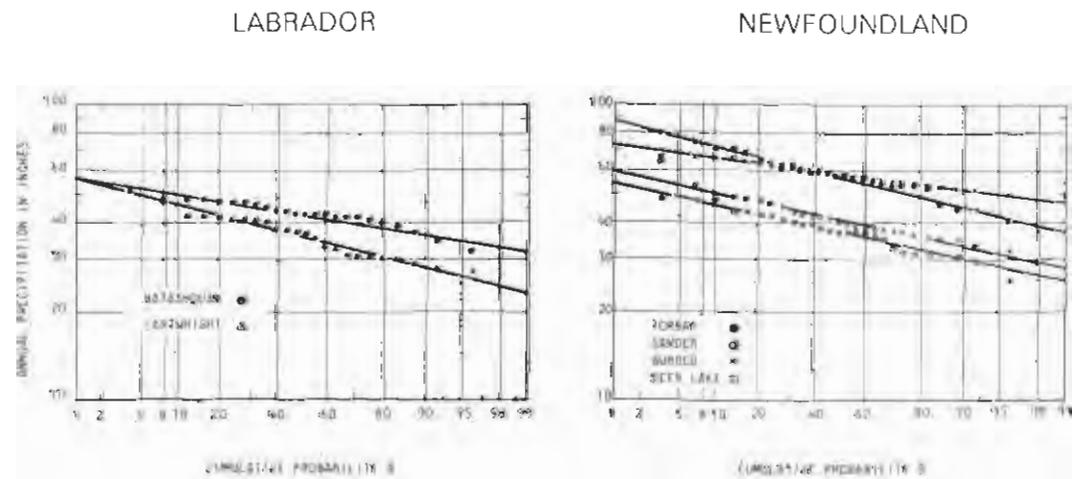
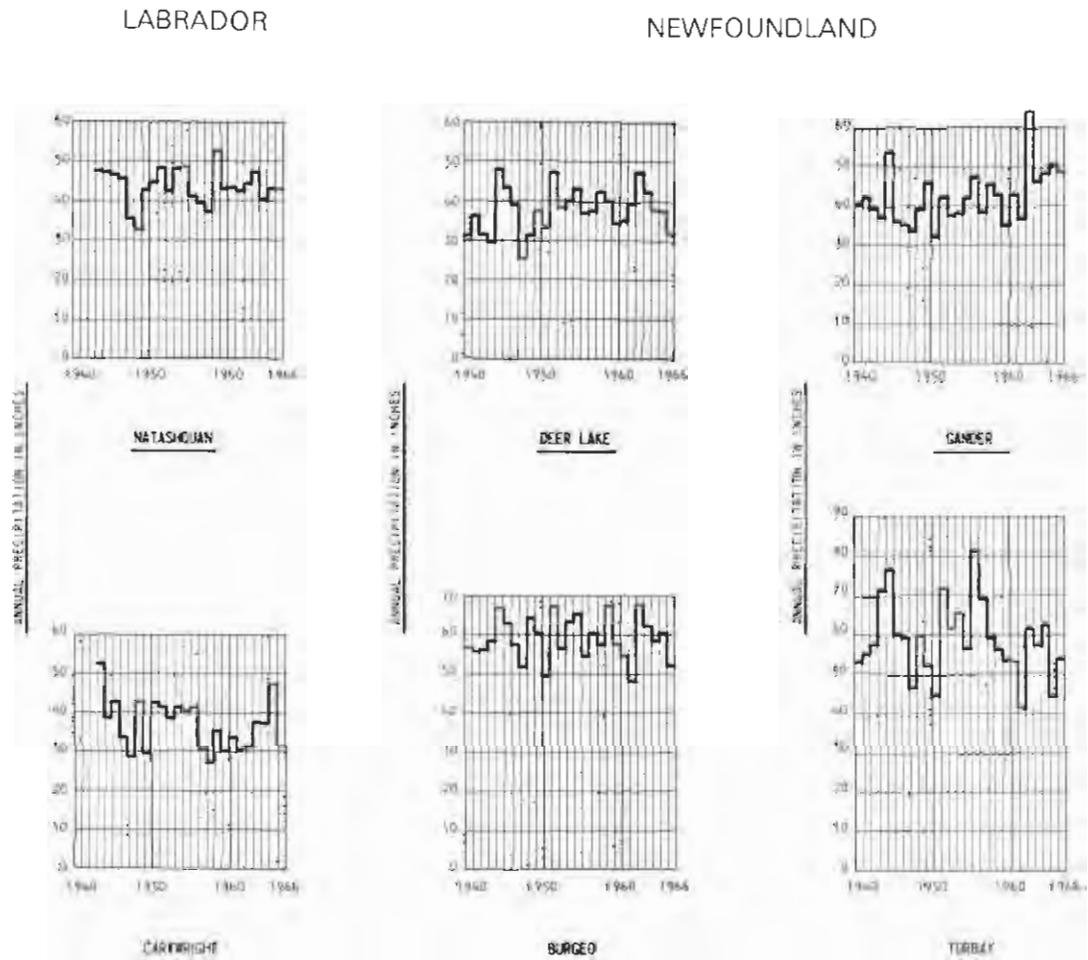
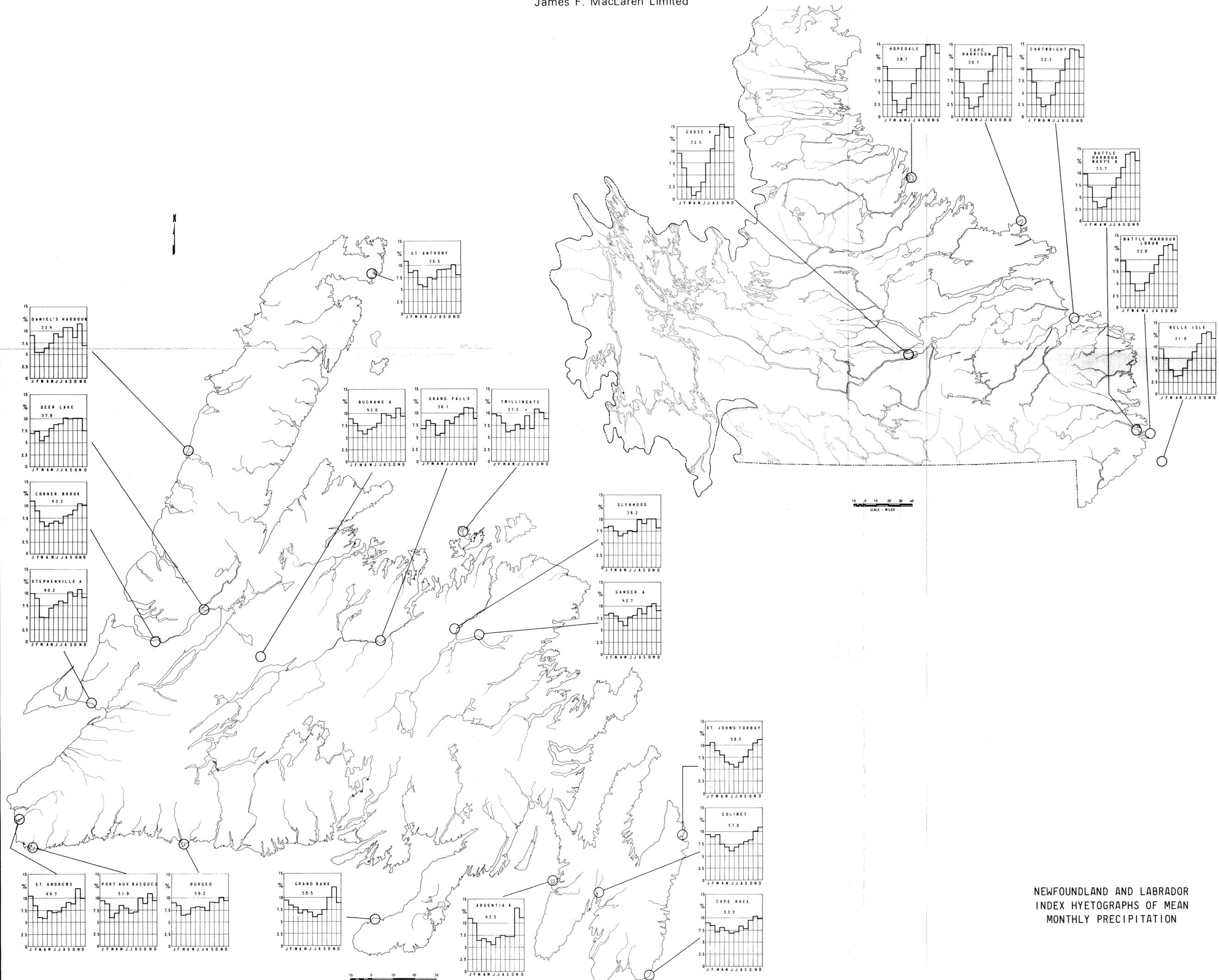


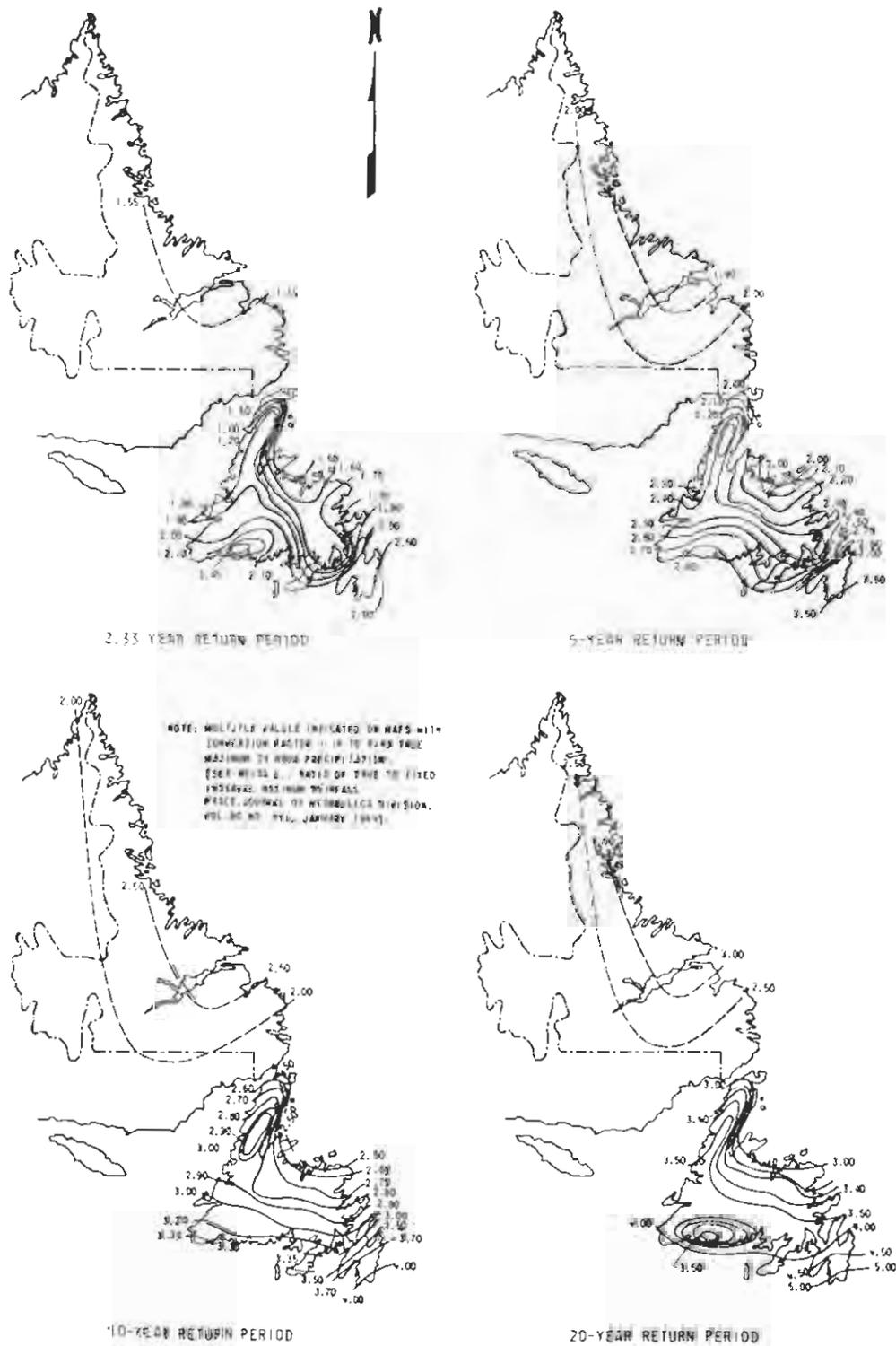
FIGURE 8-14



NEWFOUNDLAND AND LABRADOR  
INDEX HYETOGRAPHS OF MEAN  
MONTHLY PRECIPITATION

NOTE: NUMBERS REPRESENT MEAN ANNUAL PRECIPITATION

NEWFOUNDLAND AND LABRADOR  
MAXIMUM 24 HOUR PRECIPITATION  
DISTRIBUTION FOR DIFFERENT FREQUENCIES



NEWFOUNDLAND AND LABRADOR  
REGIONAL MAXIMIZED STORM PRECIPITATION  
LOCATION OF ZONES

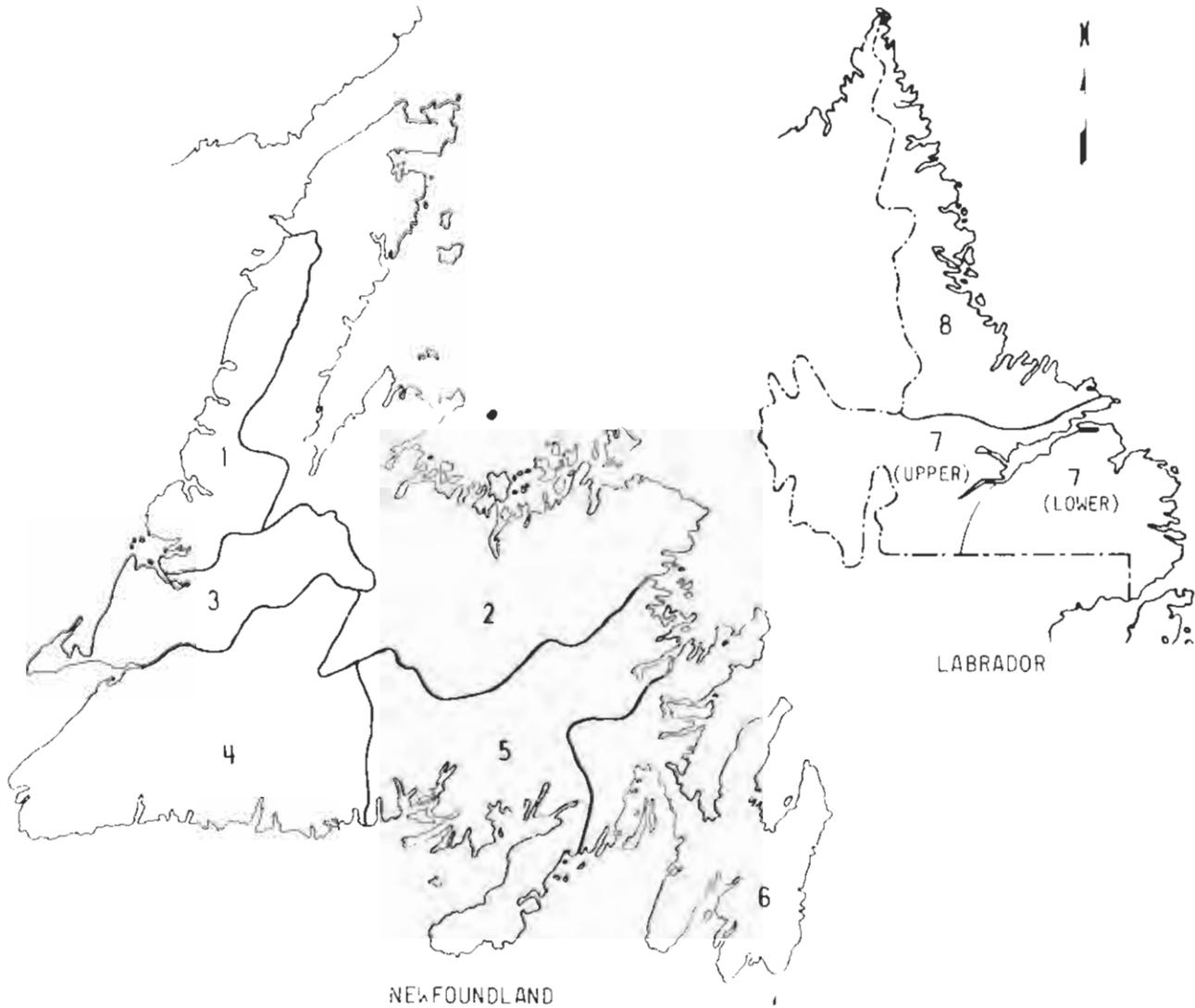
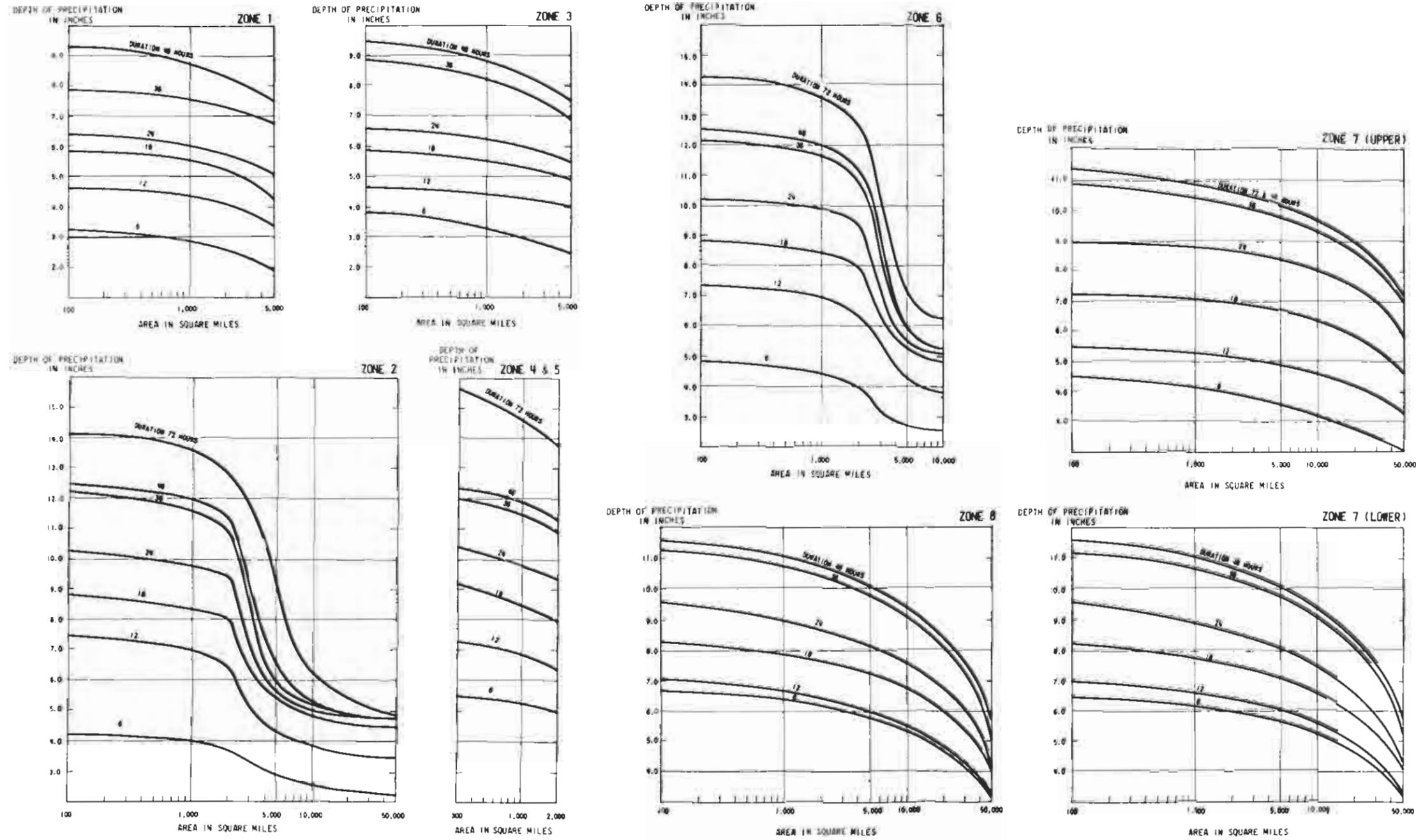
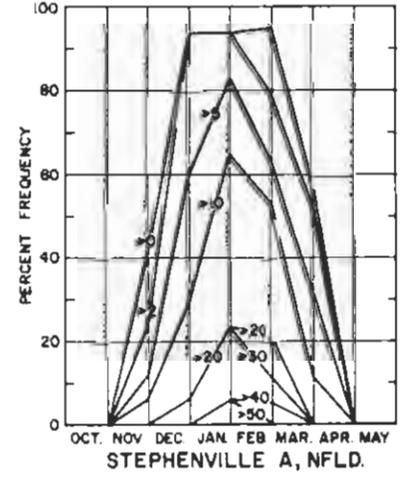
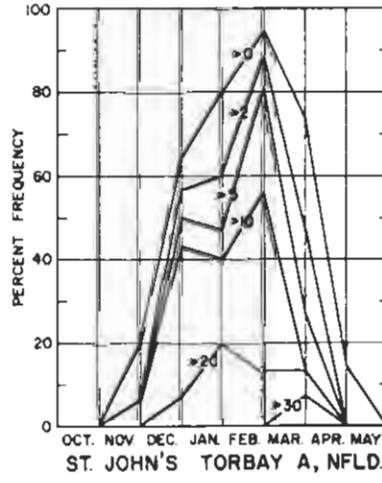
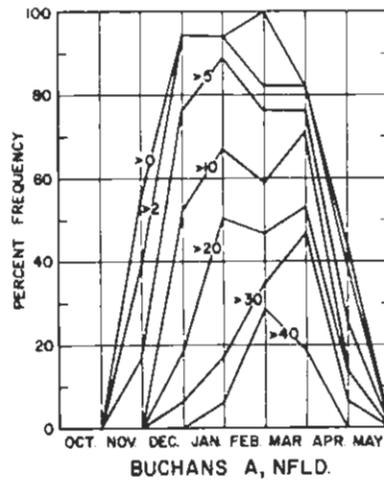
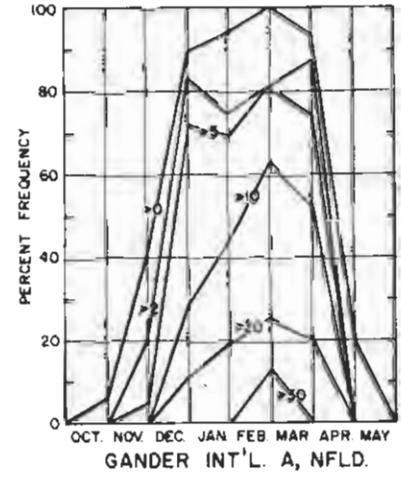
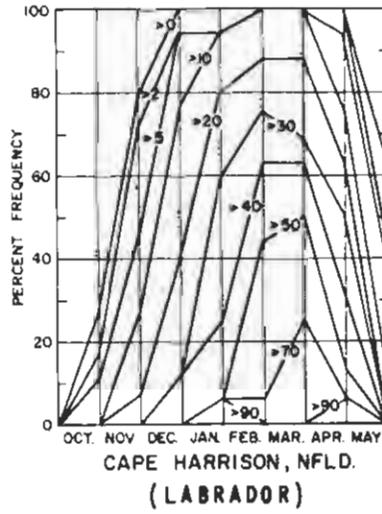
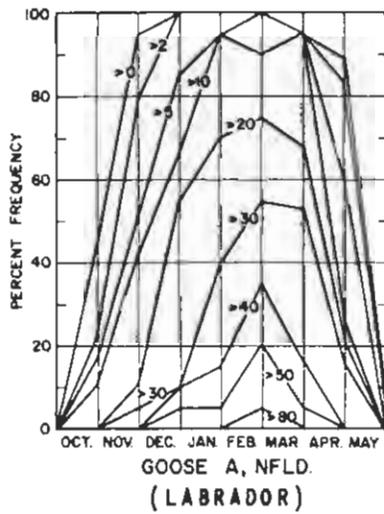


FIGURE 8-17A



NEWFOUNDLAND AND LABRADOR  
REGIONAL MAXIMIZED STORM  
PRECIPITATION-AREA  
DURATION CURVES

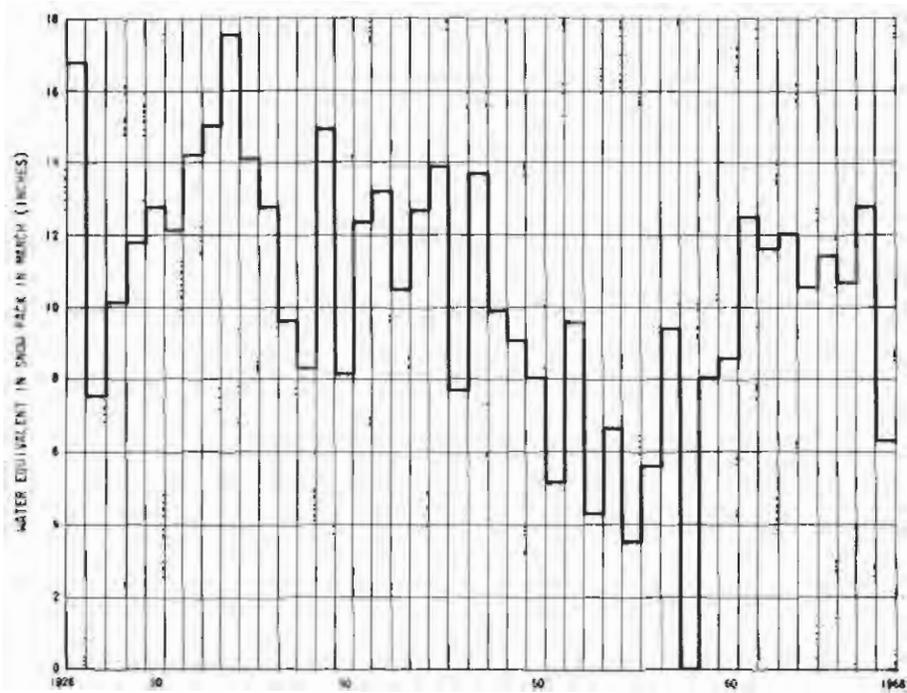
NEWFOUNDLAND AND LABRADOR  
 SNOW COVER FREQUENCIES AT SELECTED STATIONS



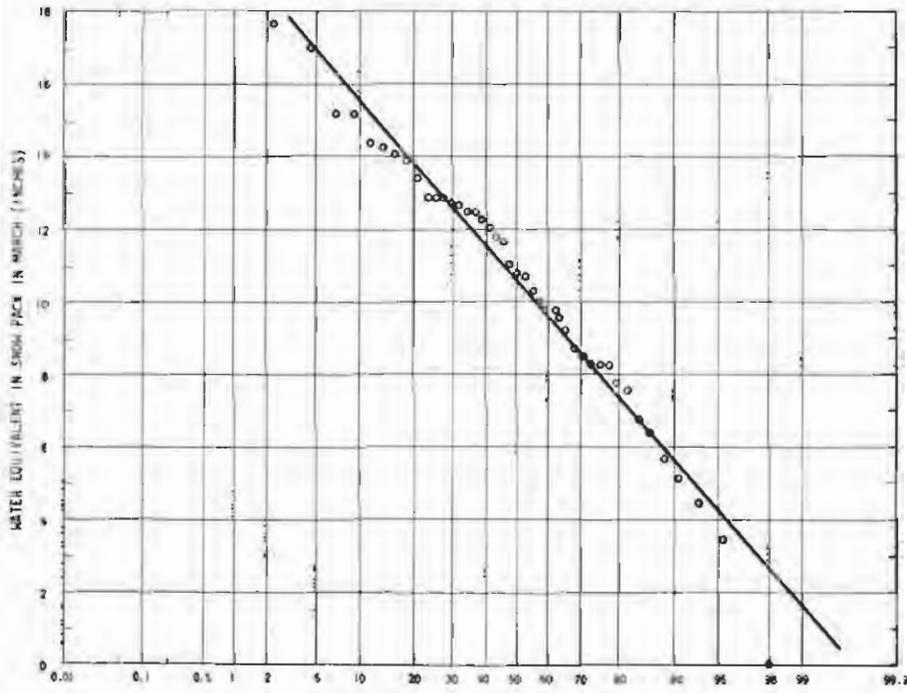
SNOW COVER IN INCHES

SOURCE: DEPARTMENT OF TRANSPORT  
 METEOROLOGICAL BRANCH  
 U.D.C. 551, 578.46  
 SNOW COVER BY J.G. POTTER.

NEWFOUNDLAND  
VARIATION IN TIME AND PROBABILITY OF WATER  
EQUIVALENT IN THE MARCH SNOW PACK IN THE  
HUMBER RIVER BASIN ABOVE THE GRAND LAKE OUTLET



8) VARIATION OF  
WATER EQUIVALENT IN SNOW PACK IN MARCH



9) PROBABILITY OF WATER EQUIVALENT IN SNOW PACK IN MARCH

### NEWFOUNDLAND AND LABRADOR MAXIMIZED SEASONAL SNOWFALL

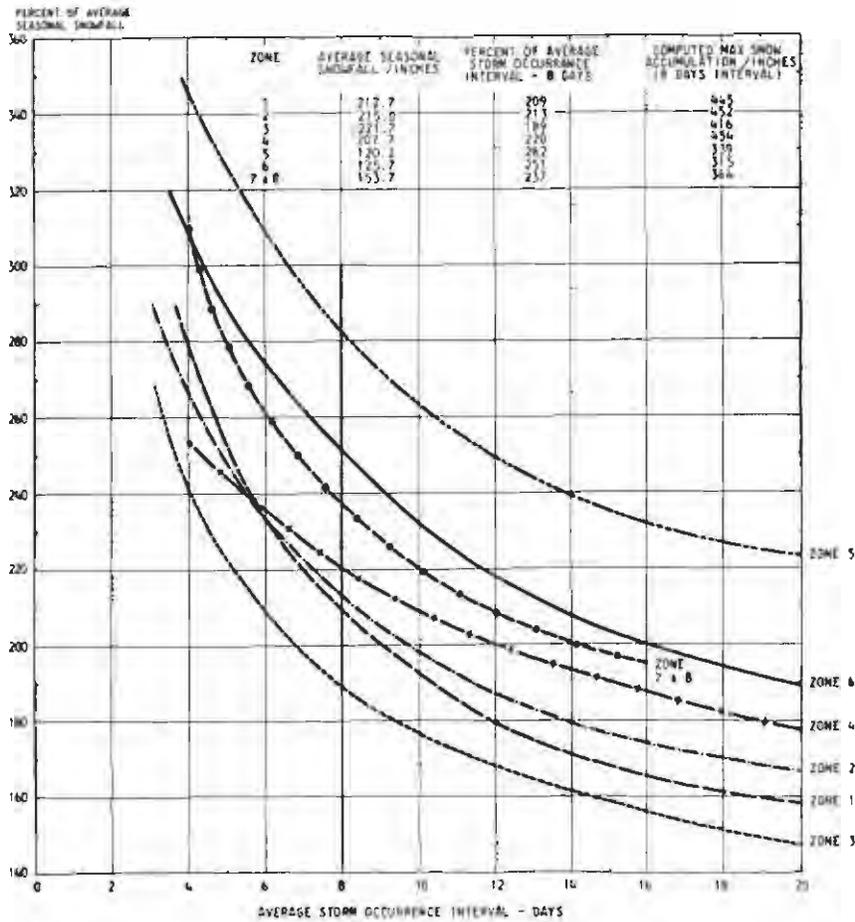
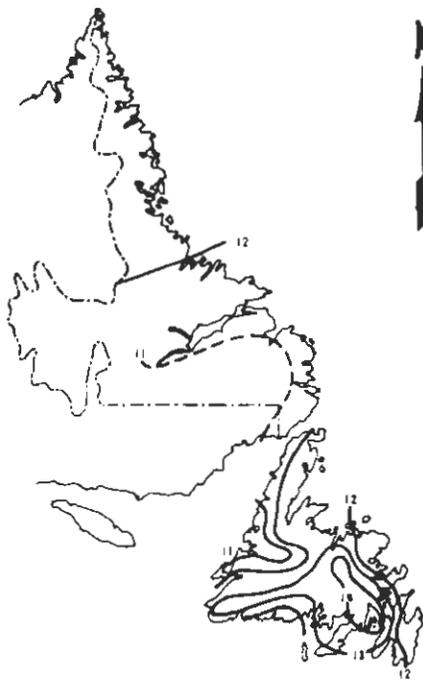
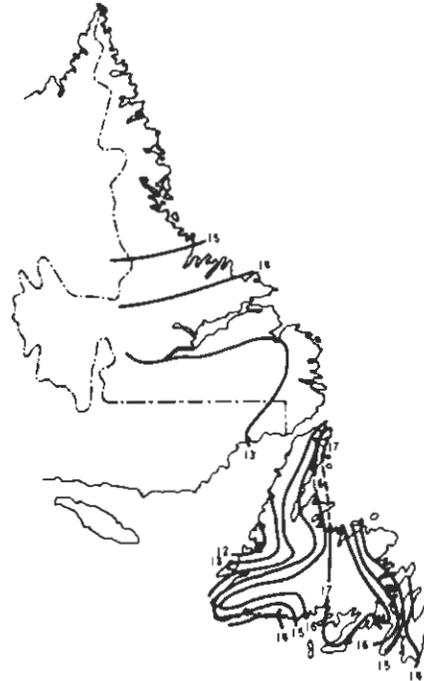


FIGURE 8-20

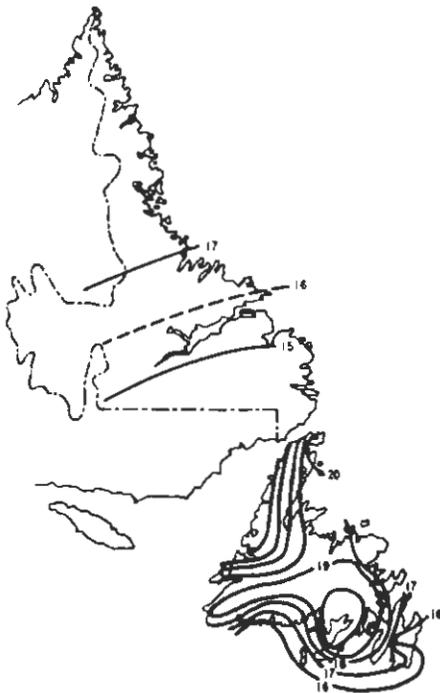
NEWFOUNDLAND AND LABRADOR  
PRELIMINARY METEOROLOGIC DROUGHT DURATION ISOLINES



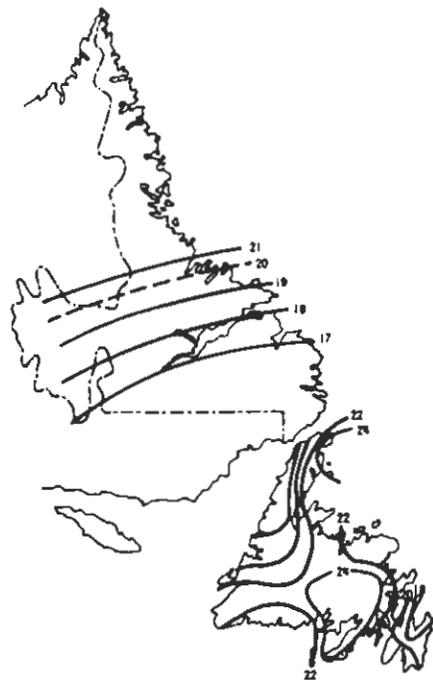
2.33-YR RETURN PERIOD



5-YR RETURN PERIOD



10-YR RETURN PERIOD



20-YR RETURN PERIOD

NEWFOUNDLAND  
 SQUARE GRID DISTRIBUTION OF  
 ANNUAL EVAPORATION

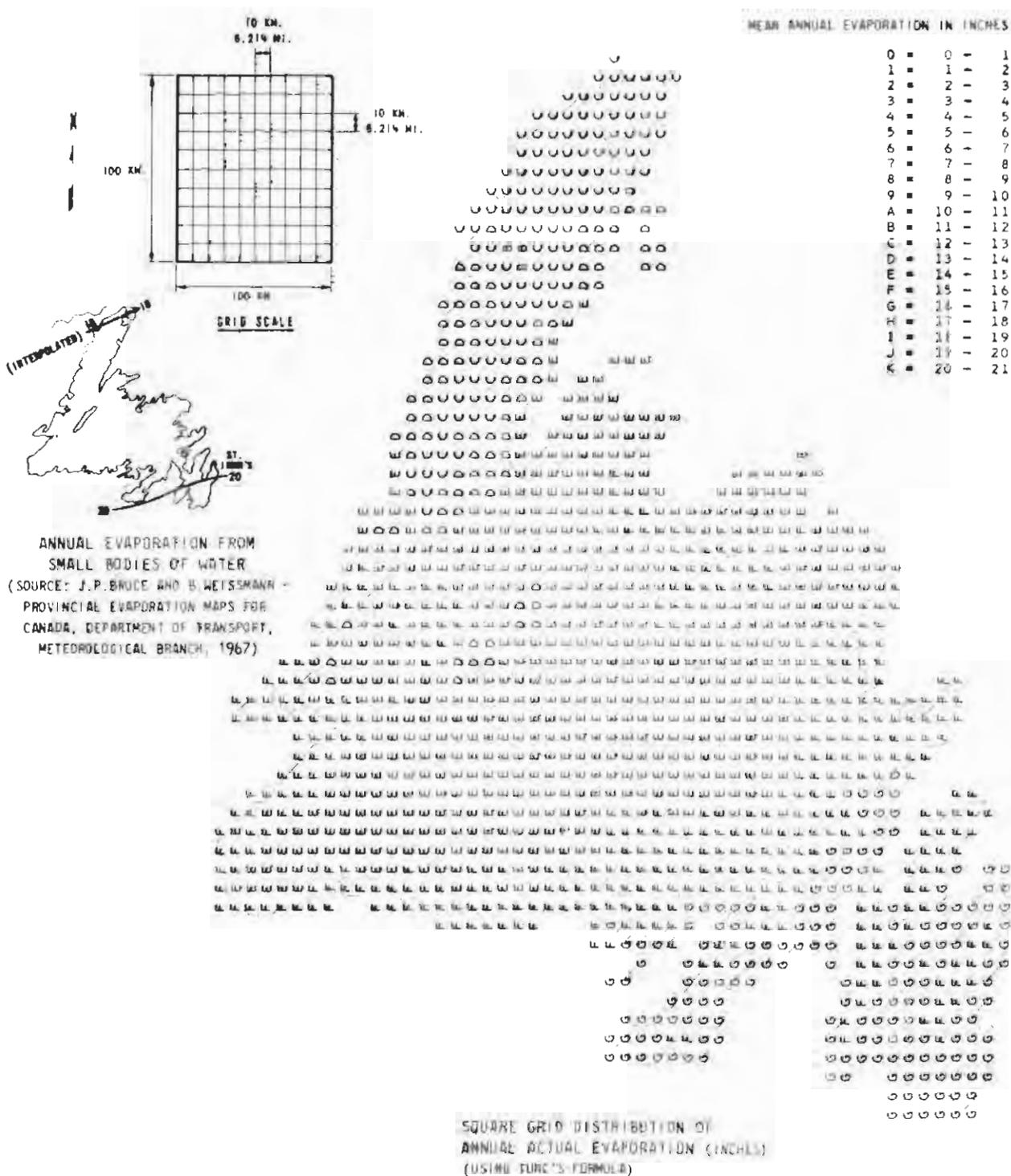
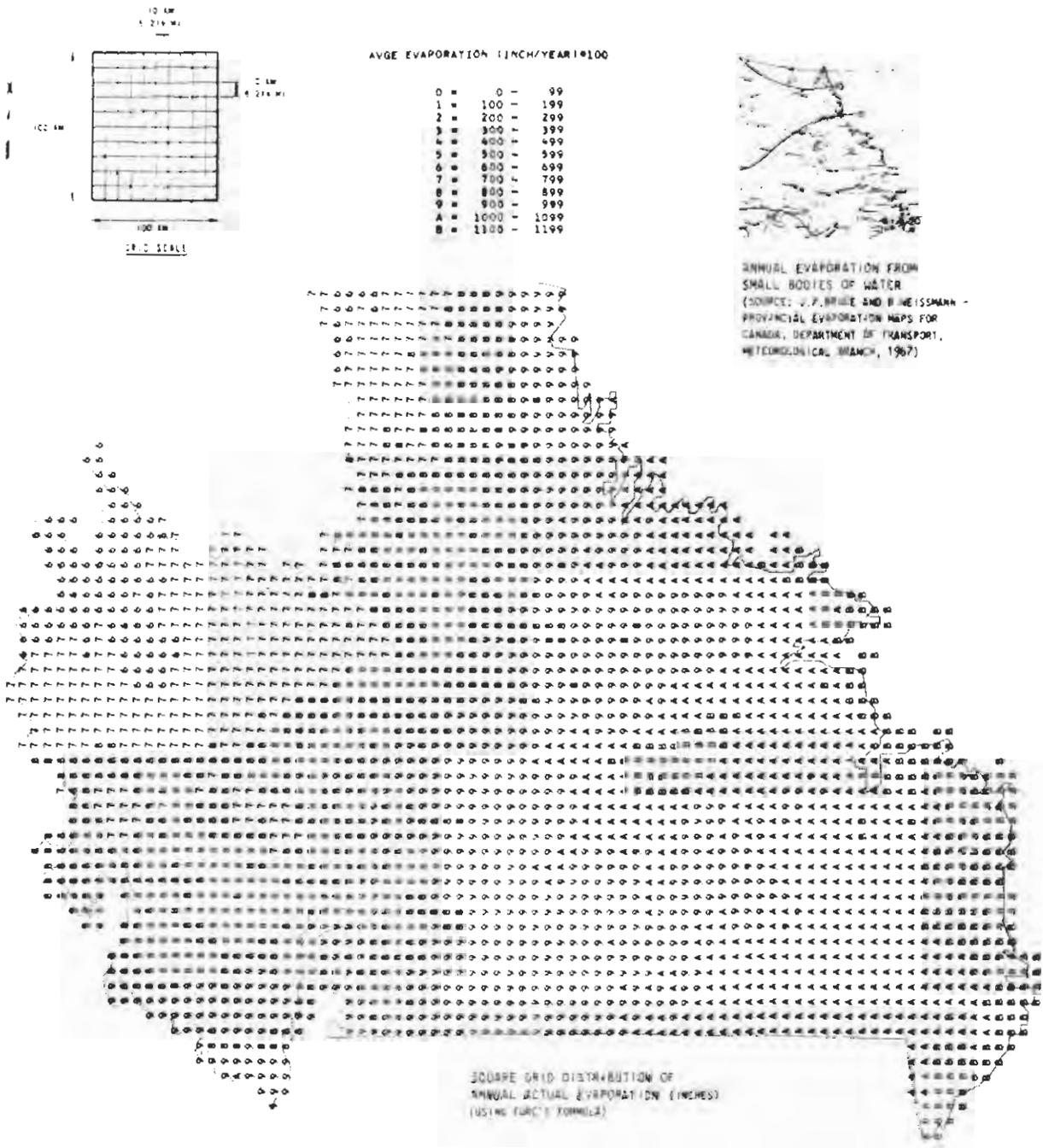


FIGURE 8-22

# LABRADOR SQUARE GRID DISTRIBUTION OF ANNUAL EVAPORATION





NEWFOUNDLAND AND LABRADOR  
CLIMATOLOGIC STATIONS CATALOGUE  
1966

CANADA DEPARTMENT OF TRANSPORT METEOROLOGICAL BRANCH - CLIMATOLOGICAL STATION CATALOGUE

Station Number	Station Name (□ Indicates part of record under another name.)	Province	Latitude	Longitude	Elevation (feet)	Date of first report year mo.	Observing Program											Periods with no change in program, location or name (indicates summer only)	
							Synoptic Report	Hourly Weather	Temperature	Precipitation	Rate of Evaporation	Wind Direction	Wind Velocity	Soil Temperature	Evaporation	Sunshine	Radiation	Air Pollution	Upper Air
NEWFOUNDLAND																			
1	8400100 ARGENTIA A	NFLD	47 18	054 00	55	1943 03	X	X	X	X								1943 03	
2	8500200 ASHIANIPI	NFLD	52 32	066 14	1790	1948 10	X	X	X	X	X							1948 10	1950 11
	8500200 ASHIANIPI	NFLD	52 32	066 14	1790	1948 10	X	X	X	X	X							1950 12	1950 12
	8500200 ASHIANIPI	NFLD	52 32	066 14	1790	1948 10												1951 01	1951 03
3	8400225 AVONDALE	NFLD	47 24	053 14	435	1955 07			X	X								1955 07	1961 12
	8400225 AVONDALE TMA	NFLD	47 24	053 14	435	1955 07			X	X								1962 01	
4	8400250 BALCAJEN	NFLD	48 07	052 48	443	1936 08												1936 08	1950 07
	8400300 BADGER	NFLD	48 59	056 03	330	1955 08					X							1955 08	1958 06
5	8400300 BADGER	NFLD	48 59	056 03	330	1955 08			X	X								1958 06	1963 09
	8400300 BADGER	NFLD	48 59	056 03	330	1955 08			X	X								1964 10	1964 11
	8400300 BADGER	NFLD	48 59	056 03	330	1955 08			X	X								1965 04	1966 05
	8400300 BADGER	NFLD	48 59	056 03	330	1955 08			X	X									
6	8400350 RAJE VERTE	NFLD	49 58	056 12	15	1958 06			X	X								1958 06	1962 12
	8400350 RAJE VERTE	NFLD	49 59	056 11	162	1958 06			X	X								1963 08	
7	8500395 BATTLE HARBOUR	NFLD	52 17	055 36	50	1947 09												1947 09	1952 01
	8500395 BATTLE HARBOUR	NFLD	52 17	055 36	50	1947 09			X	X								1952 03	1956 09
	8500395 BATTLE HARBOUR	NFLD	52 17	055 36	50	1947 09			X	X								1957 06	
8	8500398 BATTLE HARBOUR LORAN	NFLD	52 15	055 36	31	1957 10	X	X	X	X								1957 10	1958 10
	8500398 BATTLE HARBOUR LORAN	NFLD	52 15	055 36	31	1957 10	X	X	X	X								1958 10	
9	8500400 BATTLE HARBOUR MARYS R	NFLD	52 14	055 40	90	1956 11			X	X								1956 11	
10	8400415 BAY D'ESPOIR ST ALBANS	NFLD	47 58	055 51	754	1966 02	X	X	X	X								1966 02	1966 03
	8400415 BAY D'ESPOIR ST ALBANS	NFLD	47 58	055 51	754	1966 02	X	X	X	X								1966 04	
11	8400420 BAY OF ISLANDS	NFLD	48 55	058 00	60	1875 12			X									1875 12	1876 04
	8400420 BAY OF ISLANDS	NFLD	48 55	058 00	60	1875 12			X									1879 01	1880 03
12	8400430 BAY ST GEORGE	NFLD	48 26	058 29	8	1873 03			X									1873 03	1873 05
	8400430 BAY ST GEORGE	NFLD	48 26	058 29	8	1873 03			X	X								1873 05	1879 04
13	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08			X	X								1871 08	1882 02
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08			X	X								1882 02	1882 10
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08			X	X								1882 10	1883 07
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1883 08	1900 10
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1910 08	1914 07
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1916 12	1919 12
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1920 08	1933 06
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1933 11	1956 09
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1956 09	1957 12
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1958 01	1960 09
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1960 10	1960 12
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1961 01	1962 03
	8500500 BELLE ISLE	NFLD	51 53	055 23	426	1871 08	X	X	X	X								1962 04	1963 03



The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

CANADA DEPARTMENT OF TRANSPORT, METEOROLOGICAL BRANCH - CLIMATOLOGICAL STATION CATALOGUE

Station Number	Station Name (□ Indicates part of record under another name.)	Province	Latitude	Longitude	Elevation (feet)	Date of first report year mo.	Observing Program												Periods with no change in program, location or name (*indicates summer only)		
							Synoptic Report	Hourly Weather	Temperature	Precipitation	Rate of Rainfall	Wind Velocity	Soil Temperature	Evaporation	Sunshine	Air Pollution	Upper Air	Sea Level	Other	Began year mo.	Ended year mo.
26	8400850 CAPE BROYLE	NFLD	47 07	052 58	210	1955 10				X										1955 10	1957 06
	8400850 CAPE BROYLE	NFLD	47 06	052 56	70	1955 10				X											1957 06
27	8500900 CAPE HARRISON	NFLD	54 46	058 27	33	1943 11	X	P	X	X										1943 11	1950 11
	8500900 CAPE HARRISON	NFLD	54 46	058 27	33	1943 11	X	P	X	X										1950 12	1951 05
	8500900 CAPE HARRISON	NFLD	54 46	058 27	33	1943 11	X	X	X	X										1951 06	1954 08
	8500900 CAPE HARRISON	NFLD	54 46	058 27	33	1943 11	X	X	X	X										1954 09	1955 09
	8500900 CAPE HARRISON	NFLD	54 46	058 27	33	1943 11	X	X	X	X										1955 10	1961 12
28	8400940 CAPE NORMAN	NFLD	51 38	055 54	61	1882 11				X	Y									1882 11	1938 09
	8400940 CAPE NORMAN	NFLD	51 38	055 54	61	1882 11				X	X									1939 03	1939 03
	8400940 CAPE NORMAN	NFLD	51 38	055 54	61	1882 11				X	X									1941 01	1946 12
29	8400950 CAPE PINE	NFLD	46 37	053 32	314	1936 09				P										1936 09	1951 06
30	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1920 10	1920 10
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1920 11	1934 01
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1934 02	1934 06
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1934 07	1942 11
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1942 12	1943 09
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1943 10	1947 03
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1947 04	1948 06
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1948 07	1948 07
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1948 08	1948 11
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1948 12	1949 11
	8401000 CAPE RACE	NFLD	46 39	053 04	99	1920 10	X	P	X	X										1949 12	1953 09
31	8401050 CAPE ST FRANCIS	NFLD	47 48	052 49	123	1936 09				P										1936 09	1951 06
32	8401060 CAPE SPEAR	NFLD	47 32	052 37	264	1936 09				P										1936 09	1943 08
33	8401100 CARTWRIGHT PROJECT	NFLD	52 57	066 54		1959 09				X										1959 09	1960 07
34	8501100 CARTWRIGHT	NFLD	53 43	057 01	34	1934 11	X	P	X	X										1934 11	1936 11
	8501100 CARTWRIGHT	NFLD	53 43	057 01	34	1934 11	X	P	X	X										1937 08	1937 09
	8501100 CARTWRIGHT	NFLD	53 43	057 01	34	1934 11	X	P	X	X										1937 10	1950 08
	8501100 CARTWRIGHT	NFLD	53 43	057 01	34	1934 11	X	P	X	X										1950 07	1963 05
	8501100 CARTWRIGHT	NFLD	53 43	057 01	34	1934 11	X	P	X	X										1963 06	1963 09
	8501100 CARTWRIGHT	NFLD	53 43	057 01	47	1934 11	X	P	X	X										1963 09	
35	8401125 CHANNEL	NFLD	47 37	059 09	50	1873 11				X	X									1873 11	1877 03
	8401125 CHANNEL	NFLD	47 37	059 09	50	1873 11	X	P	X	X										1877 04	1884 01
	8401125 CHANNEL	NFLD	47 37	059 09	50	1873 11				X										1892 02	1893 04
	8401125 CHANNEL	NFLD	47 37	059 09	50	1873 11				X	X									1893 05	1895 12
	8401125 CHANNEL	NFLD	47 37	059 09	50	1873 11				X	X									1898 08	1899 01
	8401125 CHANNEL	NFLD	47 37	059 09	50	1873 11				X	X									1934 11	1936 09
	8401125 CHANNEL	NFLD	47 37	059 09	50	1873 11				X	X									1936 11	1949 03
36	8401150 DEJAYS	NFLD	47 12	052 57	400	1955 10				X										1955 10	1959 05
	8401150 DEJAYS	NFLD	47 12	052 57	400	1955 10				X										1960 02	1960 05







The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

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							Synoptic Report	Hourly Weather	Temperature	Precipitation	Rate of Rainfall	Wind Velocity	Sea Temperature	Evaporation	Soil Moisture	Air Pollution	Upper Air	Space Survey	Other	Began year mo.	Ended year mo.
							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
70	8402310 HOLYROOD GOLDEN EAGLE	NFLD	47 23	053 08	23	1961 12		X	X									1964 09	1965 07		
	8402310 HOLYROOD GOLDEN EAGLE	NFLD	47 23	053 08	23	1961 12		X	X									1965 08	1965 11		
	8402310 HOLYROOD GOLDEN EAGLE	NFLD	47 23	053 08	23	1961 12		X	X									1965 12			
	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1942 01	1944 04		
	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1944 05	1945 07		
	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1945 08	1946 07		
	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1946 09	1947 11		
71	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1947 12	1948 06		
	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1948 07	1952 08		
	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1952 09	1963 06		
	8502400 HOPEDALE	NFLD	55 27	060 14	35	1942 01	X	X	X									1963 06			
72	8402415 HUNLEY	NFLD	49 11	057 06	384	1934 11		X	X									1934 11	1935 05		
	8402415 HUNLEY	NFLD	49 11	057 06	384	1934 11		X										1937 02	1944 06		
73	8402450 ISLE AUX MORTS	NFLD	47 35	058 59		1898 03		X	X									1898 03	1898 07		
74	8402300 LAKE AMBRUSE	NFLD	48 35	056 39	862	1955 08			X									1955 08	1956 06		
	8402300 LAKE AMBRUSE	NFLD	48 35	056 39	862	1955 08			X									1956 08	1957 08		
75	8402515 LAMARINE	NFLD	46 52	055 49	64	1937 06		X										1937 06	1947 08		
	8402515 LAMARINE	NFLD	46 52	055 49	64	1937 06		X										1943 03	1943 07		
76	8402544 LETHBRIDGE	NFLD	48 22	053 53	70	1954 01			X									1954 01	1957 12		
	8402544 LETHBRIDGE	NFLD	48 22	053 53	70	1954 01			X									1956 05	1956 10		
	8402544 LETHBRIDGE COMM	NFLD	48 22	053 53	70	1954 01			X									1942 06	1952 11		
77	8402570 LONG POINT	NFLD	49 40	054 47	510	1936 09		X										1936 09	1938 07		
	8402570 LONG POINT	NFLD	49 40	054 47	510	1936 09		X										1938 08	1940 08		
	8402570 LONG POINT	NFLD	49 40	054 47	510	1936 09		X										1938 09	1943 08		
78	8402588 LORAINSE THICK	NFLD	48 21	059 14	455	1958 08			X									1958 08	1959 08		
79	8502600 MENTHER RAPIDS	NFLD	54 28	066 37	1605	1952 04	X	X	X									1952 04	1953 12		
	8502600 MENTHER RAPIDS	NFLD	54 28	066 37	1605	1952 04	X	X	X									1954 04	1960 04		
	8502600 MENTHER RAPIDS	NFLD	54 28	066 37	1605	1952 04	X	X	X									1960 10	1961 04		
80	8502700 MILL 1A2	NFLD	52 33	065 43	1970	1952 07	X	X	X									1952 07	1953 07		
	8502700 MILL 1A2	NFLD	52 33	065 43	1970	1952 07	X	X	X									1952 04	1953 04		
	8502700 MILL 1A4	NFLD	52 33	065 43	1970	1952 07	X	X	X									1953 05	1953 05		
81	8502740 MILL 2A4	NFLD	52 36	065 14	1740	1957 03		X										1955 03	1959 10		
82	8402750 MILL 1A2	NFLD	49 00	056 21	692	1944 11	X	X	X									1944 11	1954 11		
	8402750 MILL 1A2	NFLD	49 00	056 21	692	1944 11	X	X	X									1953 01	1949 07		
	8402750 MILL 1A2	NFLD	49 00	056 21	692	1944 11	X	X	X									1948 09	1948 09		
83	8502800 NAIN	NFLD	56 33	063 48	20	1926 11	X	X	X									1926 11	1930 12		
	8502800 NAIN	NFLD	56 33	063 48	20	1926 11	X	X	X									1932 07	1932 12		
	8502800 NAIN	NFLD	56 33	063 48	20	1926 11	X	X	X									1933 01	1933 07		
	8502800 NAIN	NFLD	56 33	063 48	20	1926 11	X	X	X									1934 10	1935 08		
	8502800 NAIN	NFLD	56 33	063 48	20	1926 11	X	X	X									1935 09	1935 08		











The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

ST. JOHN'S WEST CDA

GOOSE BAY A

Year	Month	Solar Radiation in Langley's			Average Temperature in degrees F	Average Cloudiness in percent	Total Bright Sunshine in hours	Year	Month	Solar Radiation in Langley's			Average Temperature in degrees F	Average Cloudiness in percent	Total Bright Sunshine in hours
		Max	Mean	Min						Max	Mean	Min			
1966	June	722	454	174	52.9	77	158.6	1966	June	765	443	109	51.9	74	196.9
	July	---	incomplete---		61.9	70	213.0		July	694	407	57	58.8	74	187.0
	August	---	incomplete---		59.8	74	212.8		August	613	347	59	58.2	81	139.6
	September	485	263	44	51.5	63	137.1		September	486	272	69	50.0	71	139.8
	October	359	151	18	45.8	75	97.8		October	298	123	20	39.6	76	84.7
	November	228	91	20	42.0	80	62.1		November	171	76	22	28.1	77	67.3
	December	129	55	12	35.5	88	29.9		December	111	57	8	13.2	69	72.2
	1967	January	183	55	17	25.3	80		82.9	1967	January	142	87	15	-2.6
February		295	176	30	23.0	73	122.8	February	266		170	67	-0.5	58	93.4
March		446	265	62	24.5	77	99.5	March	498		335	130	8.2	53	204.0
April		674	358	90	30.1	78	124.6	April	643		431	110	24.3	59	170.2
May		703	367	85	41.7	76	144.2	May	742		406	114	40.9	77	139.6
June		738	523	78	54.5	61	252.7	June	774		508	121	57.4	71	237.6
July		---	incomplete---		64.6	69	238.9	July	697		411	120	62.0	78	191.8
August		596	394	146	66.4	67	204.3	August	520		419	86	63.4	64	224.1
September		450	283	82	55.5	66	139.8	September	515		252	22	50.2	71	116.8
October		342	173	39	47.9	69	96.4	October	311		163	42	39.3	62	118.3
November		196	102	11	42.0	76	83.7	November	150		78	16	27.5	73	70.2

NEWFOUNDLAND AND LABRADOR  
SUMMARY OF RADIATION DATA

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND

LONG TERM ANNUAL PRECIPITATION AND TEMPERATURE  
AVERAGES USED IN THE CORRELATION WITH  
PHYSIOGRAPHIC CHARACTERISTICS

# STA.	STATION	PRECIP. MEASUREMENTS TAKEN	AVGE PRECIP. USED IN THE STUDY ( INCHES)	TEMP. MEASUREMENTS TAKEN	AVGE TEMP. USED IN THE STUDY ( °F)
1	ARGENTIA A.	X	43.5	X	41.7
2	AVONDALE CDA	X		X	
3	BADGER	X	36.2	X	39.3
4	BAIE VERTE	X	41.0	X	38.1
5	BONAVISTA	X	44.1	X	39.8
6	BUCHANS	X	42.0	X	36.9
7	BURGED	X	59.2	X	39.5
8	CAPE BROYLE	X	57.9		
9	CAPE RACE	X	53.3	X	39.7
10	COLINET	X	57.0	X	41.1
11	COLINET PEAT BOG CDA	X	57.0	X	40.7
12	CORNER BROOK	X	43.3	X	40.6
13	DANIELS HARBOUR	X	33.4	X	38.0
14	DEER LAKE	X	37.9	X	39.3
15	DEER LAKE A	X		X	
16	EXPLOITS DAM	X	42.0	X	38.5
17	FOGO	X		X	
18	GANDER INTERNATIONAL A	X	42.7	X	39.7
19	GLENWOOD	X	38.2	X	39.7
20	GRAND BANK	X	50.5	X	41.9
21	GRAND FALLS	X	36.1	X	40.3
22	GULL POND	X		X	
23	HEARTS CONTENT	X	51.6	X	41.9
24	HOLYROOD	X	41.4	X	40.2
25	HOLYROOD GOLDEN EAGLE	X		X	
26	NEW CHELSEA	X	54.0	X	41.9
27	PETTY HARBOUR	X	48.6		
28	PIERRES BROOK	X	60.0		
29	PORT AUX BASQUES	X	51.9	X	39.7
30	RATTLING BROOK MORRIS ARM	X		X	40.3
31	ST. ALBANS	X		X	40.3
32	ST. ANDREWS	X	44.7	X	40.5
33	ST. ANTHONY	X	36.5	X	34.9
34	ST. ANTHONY A.	X		X	
35	ST. JOHNS	X	60.3	X	41.8
36	ST. JOHNS TORBAY A	X	59.5	X	40.6
37	ST. JOHNS WEST CDA	X	62.5	X	40.8
38	SEAL COVE	X	55.2	X	42.6
39	SPRINGDALE	X	34.9	X	39.1
40	STEPHENVILLE A	X	40.2	X	40.8
41	TERRA NOVA NAT PARK H.Q.	X		X	40.5
42	TERRA NOVA NAT PARK S	X		X	
43	TOPSAIL	X			
44	TORS COVE	X	54.0		
45	TWILLINGATE	X	37.5	X	39.8
46	WESTBROOK ST. LAWRENCE	X	57.0		
47	WHALESBACK	X			

TABLE 8-3A

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

LABRADOR

LONG TERM ANNUAL PRECIPITATION AND TEMPERATURE  
AVERAGES USED IN THE CORRELATION WITH  
PHYSIOGRAPHIC CHARACTERISTICS

STA.	STATION	PRECIP. MEASUREMENTS	AVGE PRECIP. USED IN THE STUDY ( INCHES )	TEMP. MEASUREMENTS TAKEN	AVGE TEMP. USED IN THE STUDY ( F )
1	BATTLE HARBOUR	X	33.7	X	33.1
2	BATTLE HARBOUR LORAN	X	27.8	X	32.9
3	BATTLE HARBOUR MARY'S RIVER	X	-	X	35.7
4	BELLE ISLE	X	34.2	X	31.9
5	CAPE HARRISON	X	31.9	X	30.7
6	CARTWRIGHT	X	36.9	X	32.3
7	GOOSE A	X	34.0	X	32.3
8	HOPEDALE	X	30.0	X	28.7
9	MENIHEK RAPIDS	X	26.6	X	24.2
10	NAIN	X	20.7	X	25.5
11	SANDGIRT LAKE	X	36.6	X	25.1
12	TWIN FALLS	X	-	X	25.2
13	WABUSH LAKE	X	32.2	X	25.2

NEWFOUNDLAND  
CORRELATION BETWEEN  
TEMPERATURE AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 4

F LEVEL 6.086

STANDARD ERROR OF DEP VARIABLE = 6.0363

CONSTANT 426.8329

R = .863

VARIABLE	COEFF	STANDARD ERROR/
X - 1	-0.77192476	0.10060913
X - 2	0.08199127	0.02341455
X - 7	0.12031129	0.03833969
X - 8	-0.01969581	0.00798359

LATITUDE (J) COORDINATE OF SQUARE IN MASTER FILE - SEE APPENDIX A)  
DISTANCE TO THE SEA IN SOUTH WEST DIRECTION - KILOMETERS  
AVERAGE BARRER HEIGHT IN SOUTH EAST DIRECTION - (FEET X 10)  
ACTUAL ELEVATION OF STATION FEET

ACTUAL	PREDICTED	DEVIATION	ACTUAL	PREDICTED	DEVIATION
409.00006	405.95269	-1.95263	397.00006	399.08972	-2.08966
397.00006	399.18682	-2.18676	398.00006	394.71228	3.28778
418.00006	414.29632	-3.29626	397.00006	396.91906	0.08099
406.00006	412.28149	-3.71856	417.00006	408.73974	8.26031
395.00006	398.76141	-3.76134	405.00006	398.11846	6.88159
350.00006	377.71275	-2.71279	411.00006	413.59448	-2.59442
393.00006	413.61377	-1.61371	407.00006	408.44445	-1.44439
369.00006	377.84271	-7.84265	419.00006	404.80932	14.19073
385.00006	383.16588	-3.16582	402.00006	413.37402	-11.37396
381.00006	389.72112	-8.72112	419.00006	414.94464	-4.05542
393.00006	390.25701	2.74304	398.00006	403.85247	-5.85241
391.00006	398.29486	-7.29480	426.00006	414.84711	11.15294
403.00006	401.59521	1.40484	397.00006	414.08166	-17.08160
419.00006	414.38346	4.61659	408.00006	401.25018	6.74987
403.00006	395.18920	7.81086	406.00006	402.03601	3.96405
349.00006	350.50947	-1.50933	418.00006	417.03057	10.96948
403.00006	399.44504	3.55501			

TEMP (F X 10<sup>1</sup>) =  
 $77.52476 x_1 + 08199127 x_2 + 12031123 x_3$   
 $01989381 x_8 - 426.8329$   
 (EO 11 - F)

LABRADOR  
CORRELATION BETWEEN  
TEMPERATURE AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	331.00000	324.94146	6.05853	BATTLE HARBOUR
2	329.00000	327.10992	1.89007	BATTLE HARBOUR LORAN
3	357.00000	324.38800	32.61200	BATTLE HARBOUR MARY'S RIVER
4	319.00000	317.18292	1.81707	BELLE ISLE
5	307.00000	314.00354	-7.00354	CAPE HARRISON
6	323.00000	322.38366	0.61633	CARTWRIGHT
7	323.00000	313.83355	9.16644	GOOSE A
8	287.00000	294.31933	-7.31933	HOPEDALE
9	242.00000	230.85409	11.14590	MENIHEK RAPIDS
10	255.00003	294.20117	-39.20111	NAIN
11	251.00000	247.02044	3.97955	SANDGIRT LAKE
12	252.00000	240.78772	11.21228	TWIN FALLS
13	252.00000	262.05450	-10.05447	WABUSH LAKE

NOTE: DATA FROM ISOTHERMS AS TRACED BY DOT. METEOROLOGICAL BRANCH (FIG.8-7A) WERE USED IN THE CORRELATION WITH A WEIGHT ONE HUNDRED TIMES SMALLER THAN THAT OF A RAIN GAUGING STATION HAVING A FULL PERIOD OF RECORD.

COEFFICIENT OF CORRELATION = 0.9199

X( 1) - LATITUDE ( NUMBER OF SQUARE IN GRID )  
X( 2) - SLOPE OF SQUARE ( FT/FT)\*100000  
X( 3) - (SLOPE)\*\*2  
X( 4) - AZIMUTH OF SLOPE MEASURED FROM NORTH (RANGE = 0 TO 180 DEGREES)  
X( 5) - AVERAGE ELEVATION OF SQUARE OR STATION (TENS OF FEET)  
X( 6) - (AVERAGE ELEVATION)\*\*2  
X( 7) - DISTANCE TO THE SEA IN EAST DIRECTION (KILOMETERS)  
X( 8) - (DISTANCE TO THE SEA IN EAST DIRECTION)\*\*2  
X( 9) - DISTANCE TO THE SEA IN SOUTH EAST DIRECTION (KILOMETERS)  
X(10) - (DISTANCE TO THE SEA IN SOUTH EAST DIRECTION)\*\*2  
X(11) - BARRIER HEIGHT IN EAST DIRECTION (TENS OF FEET)  
X(12) - (BARRIER HEIGHT IN EAST DIRECTION)\*\*2  
X(13) - BARRIER HEIGHT IN SOUTH EAST DIRECTION (TENS OF FEET)  
X(14) - (BARRIER HEIGHT IN SOUTH EAST DIRECTION)\*\*2  
X(15) - DEPENDANT VARIABLE = TEMPERATURE (DEGREES FAHRENHEIT)\*10

STANDARD ERROR OF DEP VARIABLE = 10.4654

CONSTANT	325.3616		
VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR	
X - 2	0.00919562	0.00087304	
X - 3	-0.00000056	0.00000011	
X - 4	-0.01459635	0.00865569	
X - 5	-0.23512300	0.03568340	
X - 6	0.00086739	0.00017672	
X - 7	-0.08540004	0.01355382	
X - 8	0.00005571	0.00001631	
X - 10	-0.00011597	0.00000478	
X - 11	0.12904226	0.01550829	
X - 13	-0.11538445	0.03286132	
X - 14	0.00052901	0.00015506	

NOTE: APPLIES ONLY SOUTH OF 55° 30'  
LATITUDE NORTH

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{CONSTANT} + \sum_{i=1}^n \text{RC}_i X_i$$

NEWFOUNDLAND AND LABRADOR

AVERAGE AND EXTREME MEAN MONTHLY TEMPERATURES

STATION	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
500-ARGENTIA PERIOD OF RECORD = 1924-1979												
AVERAGE NO. DAYS WITH FROST	25.2	25.3	16.3	10.8	3.2	0.0	0.0	0.0	0.0	0.0	7.3	24.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	25.7	27.3	30.6	32.0	34.1	38.9	57.0	59.5	59.4	57.2	51.1	32.8
MAX. MONTHLY TEMPERATURE (DEG.F)	35.3	37.7	35.8	42.9	45.8	51.7	57.4	56.6	58.7	51.8	46.7	37.6
MAX. DAILY TEMPERATURE (DEG.F)	58.0	53.0	51.0	60.0	74.0	72.0	78.0	78.0	78.0	71.0	58.0	40.0
MIN. MONTHLY TEMPERATURE (DEG.F)	21.6	20.3	23.8	31.3	35.9	46.9	53.8	57.2	52.7	45.3	37.5	27.1
MIN. DAILY TEMPERATURE (DEG.F)	-4.0	-6.0	2.0	15.0	22.0	31.0	40.0	44.0	38.0	29.0	22.0	7.0
510-BELLE ISLE PERIOD OF RECORD = 1939-1979												
AVERAGE NO. DAYS WITH FROST	30.5	28.1	24.7	20.2	15.5	7.4	0.0	0.0	1.7	11.6	27.6	30.7
AVERAGE MONTHLY TEMPERATURE (DEG.F)	19.1	19.8	19.8	20.4	24.6	32.2	51.4	53.0	46.5	37.7	27.1	14.6
MAX. MONTHLY TEMPERATURE (DEG.F)	17.5	18.0	28.8	30.0	38.5	48.4	58.8	59.7	54.0	42.4	22.0	19.2
MAX. DAILY TEMPERATURE (DEG.F)	40.0	39.0	40.0	38.0	39.0	45.0	59.0	59.0	51.0	38.0	28.0	20.0
MIN. MONTHLY TEMPERATURE (DEG.F)	-7.3	-10.8	14.2	21.5	30.8	37.2	44.0	48.1	42.2	33.9	21.8	7.5
MIN. DAILY TEMPERATURE (DEG.F)	-27.0	-26.0	-18.0	-6.0	12.0	22.0	28.0	31.0	31.0	18.0	-6.0	-21.0
520-BELLE ISLE PERIOD OF RECORD = 1904-1979												
AVERAGE NO. DAYS WITH FROST	31.0	28.5	24.8	20.5	15.8	7.8	1.3	0.1	1.8	14.5	27.9	30.7
AVERAGE MONTHLY TEMPERATURE (DEG.F)	9.4	10.7	12.1	17.1	23.7	30.9	47.8	51.4	45.2	37.0	27.7	17.0
MAX. MONTHLY TEMPERATURE (DEG.F)	21.1	27.7	26.8	34.0	37.6	44.2	53.5	54.5	52.6	41.9	32.6	25.9
MAX. DAILY TEMPERATURE (DEG.F)	39.0	39.0	45.0	49.0	55.0	64.0	69.0	70.0	69.0	58.0	50.0	41.0
MIN. MONTHLY TEMPERATURE (DEG.F)	3.8	2.3	9.3	13.4	17.2	25.8	32.1	34.4	38.3	32.7	23.0	9.4
MIN. DAILY TEMPERATURE (DEG.F)	-21.0	-20.0	-12.0	-1.0	9.0	19.0	23.0	24.0	15.0	18.0	-8.0	-20.0
530-BELLE ISLE PERIOD OF RECORD = 1933-1979												
AVERAGE NO. DAYS WITH FROST	30.5	28.1	24.8	20.5	15.5	7.5	0.2	0.0	1.2	14.7	28.5	30.6
AVERAGE MONTHLY TEMPERATURE (DEG.F)	14.5	16.7	20.7	23.2	31.1	40.1	48.9	50.5	43.3	38.9	29.4	16.1
MAX. MONTHLY TEMPERATURE (DEG.F)	17.8	24.4	27.8	31.4	37.4	43.9	51.9	54.5	48.5	38.4	23.7	17.2
MAX. DAILY TEMPERATURE (DEG.F)	40.0	40.0	44.0	48.0	54.0	61.0	71.0	72.0	67.0	58.0	52.0	43.0
MIN. MONTHLY TEMPERATURE (DEG.F)	1.0	5.7	10.7	14.8	20.9	28.8	35.4	35.4	31.5	26.9	12.9	0.9
MIN. DAILY TEMPERATURE (DEG.F)	-24.0	-21.0	-12.0	-1.0	9.0	15.0	24.0	24.0	12.0	12.0	-1.0	-19.0
540-BURNHAM BAY PERIOD OF RECORD = 1914-1979												
AVERAGE NO. DAYS WITH FROST	31.2	27.6	20.0	15.5	10.5	4.5	0.0	0.0	2.4	14.1	29.8	49.9
AVERAGE MONTHLY TEMPERATURE (DEG.F)	17.2	16.1	21.8	26.7	33.1	40.5	50.9	54.9	51.5	41.3	32.9	24.0
MAX. MONTHLY TEMPERATURE (DEG.F)	17.8	28.4	27.8	34.0	40.5	48.5	58.8	61.4	62.4	54.8	43.7	27.0
MAX. DAILY TEMPERATURE (DEG.F)	47.0	46.0	53.0	61.0	61.0	69.0	84.0	87.0	83.0	69.0	63.0	51.0
MIN. MONTHLY TEMPERATURE (DEG.F)	5.6	4.8	13.1	20.6	27.7	37.3	44.3	51.7	48.4	37.4	28.8	15.4
MIN. DAILY TEMPERATURE (DEG.F)	-28.0	-35.0	-24.0	-11.0	4.0	18.0	24.0	30.0	28.0	14.0	4.0	-23.0
550-BURROCK PERIOD OF RECORD = 1933-1979												
AVERAGE NO. DAYS WITH FROST	28.2	24.7	28.3	24.2	17.7	0.0	0.0	0.0	0.0	4.8	14.0	17.2
AVERAGE MONTHLY TEMPERATURE (DEG.F)	24.4	23.1	27.7	34.4	41.3	48.3	51.9	58.2	52.8	44.8	37.9	28.7
MAX. MONTHLY TEMPERATURE (DEG.F)	33.3	32.5	34.8	41.2	45.4	51.4	58.0	62.2	55.0	48.0	44.8	44.0
MAX. DAILY TEMPERATURE (DEG.F)	49.0	49.0	59.0	61.0	74.0	70.0	78.0	78.0	77.0	65.0	59.0	54.0
MIN. MONTHLY TEMPERATURE (DEG.F)	15.9	15.1	19.4	28.6	38.2	46.2	54.9	56.1	47.9	30.4	23.8	22.0
MIN. DAILY TEMPERATURE (DEG.F)	-11.0	-7.0	-9.0	7.0	23.0	31.0	30.0	38.0	31.0	24.0	12.0	9.0
560-BURN PERIOD OF RECORD = 2/1909-10/1971												
AVERAGE NO. DAYS WITH FROST	28.5	28.1	29.5	21.6	7.2	0.0	0.0	0.0	0.0	4.1	16.9	28.1
AVERAGE MONTHLY TEMPERATURE (DEG.F)	25.6	22.9	28.2	35.4	41.7	50.2	57.2	59.0	54.9	46.2	38.1	31.0
MAX. MONTHLY TEMPERATURE (DEG.F)	34.8	30.0	36.8	43.0	47.5	54.4	61.4	62.4	64.8	53.4	44.9	35.4
MAX. DAILY TEMPERATURE (DEG.F)	52.0	49.0	52.0	61.0	71.0	74.0	82.0	81.0	85.0	74.0	61.0	54.0
MIN. MONTHLY TEMPERATURE (DEG.F)	19.1	18.9	22.0	24.4	30.4	37.0	43.8	46.4	38.0	24.4	34.4	23.7
MIN. DAILY TEMPERATURE (DEG.F)	-5.0	-11.0	-8.0	1.0	24.0	30.0	35.0	36.0	28.0	26.0	9.0	5.0
570-CAPE HARRISON PERIOD OF RECORD = 1/1947-12/1961												
AVERAGE NO. DAYS WITH FROST	31.0	27.5	30.4	27.6	23.6	6.7	0.4	0.4	2.6	10.3	28.7	44.9
AVERAGE MONTHLY TEMPERATURE (DEG.F)	8.8	8.3	15.6	25.1	35.5	45.4	53.4	53.1	-7.0	17.9	28.1	17.9
MAX. MONTHLY TEMPERATURE (DEG.F)	17.7	25.8	22.8	33.9	43.4	49.5	58.0	58.6	-8.2	11.2	31.7	28.1
MAX. DAILY TEMPERATURE (DEG.F)	45.0	49.0	52.0	62.0	69.0	72.0	82.0	81.0	65.0	68.0	61.0	54.0
MIN. MONTHLY TEMPERATURE (DEG.F)	-9.1	-2.1	7.4	17.2	28.4	34.5	41.4	48.0	44.8	34.5	24.2	3.4
MIN. DAILY TEMPERATURE (DEG.F)	-32.0	-28.0	-25.0	-21.0	8.0	23.0	32.0	32.0	26.0	15.0	-2.0	-22.0
1000-CAPE RACE PERIOD OF RECORD = 1/1939-1/1968												
AVERAGE NO. DAYS WITH FROST	28.4	27.4	31.0	25.5	11.8	1.4	0.0	0.0	0.8	6.2	13.9	44.8
AVERAGE MONTHLY TEMPERATURE (DEG.F)	26.5	25.7	28.2	32.6	39.2	45.6	53.0	55.5	52.4	43.0	34.4	21.0
MAX. MONTHLY TEMPERATURE (DEG.F)	32.5	31.8	34.1	38.4	42.2	48.4	56.4	58.5	54.0	42.9	35.4	24.0
MAX. DAILY TEMPERATURE (DEG.F)	49.0	49.0	48.0	52.0	60.0	77.0	87.0	82.0	74.0	68.0	59.0	52.0
MIN. MONTHLY TEMPERATURE (DEG.F)	21.0	17.9	21.5	31.4	36.7	42.4	48.8	52.7	47.8	40.8	33.0	28.9
MIN. DAILY TEMPERATURE (DEG.F)	-11.0	-7.0	-6.0	8.0	18.0	23.0	31.0	34.0	26.0	14.0	10.0	0.0

TABLE 8-6  
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The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

1300- CARTWRIGHT PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	30.4	27.7	20.7	12.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	4.0	9.9	17.0	27.7	37.5	46.7	55.2	64.0	69.0	67.9	58.9	48.9
MAX. MONTHLY TEMPERATURE (DEG.F)	21.0	25.7	28.0	36.5	45.9	51.4	59.0	66.4	70.0	71.0	64.0	51.0
MAX. DAILY TEMPERATURE (DEG.F)	44.0	48.0	56.0	65.0	80.0	92.0	97.0	99.0	94.0	86.0	74.0	60.0
MIN. MONTHLY TEMPERATURE (DEG.F)	-7.1	-2.0	4.5	20.2	31.6	44.5	51.1	57.5	63.3	64.7	54.0	34.0
MIN. DAILY TEMPERATURE (DEG.F)	-32.0	-27.0	-26.0	-14.0	5.0	22.0	29.0	31.0	25.0	11.0	-5.0	-29.0
1125- CHAMPLAIN PERIOD OF RECORD = 1/1899-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	30.5	27.5	20.7	12.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	22.4	21.5	23.0	33.0	41.1	48.0	55.1	61.9	66.0	64.0	54.0	43.0
MAX. MONTHLY TEMPERATURE (DEG.F)	34.1	31.1	34.9	44.4	54.8	62.5	69.6	75.8	80.3	80.8	70.0	56.0
MAX. DAILY TEMPERATURE (DEG.F)	65.0	67.0	72.0	72.0	71.0	83.0	89.0	90.0	89.0	84.0	74.0	55.0
MIN. MONTHLY TEMPERATURE (DEG.F)	14.0	14.2	20.9	31.0	40.0	46.5	51.7	51.7	49.1	41.0	24.7	11.0
MIN. DAILY TEMPERATURE (DEG.F)	-8.0	-20.1	-14.0	0.0	21.0	29.0	35.0	38.0	29.0	15.0	8.0	-5.0
1300- COLINET PERIOD OF RECORD = 1/1947-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	27.0	26.5	17.4	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	22.7	22.4	30.0	38.3	44.5	51.5	58.7	65.7	71.9	74.1	70.4	60.2
MAX. MONTHLY TEMPERATURE (DEG.F)	34.2	33.3	34.2	44.5	54.0	61.3	68.4	74.2	78.0	78.0	70.0	56.0
MAX. DAILY TEMPERATURE (DEG.F)	59.0	59.0	65.0	74.0	79.0	86.0	92.0	92.0	88.0	84.0	74.0	58.0
MIN. MONTHLY TEMPERATURE (DEG.F)	19.0	19.2	24.0	31.4	40.0	47.0	54.0	57.0	57.0	51.0	37.0	21.0
MIN. DAILY TEMPERATURE (DEG.F)	-12.0	-17.0	-9.0	9.0	20.0	27.0	30.0	32.0	21.0	15.0	9.0	-14.0
1300- COOPER BROWN PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	28.7	26.9	17.8	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	22.1	22.8	30.5	38.8	44.5	51.5	58.7	65.7	71.9	74.1	70.4	60.2
MAX. MONTHLY TEMPERATURE (DEG.F)	33.4	32.0	34.9	44.5	54.0	61.3	68.4	74.2	78.0	78.0	70.0	56.0
MAX. DAILY TEMPERATURE (DEG.F)	54.0	59.0	65.0	74.0	79.0	86.0	92.0	92.0	88.0	84.0	74.0	58.0
MIN. MONTHLY TEMPERATURE (DEG.F)	10.1	9.3	15.2	24.0	31.4	40.0	47.0	54.0	57.0	57.0	51.0	37.0
MIN. DAILY TEMPERATURE (DEG.F)	-10.0	-22.0	-25.0	9.0	0.0	27.0	37.0	45.0	47.0	24.0	7.0	-5.0
1400- DANIEL'S HARBOR PERIOD OF RECORD = 11/1945-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	24.9	27.5	27.5	24.0	11.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	22.7	17.5	24.9	32.4	40.8	47.0	57.2	64.2	71.5	74.5	70.5	60.5
MAX. MONTHLY TEMPERATURE (DEG.F)	32.4	27.9	32.5	42.5	49.7	57.9	64.8	71.9	78.0	84.0	84.0	70.0
MAX. DAILY TEMPERATURE (DEG.F)	54.0	54.0	60.0	67.0	74.0	81.0	88.0	94.0	94.0	84.0	74.0	60.0
MIN. MONTHLY TEMPERATURE (DEG.F)	12.5	3.0	14.0	25.1	28.7	35.9	48.0	55.5	61.4	60.9	51.8	31.8
MIN. DAILY TEMPERATURE (DEG.F)	-8.0	-10.0	-24.0	0.0	14.0	21.0	25.0	35.0	23.0	14.0	0.0	-6.0
1800- DEER LAKE PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	30.1	27.5	20.3	12.5	11.5	1.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	22.0	17.4	25.1	33.1	43.9	50.0	57.5	64.5	71.5	74.5	70.5	60.5
MAX. MONTHLY TEMPERATURE (DEG.F)	32.4	28.3	34.5	44.5	54.0	61.3	68.4	74.2	78.0	78.0	70.0	56.0
MAX. DAILY TEMPERATURE (DEG.F)	51.0	54.0	60.0	67.0	74.0	81.0	88.0	94.0	94.0	84.0	74.0	60.0
MIN. MONTHLY TEMPERATURE (DEG.F)	14.0	5.4	15.1	27.4	31.2	38.9	46.7	54.2	61.4	60.9	51.8	31.8
MIN. DAILY TEMPERATURE (DEG.F)	-24.0	-35.0	-25.0	-7.0	0.0	25.0	34.0	42.0	20.0	15.0	-5.0	-21.0
1800- FOGG PERIOD OF RECORD = 1/1910-12/1934	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	30.7	28.1	20.1	10.1	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	20.7	18.0	23.9	31.9	42.9	50.7	59.1	67.9	72.8	74.5	70.5	60.5
MAX. MONTHLY TEMPERATURE (DEG.F)	32.0	28.9	34.0	44.0	54.0	61.3	68.4	74.2	78.0	78.0	70.0	56.0
MAX. DAILY TEMPERATURE (DEG.F)	52.0	56.0	62.0	69.0	76.0	83.0	90.0	96.0	96.0	86.0	76.0	62.0
MIN. MONTHLY TEMPERATURE (DEG.F)	12.4	8.8	21.8	29.3	37.9	44.9	52.5	60.5	67.5	70.0	60.1	31.1
MIN. DAILY TEMPERATURE (DEG.F)	-20.0	-16.0	-5.0	10.0	24.0	28.0	30.0	32.0	20.0	20.0	9.0	-5.0
1700- SANDER R. PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	30.1	27.5	20.3	12.5	11.5	1.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	20.9	20.4	28.4	36.5	46.4	54.4	61.9	69.5	75.4	77.4	73.4	63.4
MAX. MONTHLY TEMPERATURE (DEG.F)	29.9	27.5	32.5	42.5	52.0	59.7	67.2	74.2	80.3	81.3	74.0	60.0
MAX. DAILY TEMPERATURE (DEG.F)	53.0	59.0	65.0	74.0	82.0	91.0	98.0	104.0	104.0	94.0	84.0	70.0
MIN. MONTHLY TEMPERATURE (DEG.F)	11.4	11.0	17.0	28.9	37.9	47.2	55.0	62.8	69.8	72.0	62.0	32.0
MIN. DAILY TEMPERATURE (DEG.F)	-17.0	-10.0	-1.0	9.0	15.0	24.0	30.0	36.0	30.0	24.0	7.0	-5.0
1800- SLEWOOD PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE NO. DAYS WITH FROST	29.7	27.2	20.0	11.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	22.4	20.3	28.0	36.9	46.2	54.0	61.9	69.4	75.7	78.7	74.7	64.7
MAX. MONTHLY TEMPERATURE (DEG.F)	32.0	28.3	34.0	44.0	54.0	61.3	68.4	74.2	78.0	78.0	70.0	56.0
MAX. DAILY TEMPERATURE (DEG.F)	51.0	56.0	62.0	70.0	80.0	87.0	94.0	100.0	100.0	90.0	80.0	66.0
MIN. MONTHLY TEMPERATURE (DEG.F)	10.1	8.4	17.0	29.0	38.0	47.5	55.4	63.4	70.4	72.0	62.0	32.0
MIN. DAILY TEMPERATURE (DEG.F)	-22.0	-25.0	-20.0	-4.0	12.0	21.0	28.0	32.0	24.0	14.0	-9.0	-27.0

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1800 - CROSS ST PERIOD OF RECORD = 12/1941-12/1966												
AVERAGE NO. DAYS WITH FROST	30.7	28.0	31.2	26.8	16.6	1.5	0.0	0.0	3.1	17.9	27.7	30.6
AVERAGE MONTHLY TEMPERATURE (DEG.F)	21.1	6.2	-7.3	29.1	42.8	51.7	60.2	58.0	49.7	37.7	23.2	9.2
MAX. MONTHLY TEMPERATURE (DEG.F)	15.6	25.2	28.1	31.9	46.5	57.5	64.8	62.1	51.0	41.1	31.2	22.3
MAX. DAILY TEMPERATURE (DEG.F)	48.0	51.0	58.0	67.0	88.0	98.0	100.0	91.0	80.0	73.0	60.0	53.0
MIN. MONTHLY TEMPERATURE (DEG.F)	-11.0	-5.6	5.0	21.6	35.1	47.0	57.0	55.2	46.5	33.1	18.6	-1.0
MIN. DAILY TEMPERATURE (DEG.F)	-38.0	-35.0	-32.0	-14.0	9.0	28.0	39.0	32.0	20.0	11.0	-9.0	-23.0
2000 - GRAND BANK PERIOD OF RECORD = 1/1939-2/1965												
AVERAGE NO. DAYS WITH FROST	27.6	24.2	27.9	20.9	8.1	0.2	0.0	0.0	3.2	11.2	25.4	
AVERAGE MONTHLY TEMPERATURE (DEG.F)	27.4	21.3	23.6	31.7	42.7	49.9	58.4	62.5	59.0	48.7	35.3	21.4
MAX. MONTHLY TEMPERATURE (DEG.F)	39.9	32.5	36.1	40.8	46.7	53.0	62.6	64.2	58.5	49.6	44.6	35.8
MAX. DAILY TEMPERATURE (DEG.F)	52.0	52.0	58.0	64.0	72.0	77.0	84.0	86.0	77.0	71.0	63.0	55.0
MIN. MONTHLY TEMPERATURE (DEG.F)	21.3	19.6	23.3	31.2	41.0	45.8	54.7	58.0	55.2	42.3	28.7	27.5
MIN. DAILY TEMPERATURE (DEG.F)	-4.0	0.0	-1.0	10.0	24.0	29.0	39.0	39.0	33.0	23.0	16.0	6.0
2050 - GRAND FALLS PERIOD OF RECORD = 1/1938-12/1961												
AVERAGE NO. DAYS WITH FROST	30.4	27.1	28.5	24.2	11.6	1.1	0.0	0.0	1.8	11.1	21.9	29.2
AVERAGE MONTHLY TEMPERATURE (DEG.F)	19.5	24.2	29.8	38.3	44.7	52.9	62.2	61.0	53.6	43.8	33.3	20.9
MAX. MONTHLY TEMPERATURE (DEG.F)	29.0	25.9	31.1	40.0	51.5	57.9	65.1	63.8	58.2	48.9	40.5	31.8
MAX. DAILY TEMPERATURE (DEG.F)	51.0	49.0	54.0	60.0	64.0	71.0	76.0	81.0	84.0	72.0	69.0	57.0
MIN. MONTHLY TEMPERATURE (DEG.F)	10.9	7.8	15.1	31.9	37.5	45.1	56.8	56.8	47.7	34.1	20.5	14.9
MIN. DAILY TEMPERATURE (DEG.F)	-29.0	-23.0	-23.0	-9.0	17.0	24.0	33.0	32.0	21.0	10.0	0.0	-14.0
2400 - HURDEDALE PERIOD OF RECORD = 1/1942-12/1966												
AVERAGE NO. DAYS WITH FROST	30.6	28.1	30.7	29.1	23.2	9.7	0.0	0.0	1.9	17.9	28.2	30.8
AVERAGE MONTHLY TEMPERATURE (DEG.F)	21.0	3.6	13.0	23.8	36.5	43.2	51.0	51.5	48.0	38.1	25.9	11.9
MAX. MONTHLY TEMPERATURE (DEG.F)	14.3	21.9	24.5	33.0	39.8	46.5	55.4	54.7	53.9	42.1	32.3	24.9
MAX. DAILY TEMPERATURE (DEG.F)	42.0	44.0	50.0	53.0	63.0	68.0	74.0	74.0	67.0	59.0	52.0	44.0
MIN. MONTHLY TEMPERATURE (DEG.F)	-11.1	-5.8	2.3	17.4	29.8	39.0	46.3	48.1	43.5	32.6	21.2	0.9
MIN. DAILY TEMPERATURE (DEG.F)	-32.0	-30.0	-31.0	-13.0	1.0	22.0	30.0	34.0	23.0	12.0	-9.0	-22.0
1975 - PORT AUX BASQUES PERIOD OF RECORD = 2/1934-5/1962												
AVERAGE NO. DAYS WITH FROST	29.7	29.0	29.9	29.9	8.4	0.0	0.0	0.0	2.9	17.0	27.7	
AVERAGE MONTHLY TEMPERATURE (DEG.F)	21.0	17.7	24.9	32.9	41.1	48.9	56.6	59.5	52.9	44.7	33.9	27.9
MAX. MONTHLY TEMPERATURE (DEG.F)	27.0	25.9	33.8	37.8	44.8	54.3	60.7	63.0	59.2	50.6	40.3	31.0
MAX. DAILY TEMPERATURE (DEG.F)	49.0	41.0	52.0	60.0	71.0	77.0	81.0	81.0	79.0	71.0	59.0	51.0
MIN. MONTHLY TEMPERATURE (DEG.F)	12.9	9.0	17.2	26.9	31.2	44.7	53.7	53.3	49.7	42.0	34.6	21.0
MIN. DAILY TEMPERATURE (DEG.F)	-10.0	-10.0	-10.0	8.0	22.0	31.0	41.0	37.0	32.0	23.0	14.0	3.0
1977 - PORT AUX BASQUES PERIOD OF RECORD = 8/1955-12/1966												
AVERAGE NO. DAYS WITH FROST	27.6	27.2	26.4	24.5	11.1	1.4	0.0	0.0	1.0	3.6	16.8	17.9
AVERAGE MONTHLY TEMPERATURE (DEG.F)	20.9	22.7	29.0	33.9	41.5	47.7	55.0	58.6	51.2	44.7	38.6	31.8
MAX. MONTHLY TEMPERATURE (DEG.F)	33.5	30.1	36.3	46.7	53.9	61.4	69.0	71.6	67.6	57.6	44.4	37.0
MAX. DAILY TEMPERATURE (DEG.F)	48.0	47.0	52.0	59.0	68.0	71.0	81.0	81.0	80.0	71.0	51.0	44.0
MIN. MONTHLY TEMPERATURE (DEG.F)	17.2	17.2	23.0	31.6	37.7	46.1	54.9	57.9	50.7	42.4	34.6	24.9
MIN. DAILY TEMPERATURE (DEG.F)	0.0	-1.0	1.0	11.0	19.0	30.0	40.0	39.0	36.0	27.0	19.0	9.0
2300 - ST ANNE PERIOD OF RECORD = 12/1943-1/1961												
AVERAGE NO. DAYS WITH FROST	29.3	28.8	28.9	24.9	12.1	1.6	0.0	0.0	1.2	7.1	18.9	17.9
AVERAGE MONTHLY TEMPERATURE (DEG.F)	26.2	23.3	27.2	34.9	42.7	51.2	58.9	54.6	52.9	44.7	38.6	29.6
MAX. MONTHLY TEMPERATURE (DEG.F)	35.6	31.6	37.6	46.0	54.9	61.4	69.9	63.0	61.4	47.6	42.0	34.8
MAX. DAILY TEMPERATURE (DEG.F)	55.0	52.0	58.0	67.0	75.0	79.0	81.0	79.0	74.0	64.0	53.0	44.0
MIN. MONTHLY TEMPERATURE (DEG.F)	20.6	15.1	13.0	24.9	33.2	40.9	50.1	57.9	50.9	42.6	34.4	24.2
MIN. DAILY TEMPERATURE (DEG.F)	-12.0	-10.0	-9.0	3.0	19.0	27.0	35.0	39.0	29.0	19.0	10.0	1.0
1800 - ST ANTHONY PERIOD OF RECORD = 2/1940-12/1961												
AVERAGE NO. DAYS WITH FROST	29.9	27.8	30.2	26.7	17.6	2.7	0.0	0.0	1.3	12.0	24.1	29.8
AVERAGE MONTHLY TEMPERATURE (DEG.F)	18.1	14.0	22.9	31.5	39.1	46.3	54.9	58.9	49.9	41.6	34.7	24.4
MAX. MONTHLY TEMPERATURE (DEG.F)	27.3	21.0	31.6	35.5	41.0	49.9	58.9	60.9	52.9	42.0	35.6	26.6
MAX. DAILY TEMPERATURE (DEG.F)	44.0	48.0	54.0	61.0	70.0	80.0	86.0	86.0	79.0	69.0	58.0	49.0
MIN. MONTHLY TEMPERATURE (DEG.F)	1.1	5.9	12.9	20.6	34.8	43.0	51.4	51.4	45.0	37.0	28.7	18.7
MIN. DAILY TEMPERATURE (DEG.F)	-24.0	-24.0	-20.0	-6.0	17.0	27.0	32.0	30.0	21.0	10.0	0.0	-13.0

TABLE 8-6  
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The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

3440- ST GEORGES PERIOD OF RECORD = 1/1969-12/1969	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	30.2	28.0	29.0	22.4	8.4	0.3	0.0	0.0	1.2	4.7	20.2	48.4
AVERAGE MONTHLY TEMPERATURE (DEG.F)	20.8	18.4	25.2	33.8	44.4	53.6	59.0	64.0	64.0	61.0	57.2	48.0
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	28.2	28.3	34.9	47.1	52.1	57.8	57.9	64.8	62.0	52.1	49.7	37.3
MAXIMUM DAILY TEMPERATURE (DEG.F)	38.0	30.0	38.2	50.0	57.0	62.0	67.0	69.0	61.0	53.0	48.0	38.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	11.8	9.0	16.4	24.9	31.8	40.2	45.1	46.7	47.0	44.0	34.0	27.4
MINIMUM DAILY TEMPERATURE (DEG.F)	-11.0	-24.0	-21.0	-11.0	22.0	29.0	33.0	35.0	31.0	23.0	11.0	0.0

3100- ST JOHN'S PERIOD OF RECORD = 1/1970-12/1969	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	29.3	27.2	27.0	24.4	14.3	1.1	0.1	0.1	1.1	5.0	17.7	47.8
AVERAGE MONTHLY TEMPERATURE (DEG.F)	23.1	22.6	27.4	34.4	41.0	48.0	52.0	56.0	56.0	51.0	46.9	41.8
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	31.2	32.0	34.5	44.8	49.1	57.7	64.0	69.7	67.0	52.1	44.4	34.8
MAXIMUM DAILY TEMPERATURE (DEG.F)	39.0	30.0	37.0	49.0	54.0	61.0	67.0	70.0	62.0	48.0	38.0	28.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	12.1	12.8	19.0	27.0	34.0	40.0	44.0	46.0	47.0	40.8	31.8	24.7
MINIMUM DAILY TEMPERATURE (DEG.F)	-19.0	-19.0	-11.0	0.0	20.0	29.0	33.0	32.0	29.0	21.0	9.0	0.0

3100- ST JOHN'S PERIOD OF RECORD = 1/1909-12/1938	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	29.5	27.6	28.9	22.5	7.9	1.0	0.0	0.0	0.5	4.3	16.3	27.0
AVERAGE MONTHLY TEMPERATURE (DEG.F)	23.5	21.5	27.7	35.1	43.8	51.8	57.3	61.8	61.3	56.1	50.5	43.8
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	30.1	28.8	35.4	44.9	48.0	56.0	60.2	65.0	62.5	52.1	42.1	34.0
MAXIMUM DAILY TEMPERATURE (DEG.F)	38.0	31.0	37.0	49.0	54.0	61.0	67.0	69.0	62.0	48.0	38.0	28.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	15.4	12.6	20.4	28.9	36.0	42.0	46.0	47.0	49.0	42.0	32.4	24.5
MINIMUM DAILY TEMPERATURE (DEG.F)	-11.0	-11.0	-7.0	0.0	20.0	29.0	33.0	36.0	32.0	24.0	10.0	-5.0

3000- TORBAY PERIOD OF RECORD = 1/1942-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	29.1	27.3	27.7	25.7	13.4	0.4	0.0	0.0	0.1	3.5	16.0	48.1
AVERAGE MONTHLY TEMPERATURE (DEG.F)	25.3	24.3	27.3	34.1	42.1	50.9	59.8	59.7	53.5	49.0	43.1	38.2
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	31.1	30.2	32.8	39.3	46.4	54.1	59.0	63.8	58.0	48.2	43.2	34.5
MAXIMUM DAILY TEMPERATURE (DEG.F)	38.0	31.0	38.0	50.0	55.0	62.0	67.0	69.0	62.0	48.0	38.0	28.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	17.5	15.4	20.4	29.8	38.3	44.0	48.0	50.8	50.8	42.7	34.3	28.4
MINIMUM DAILY TEMPERATURE (DEG.F)	-10.0	-13.0	-9.0	7.0	20.0	27.0	31.0	32.0	30.0	22.0	9.0	1.0

3000- ST JOHN'S WEST PERIOD OF RECORD = 21/1950-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	27.3	26.8	28.9	23.0	11.7	1.5	0.1	0.0	1.2	6.0	18.0	48.4
AVERAGE MONTHLY TEMPERATURE (DEG.F)	24.4	23.0	27.8	34.4	42.8	51.0	59.3	59.8	52.4	48.1	42.1	38.4
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	32.4	30.4	37.3	44.4	48.0	56.0	62.0	67.0	61.0	51.0	40.8	33.0
MAXIMUM DAILY TEMPERATURE (DEG.F)	39.0	32.0	39.0	51.0	56.0	63.0	69.0	71.0	64.0	50.0	40.0	30.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	18.0	15.2	24.1	30.5	37.2	43.3	48.0	50.2	50.7	43.2	34.3	28.1
MINIMUM DAILY TEMPERATURE (DEG.F)	-10.0	-14.0	-8.0	9.0	19.0	26.0	30.0	34.0	29.0	23.0	10.0	2.0

3100- SPRINGDALE PERIOD OF RECORD = 7/1955-11/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	28.3	28.0	*****	23.0	13.1	*****	0.4	0.0	3.7	10.4	41.1	29.3
AVERAGE MONTHLY TEMPERATURE (DEG.F)	21.0	19.8	*****	24.3	34.0	*****	41.0	50.2	52.5	48.0	43.7	38.1
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	33.4	29.6	*****	38.2	48.8	*****	64.2	63.3	55.2	47.0	41.4	31.8
MAXIMUM DAILY TEMPERATURE (DEG.F)	40.0	48.0	40.0	57.0	63.0	72.0	74.0	72.0	65.0	50.0	40.0	27.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	11.0	12.1	*****	32.8	40.2	*****	53.7	57.2	50.0	40.1	31.4	19.3
MINIMUM DAILY TEMPERATURE (DEG.F)	-27.0	-27.0	-29.0	3.0	3.0	21.0	30.0	30.0	25.0	9.0	2.0	-19.0

3000- STARRS HILL PERIOD OF RECORD = 2/1942-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	23.6	24.2	28.4	22.0	7.0	1.8	0.0	0.0	2.1	3.0	13.8	47.5
AVERAGE MONTHLY TEMPERATURE (DEG.F)	23.0	21.8	27.0	35.2	44.5	52.8	60.9	65.8	64.8	59.4	51.5	47.5
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	34.8	30.4	34.0	42.4	49.2	56.0	64.8	69.7	68.1	63.5	54.4	44.4
MAXIMUM DAILY TEMPERATURE (DEG.F)	42.0	33.0	39.0	51.0	56.0	63.0	69.0	74.0	72.0	62.0	48.0	34.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	12.4	7.0	17.8	26.7	34.1	40.2	47.0	51.8	50.5	42.3	33.8	24.9
MINIMUM DAILY TEMPERATURE (DEG.F)	-19.0	-17.0	-9.0	10.0	21.0	27.0	30.0	37.0	37.0	29.0	19.0	1.0

4100- STANLEYDALE PERIOD OF RECORD = 21/1950-12/1985	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE HOURS WITH FROST	27.0	27.8	29.8	25.2	12.3	3.4	0.0	0.0	1.0	2.0	13.4	48.4
AVERAGE MONTHLY TEMPERATURE (DEG.F)	21.0	20.8	25.2	33.5	41.4	50.0	58.0	58.7	51.5	46.8	42.4	38.4
MAXIMUM MONTHLY TEMPERATURE (DEG.F)	31.0	31.2	35.4	44.0	51.2	59.0	65.8	69.2	63.0	54.0	46.0	38.0
MAXIMUM DAILY TEMPERATURE (DEG.F)	38.0	31.0	38.0	50.0	55.0	62.0	68.0	74.0	72.0	62.0	48.0	38.0
MINIMUM MONTHLY TEMPERATURE (DEG.F)	12.4	10.8	17.8	26.7	34.0	40.2	47.0	51.8	50.5	42.3	33.8	24.9
MINIMUM DAILY TEMPERATURE (DEG.F)	-19.0	-22.0	-12.0	2.0	2.0	9.0	16.0	21.0	20.0	12.0	2.0	0.0

NEWFOUNDLAND AND LABRADOR  
AVERAGE AND EXTREME MEAN MONTHLY SEA LEVEL PRESSURE  
RECORDED AT SELECTED CLIMATOLOGICAL STATIONS

(All Pressures in Millibars at Sea Level)

Station	Years of Record	NEWFOUNDLAND												Annual
		January	February	March	April	May	June	July	August	September	October	November	December	
1. Argentia Airport	15	Max 1015.1 Mean 1008.7 Min 998.4	1011.0 1008.1 997.7	1010.4 1007.6 999.0	1012.6 1011.0 1002.7	1010.9 1014.4 1009.7	1010.3 1014.0 1010.4	1010.1 1015.0 1012.2	1017.9 1014.5 1010.6	1018.5 1014.5 1010.6	1016.5 1011.0 1011.5	1024.5 1014.8 1004.4	1018.0 1012.1 1001.1	1021.5 1012.2 1001.4
2. Bonaville	7	Max 1015.0 Mean 1009.1 Min 1002.1	1012.4 1008.1 991.3	1014.6 1001.4 993.2	1014.1 1006.5 1002.4	1016.5 1014.4 1010.0	1015.1 1014.4 1009.5	1015.3 1012.6 1012.9	1016.7 1013.0 1011.9	1018.9 1011.0 1011.3	1014.4 1011.0 1000.0	1021.7 1013.8 1007.0	1017.8 1009.9 1002.0	1021.7 1011.2 996.1
3. Benwood	6	Max 1014.5 Mean 1009.2 Min 1001.0	1017.1 1009.7 1002.1	1014.4 1003.2 1001.0	1014.6 1012.5 1008.6	1016.1 1015.4 1012.9	1014.1 1015.4 1012.9	1015.4 1014.5 1010.8	1017.1 1015.5 1010.9	1019.1 1016.4 1011.8	1017.3 1014.0 1009.9	1020.1 1014.0 1007.9	1015.7 1007.2 1000.6	1020.1 1012.4 1000.0
4. Barbanks Airport	25	Max 1015.7 Mean 1009.4 Min 1000.2	1020.7 1009.8 994.0	1018.6 1009.1 999.9	1017.5 1012.5 1004.5	1018.7 1014.4 1010.0	1016.1 1014.0 1009.2	1016.9 1014.0 1011.9	1017.4 1014.0 1010.4	1019.2 1014.5 1011.5	1018.4 1014.0 1010.0	1020.2 1014.0 1004.1	1017.7 1010.6 1001.9	1020.7 1012.4 996.6
5. Cape Race	21	Max 1014.0 Mean 1009.1 Min 995.0	1020.4 1009.4 994.5	1015.0 1007.0 995.1	1018.1 1011.8 1001.7	1019.4 1011.0 1002.4	1016.7 1011.9 1006.4	1018.7 1011.9 1002.1	1018.6 1015.1 1011.4	1021.2 1016.0 1011.2	1018.6 1014.0 1007.0	1020.5 1011.9 1007.7	1016.7 1010.1 1000.5	1020.9 1012.7 995.0
6. Daniels Harbour	20	Max 1015.4 Mean 1007.0 Min 1001.1	1016.8 1007.2 1005.9	1018.9 1008.2 999.4	1014.5 1010.0 1006.2	1015.8 1015.0 1007.1	1014.9 1011.1 1006.2	1015.9 1011.2 1006.3	1016.1 1011.2 1007.8	1016.7 1011.0 1009.2	1016.1 1011.4 1007.3	1020.2 1011.0 1004.0	1011.4 1001.1 1000.4	1022.2 1010.5 995.9
7. Fogo	9	Max 1011.0 Mean 1007.4 Min 1000.3	1002.9 1006.1 993.0	1013.8 1001.0 1001.1	1014.0 1012.4 1008.2	1016.2 1015.0 1009.1	1015.0 1011.7 1010.4	1015.5 1011.1 1011.1	1016.7 1011.4 1006.7	1016.7 1015.4 1009.4	1018.5 1011.0 1009.7	1016.8 1011.4 1007.5	1015.0 1006.7 1000.2	1018.8 1011.7 997.0
8. Gander International Airport	21	Max 1016.7 Mean 1008.4 Min 999.1	1021.0 1008.1 998.1	1019.2 1012.0 998.0	1019.4 1011.4 1003.4	1018.4 1014.4 1009.0	1016.1 1012.9 1009.9	1018.1 1014.0 1009.0	1017.2 1013.9 1009.0	1014.0 1011.2 1007.7	1014.0 1011.4 1009.5	1021.8 1013.2 1004.4	1017.7 1009.4 1001.4	1021.8 1012.3 996.1
9. Grand Bank	21	Max 1017.7 Mean 1008.5 Min 999.3	1020.8 1007.1 997.7	1017.5 1008.0 999.3	1016.7 1012.5 1003.2	1019.2 1015.2 1009.1	1016.7 1013.6 1010.0	1018.7 1011.1 1007.7	1017.0 1014.3 1008.7	1017.0 1014.0 1008.2	1020.0 1014.3 1009.0	1019.4 1014.3 1009.6	1018.1 1009.9 1001.0	1020.0 1012.0 997.7
10. Millertown	5	Max 1008.0 Mean 1007.1 Min 1003.7	1010.3 1004.8 997.6	1015.0 1010.1 1005.4	1011.7 1011.5 1008.0	1014.1 1014.0 1009.0	1025.4 1012.2 1010.0	1015.4 1012.2 1011.8	1016.0 1011.2 1007.2	1018.0 1015.2 1010.0	1018.0 1012.9 1010.0	1017.2 1011.4 1010.2	1016.0 1007.9 1002.4	1018.5 1011.1 997.6
11. St. Andrews	22	Max 1018.4 Mean 1010.1 Min 1000.5	1019.4 1010.1 998.7	1017.2 1009.1 1002.4	1018.5 1011.6 1002.4	1016.5 1014.0 1010.4	1015.0 1012.8 1009.0	1016.4 1011.0 1011.2	1016.7 1013.0 1010.0	1019.4 1014.6 1011.9	1019.5 1014.8 1010.6	1018.9 1011.3 1004.5	1017.1 1011.0 1004.7	1022.9 1012.3 998.7
12. St. Anthony Airport	19	Max 1014.8 Mean 1008.1 Min 999.7	1020.5 1008.0 995.4	1020.9 1006.1 994.3	1015.1 1011.0 1005.5	1017.1 1013.6 1004.7	1016.4 1011.7 1008.5	1014.9 1012.0 1009.2	1014.9 1011.8 1009.2	1017.0 1014.8 1009.2	1016.7 1011.2 1007.2	1019.4 1011.3 1002.4	1017.0 1008.0 999.3	1020.9 1011.1 995.4
13. St. George's	5	Max 1009.5 Mean 1007.6	1008.4 1002.2	1009.5 1007.8	1017.5 1012.0	1015.0 1013.7	1013.5 1011.2	1014.7 1012.6	1014.4 1011.6	1017.4 1014.2	1015.1 1011.7	1013.9 1011.9	1012.2 1008.2	1017.4 1010.4

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

Station	Years of Record	Air Temperature in Millibars at Sea Level												Annual	
		January	February	March	April	May	June	July	August	September	October	November	December		
<b>NEW FOUNDLAND</b>															
14. St. John's - Torbay Airport	25	Max Mean Min	1017.3 1008.8 995.4	1016.6 1008.8 996.5	1017.0 1008.2 995.4	1017.7 1011.4 1001.7	1018.9 1015.0 1009.4	1018.7 1011.8 1010.0	1018.4 1025.1 1012.0	1018.2 1018.4 1011.4	1021.0 1018.4 1011.8	1018.5 1014.9 1010.7	1024.1 1014.2 1004.8	1018.7 1010.5 1002.9	1024.1 1021.9 995.4
15. Stephenville Airport	14	Max Mean Min	1018.1 1009.5 1000.0	1018.0 1009.8 998.5	1018.0 1009.0 1005.4	1018.4 1010.8 1005.0	1017.0 1014.0 1009.8	1018.1 1011.6 1009.0	1018.8 1015.4 1011.2	1018.5 1013.9 1009.5	1018.8 1012.7 1011.0	1018.5 1012.9 1010.2	1022.7 1012.9 1001.7	1018.0 1011.9 1004.0	1022.7 1012.2 998.1
16. Twillingate	16	Max Mean Min	1018.3 1010.2 1000.0	1017.4 1009.1 996.0	1017.1 1008.1 998.4	1018.2 1010.8 1004.2	1018.1 1013.8 1009.1	1018.5 1013.8 1008.8	1018.7 1013.2 1011.0	1018.7 1012.8 1009.7	1018.0 1012.8 1010.5	1017.4 1012.8 1008.4	1022.0 1012.4 1006.1	1018.7 1010.0 1001.9	1024.8 1011.8 996.0
<b>LABRADOR</b>															
17. Bellefleur - Loran	9	Max Mean Min	1013.4 1006.2 994.8	1015.1 1007.0 995.4	1015.9 1009.0 995.9	1016.6 1010.6 1002.2	1018.8 1013.5 1008.8	1018.9 1011.1 1007.4	1018.7 1010.9 1007.4	1018.3 1011.8 1008.2	1018.5 1011.4 1008.2	1018.5 1009.5 1006.1	1020.8 1011.1 1002.8	1014.8 1008.1 999.1	1020.8 1018.5 999.1
18. Bellefleur	27	Max Mean Min	1015.2 1006.4 998.8	1020.1 1007.0 994.4	1020.3 1008.4 997.9	1018.6 1010.7 1005.5	1016.7 1011.5 1008.1	1015.7 1011.4 1007.7	1016.5 1011.7 1007.7	1014.7 1011.7 1007.4	1017.0 1012.8 1008.8	1018.2 1010.9 1006.5	1020.9 1011.1 1002.0	1016.1 1005.2 994.2	1020.9 1018.2 994.4
19. Cape Harrison	14	Max Mean Min	1018.0 1009.5 1000.2	1018.3 1010.8 1000.5	1022.7 1011.8 1001.2	1016.1 1011.0 1008.5	1018.7 1011.4 1009.8	1018.9 1011.2 1008.2	1018.9 1010.9 1008.9	1018.8 1010.7 1008.1	1018.1 1010.0 1008.1	1018.1 1009.7 1005.1	1021.0 1009.4 1001.8	1014.4 1007.8 1002.2	1022.7 1010.4 1000.1
20. Cartwright	23	Max Mean Min	1018.1 1008.1 998.8	1021.0 1008.8 996.0	1022.8 1010.5 1001.2	1016.5 1012.4 1008.7	1018.8 1011.4 1009.7	1018.6 1012.0 1009.7	1018.4 1010.5 1008.9	1018.4 1010.8 1009.7	1018.5 1012.4 1009.7	1018.4 1010.3 1007.9	1020.8 1011.2 1001.8	1014.5 1007.7 998.7	1022.8 1010.4 996.0
21. Goose Airport	25	Max Mean Min	1019.0 1010.8 1001.5	1020.1 1011.8 998.2	1021.9 1012.1 1003.1	1018.7 1011.4 1008.8	1018.5 1011.2 1008.8	1018.7 1010.7 1007.3	1018.5 1009.8 1008.2	1018.4 1010.8 1007.1	1018.8 1012.8 1008.7	1018.1 1011.1 1008.2	1021.4 1012.8 1005.0	1016.4 1009.9 1001.5	1021.9 1011.5 994.2
22. Hopedale	21	Max Mean Min	1020.3 1010.2 998.8	1019.2 1010.4 998.5	1020.8 1011.0 1001.0	1017.8 1014.4 1009.4	1018.1 1011.8 1010.1	1018.7 1010.8 1008.0	1018.7 1009.9 1005.7	1018.7 1009.4 1005.7	1018.7 1009.2 1006.0	1018.0 1009.2 1006.0	1021.1 1010.4 1001.9	1014.8 1008.1 994.4	1021.8 1010.9 998.1
23. Stegik	4	Max Mean Min	1020.8 1012.8 1007.5	1020.0 1011.5 1000.2	1025.0 1014.9 1006.2	1018.0 1014.9 1011.9	1018.6 1013.7 1009.1	1018.2 1012.2 1009.3	1018.2 1008.7 1004.6	1018.4 1008.5 1004.8	1018.1 1008.1 1005.1	1018.1 1008.4 1005.4	1021.4 1008.2 1005.4	1012.9 1006.6 1001.9	1021.0 1008.0 1000.2
24. Sandgirt Lake	6	Max Mean Min	1024.0 1010.2 1004.0	1018.7 1010.5 1005.8	1011.8 1011.7 1010.8	1018.7 1013.8 1011.2	1018.9 1011.2 1008.5	1024.8 1011.9 1008.8	1011.4 1009.8 1008.0	1012.4 1010.4 1009.3	1018.8 1012.7 1010.2	1018.8 1011.7 1009.4	1021.7 1014.4 1010.2	1011.7 1011.4 1006.2	1021.7 1011.4 1004.0
25. Wabush Lake Airport	6	Max Mean Min	1017.1 1012.3 1008.4	1014.9 1009.2 1001.4	1015.0 1014.2 1011.4	1018.4 1015.1 1012.1	1017.5 1014.0 1011.0	1014.0 1011.0 1008.8	1013.4 1010.4 1007.4	1015.7 1012.1 1008.8	1018.2 1014.4 1010.8	1018.2 1014.4 1011.1	1020.2 1014.4 1011.1	1018.9 1014.4 1011.1	1021.5 1012.8 1008.4

NEWFOUNDLAND AND LABRADOR  
 PEAK WIND VELOCITY DATA AT A SELECTED STATION

3900- TORBAY A. PERIOD OF RECORD = 1/1942-12/1966	JAN	FEB	MAR	APR	MAY	JUN
AVRGE NO.DAYS WITH WIND GRT 32MPH	9.	8.	6.	6.	3.	2.
AVRGE NO.DAYS WITH WIND GRT 39MPH	4.	2.	2.	1.	0.	0.
AVRGE PEAK WIND SPEED (MPH)	78.	74.	66.	66.	54.	54.
AZIMUTH OF AVRGE PEAK WIND(NORTH)	150.	220.	240.	160.	340.	250.
MAX.PEAK WIND SPEED (MPH)	97.	120.	80.	99.	68.	65.
AZIMUTH OF MAX.PEAK WIND(NORTH)	220.	360.	220.	360.	360.	130.

	JULY	AUG	SEPT	OCT	NOV	DEC
AVRGE NO.DAYS WITH WIND GRT 32MPH	0.	0.	3.	3.	6.	8.
AVRGE NO.DAYS WITH WIND GRT 39MPH	0.	0.	0.	1.	2.	3.
AVRGE PEAK WIND SPEED (MPH)	44.	51.	60.	64.	65.	77.
AZIMUTH OF AVRGE PEAK WIND(NORTH)	180.	270.	200.	210.	200.	160.
MAX.PEAK WIND SPEED (MPH)	55.	70.	76.	75.	82.	95.
AZIMUTH OF MAX.PEAK WIND(NORTH)	130.	240.	360.	80.	240.	130.

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

Station	Period of Record	Relative Humidity - Percent												Annual	
		January	February	March	April	May	June	July	August	September	October	November	December		
NEWFOUNDLAND															
Argentia Airport	1952-66	Max	97	93	91	93	92	93	91	94	93	92	90	90	97
		Mean	83	83	84	86	87	87	89	88	84	83	84	83	85
		Min	71	74	73	80	81	83	83	82	76	75	74	75	71
Bonavista	1960-66	Max	90	93	92	91	92	88	89	89	89	87	91	88	93
		Mean	84	86	88	87	86	85	86	85	84	84	86	85	85
		Min	78	80	82	81	81	81	83	81	81	81	83	79	80
Botwood	1943-50	Max	87	91	88	87	82	82	83	85	85	88	90	89	91
		Mean	83	87	81	79	77	76	78	81	82	85	88	86	82
		Min	77	82	75	66	68	69	75	77	77	77	82	84	81
Buchans Airport	1944-64	Max	99	98	98	93	89	85	89	87	90	92	96	97	99
		Mean	90	90	88	87	80	78	81	84	84	88	90	89	86
		Min	78	76	76	79	72	70	76	75	80	84	86	83	70
Cape Race	1944-45 1955-65	Max	96	94	93	95	97	95	96	97	95	97	97	95	97
		Mean	89	88	89	91	90	90	94	92	92	89	90	88	90
		Min	82	84	85	89	87	85	92	89	83	83	83	85	82
Daniels Harbour	1953 1956-66	Max	94	92	96	91	89	88	90	90	89	88	92	90	96
		Mean	86	85	86	86	82	82	84	84	83	83	85	86	84
		Min	80	80	80	80	76	79	78	80	77	78	79	81	76
Fogo	1940-44 1946-49	Max	95	94	93	93	93	91	88	89	92	90	93	93	95
		Mean	90	90	90	90	86	86	85	86	86	86	84	87	87
		Min	84	85	86	84	75	78	79	79	79	83	82	85	84
Gander International Airport	1940-66	Max	95	95	94	92	90	89	87	87	90	93	93	93	95
		Mean	88	88	87	84	80	78	78	82	82	83	86	89	88
		Min	81	78	82	75	72	66	72	75	76	76	82	81	82
Grand Bank	1940-48 1952-65	Max	94	96	95	95	94	94	94	95	93	91	96	93	96
		Mean	85	84	84	85	87	86	88	88	88	87	86	86	84
		Min	74	71	73	77	78	80	81	83	80	80	79	80	77

NEWFOUNDLAND AND LABRADOR

SUMMARY OF HUMIDITY DATA  
AT SELECTED  
CLIMATOLOGIC STATIONS

The Shawinigan Engineering Company Limited  
James P. MacLaren Limited

Station	Period of Record	Relative Humidity - Percent												Annual	
		January	February	March	April	May	June	July	August	September	October	November	December		
NEWFOUNDLAND															
Millertown	1940-45	Max	92	94	92	91	87	87	86	90	92	92	92	95	95
		Mean	90	91	89	87	84	83	84	88	89	90	91	91	88
		Min	89	90	87	83	77	80	82	87	86	89	90	89	77
St. Andrews	1944-65	Max	92	94	91	88	88	87	88	91	93	92	93	93	94
		Mean	86	86	84	82	79	81	83	85	87	86	88	86	84
		Min	81	75	81	77	70	74	77	80	82	82	82	81	70
St. Anthony Airport	1947-65	Max	91	94	96	95	90	90	88	89	86	89	91	91	96
		Mean	81	82	84	86	84	80	83	83	81	84	87	83	83
		Min	64	72	75	73	74	71	72	76	75	79	82	76	64
St. Georges	1940-44	Max	87	90	87	88	87	85	87	90	87	86	92	88	92
		Mean	82	83	83	84	85	84	85	86	86	85	88	84	85
		Min	75	72	78	79	79	83	83	83	83	83	82	86	80
St. John's	1949-54	Max	96	97	95	88	92	88	84	89	97	95	96	95	97
		Mean	90	90	89	87	84	80	82	85	83	82	90	91	86
		Min	88	88	85	85	79	70	77	79	78	79	88	88	70
St. John's Torbay Airport	1942-66	Max	95	97	95	94	89	86	89	91	92	93	96	96	97
		Mean	88	89	88	86	82	81	83	85	84	86	89	88	86
		Min	72	79	82	77	70	71	73	77	78	80	85	81	70
Stephenville Airport	1952-57	Max	96	85	82	82	75	83	78	84	86	83	86	86	96
		Mean	81	80	77	76	72	77	76	80	81	81	83	80	79
		Min	72	76	74	67	67	72	73	77	77	77	78	74	67
Twillingate	1951-66	Max	91	91	91	91	90	88	87	91	93	93	92	95	95
		Mean	86	85	87	87	84	83	84	86	84	85	87	84	85
		Min	79	77	83	81	78	70	80	82	78	79	80	76	70

NEWFOUNDLAND AND LABRADOR

SUMMARY OF HUMIDITY DATA  
AT SELECTED  
CLIMATOLOGIC STATIONS

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

Station	Period of Record	Relative Humidity - Percent												Annual	
		January	February	March	April	May	June	July	August	September	October	November	December		
LABRADOR															
Battle Harbour Loran	1958-66	Max	87	92	94	92	92	93	92	94	88	90	90	90	94
		Mean	80	80	84	87	86	87	90	89	84	84	86	81	85
		Min	72	69	78	83	81	83	85	84	81	79	83	74	69
Belle Isle	1943-50 1952 1955-57 1959-66	Max	96	98	96	97	95	98	98	97	98	99	96	97	99
		Mean	88	89	89	95	93	93	94	93	92	92	91	89	91
		Min	79	82	83	84	89	88	91	88	81	86	87	82	79
Cape Harrison	1948-61	Max	88	88	91	94	92	89	91	89	86	87	89	86	94
		Mean	80	79	81	85	83	78	80	79	80	81	84	81	81
		Min	65	68	63	78	75	71	73	71	74	71	76	74	63
Cartwright	1943-66	Max	92	93	94	94	95	95	94	94	94	97	94	93	97
		Mean	84	84	86	89	88	86	87	88	87	89	89	85	87
		Min	71	65	74	80	79	78	81	79	77	82	83	75	65
Goose Airport	1942-66	Max	91	94	91	93	81	86	82	94	86	85	89	96	96
		Mean	81	83	78	76	69	71	73	76	77	79	82	82	77
		Min	63	64	69	68	59	61	59	66	70	67	76	67	59
Hopedale	1951-53 1956-65	Max	98	92	97	94	93	91	93	93	94	91	95	95	98
		Mean	78	77	80	82	84	82	85	89	83	82	85	78	82
		Min	59	59	68	69	73	71	77	74	73	76	78	66	59
Saglek	1955-58	Max	80	82	81	85	85	87	85	86	84	73	82	80	87
		Mean	70	68	76	74	80	81	80	80	77	71	78	73	76
		Min	56	60	70	65	75	74	71	69	72	68	72	60	56
Sandgirt Lake	1943-48	Max	93	98	94	96	92	90	86	87	90	92	99	100	100
		Mean	89	87	88	88	87	85	82	85	88	89	92	92	88
		Min	80	71	70	81	81	78	78	81	87	84	86	87	70
Wabush Lake Airport	1961-66	Max	82	80	83	80	78	78	83	88	89	90	88	86	90
		Mean	77	76	77	75	75	74	79	85	86	86	85	80	80
		Min	69	66	70	72	72	70	76	81	80	79	80	70	66

NEWFOUNDLAND AND LABRADOR  
SUMMARY OF HUMIDITY DATA  
AT SELECTED  
CLIMATOLOGIC STATIONS

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
PRELIMINARY CORRELATION BETWEEN MEAN ANNUAL  
PRECIPITATION AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 10

F LEVEL 1.117

STANDARD ERROR OF DEP VARIABLE = 42.0265

CONSTANT 582.5046

R = .888

VARIABLE	COEFF	STANDARD ERROR
X = 1	-1.95887528	0.24484422
X = 2	-1.95519354	0.22616007
X = 4	-3.13474297	0.22142990
X = 5	0.01728827	0.22640048
X = 7	-0.52614949	0.22429172
X = 8	0.14429302	0.22298094

LATITUDE (J COORDINATE OF SQUARE IN MASTER FILE - SEE APPENDIX A)  
DISTANCE TO SEA - KILOMETERS  
DISTANCE TO SEA IN SOUTH WEST DIRECTION - KILOMETERS  
SLOPE OF SQUARE - x 10<sup>5</sup>  
AVERAGE BARRIER HEIGHT IN SOUTH EAST DIRECTION - (FEET X 10)  
ACTUAL ELEVATION OF STATION - FEET

ACTUAL	PREDICTED	DEVIATION	ACTUAL	PREDICTED	DEVIATION
			375.00006	360.11090	14.88916
427.00006	472.18198	-25.18192	427.00006	453.52673	-26.52667
447.00006	472.18198	-25.18192	435.00006	521.38440	-86.38429
519.00012	532.65931	-13.65919	570.00012	524.24682	45.75330
402.00006	401.84246	0.15760	570.00012	552.98209	17.01807
433.00006	443.92077	-10.92071	516.00012	521.36853	-5.36841
592.00012	535.62194	56.37818	414.00006	501.65875	-87.65870
334.00006	305.22363	28.77643	540.00012	474.65838	65.34169
379.00006	368.11193	10.88813	441.00006	439.26367	1.73639
420.00006	450.61700	-30.61694	552.00012	532.93945	19.06067
420.00006	325.21536	94.78470	539.00012	576.11547	-43.11536
410.00006	407.63317	2.36689	579.00012	549.02636	29.97376
362.00006	378.96142	-16.96136	540.00012	548.77209	-8.77197
349.00006	372.65579	-23.65573	600.00012	531.93034	68.06978
505.00006	545.21264	-40.21258	625.00012	581.69323	43.30689
361.00006	400.71264	-39.71258	595.00012	590.37297	4.62715
365.00006	373.75616	-8.75610	486.00006	523.79333	-37.79327
570.00012	561.26196	8.73816	603.00012	559.06006	43.93906
382.00006	365.89910	16.10096			

PRECIP. ( (INCH-YEAR) x 10<sup>-1</sup> ) =

$$\begin{aligned}
 & -1.95887028 x_1 - 1.95538354 x_2 - 1.13474007 x_4 \\
 & + 0.01728827 x_5 - 0.52614949 x_7 + 0.14038302 x_8 \\
 & + 582.5046 \\
 & \text{(EQ. 11 - 2)}
 \end{aligned}$$

LABRADOR

PRELIMINARY CORRELATION BETWEEN MEAN ANNUAL  
PRECIPITATION AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	3367.99951	3336.59424	31.40527	BATTLE HARBOUR
2	2775.00049	3331.06787	-556.06750	BATTLE HARBOUR LORAN
3	3421.00000	3609.74268	-188.74270	BELLE ISLE
4	3194.00000	3168.04883	25.95117	CAPE HARRISON
5	3689.00000	3493.93506	195.06497	CARTWRIGHT
6	3400.99951	3394.87500	6.12451	GOOSE A
7	2998.00000	2893.23828	104.76173	HOPEDALE
8	2663.00000	3319.08399	-656.08410	MENIHEK RAPIDS
9	2071.00000	2544.65674	-473.65680	NAIN
10	3662.00000	3591.74414	70.25587	SANDGIRT LAKE
11	3228.99951	3702.00879	-473.00933	WABUSH LAKE

NOTE: DATA FROM ISOHYETS AS TRACED BY DOT, METEOROLOGICAL BRANCH (FIG. 8-13A) WERE USED IN THE CORRELATION WITH A WEIGHT ONE HUNDRED TIMES SMALLER THAN THAT OF A RAIN GAUGING STATION HAVING A FULL PERIOD OF RECORD.

COEFFICIENT OF CORRELATION = 0.8491

X( 1) - LATITUDE ( J NUMBER OF SQUARE IN GRID )  
X( 2) - SLOPE OF SQUARE ( FT/FT)\*100000  
X( 3) - (SLOPE)\*\*2  
X( 4) - AZIMUTH OF SLOPE MEASURED FROM NORTH (RANGE = 0 TO 180 DEGREES)  
X( 5) - AVERAGE ELEVATION OF SQUARE OR STATION (TENS OF FEET)  
X( 6) - (AVERAGE ELEVATION)\*\*2  
X( 7) - DISTANCE TO THE SEA IN EAST DIRECTION (KILOMETERS)  
X( 8) - (DISTANCE TO THE SEA IN EAST DIRECTION)\*\*2  
X( 9) - DISTANCE TO THE SEA IN SOUTH EAST DIRECTION (KILOMETERS)  
X(10) - (DISTANCE TO THE SEA IN SOUTH EAST DIRECTION)\*\*2  
X(11) - BARRIER HEIGHT IN EAST DIRECTION (TENS OF FEET)  
X(12) - (BARRIER HEIGHT IN EAST DIRECTION)\*\*2  
X(13) - BARRIER HEIGHT IN SOUTH EAST DIRECTION (TENS OF FEET)  
X(14) - (BARRIER HEIGHT IN SOUTH EAST DIRECTION)\*\*2  
X(15) - DEPENDANT VARIABLE = PRECIPITATION ( (INCH/YEAR)\*100)

STANDARD ERROR OF DEP VARIABLE = 308.9375

CONSTANT 3291.8711

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 4	0.20688006	0.15188467
X - 5	7.03028298	0.53286564
X - 6	-0.01171895	0.00265359
X - 7	3.63066149	0.23226872
X - 8	-0.00496446	0.00027829
X - 10	-0.00264762	0.00008427
X - 11	-2.45003843	0.29275822
X - 13	0.27804553	0.23350814

NOTE: APPLIES ONLY SOUTH OF 56° 30'  
LATITUDE NORTH

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{CONSTANT} + \sum_{i=1}^n RC_i X_i$$

NEWFOUNDLAND - EASTERN REGION  
FINAL CORRELATION BETWEEN  
PRECIPITATION AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 7

F LEVEL 2.251

STANDARD ERROR OF DEP VARIABLE = 376.4658

CONSTANT 5768.4296

R = 90

VARIABLE	COEFF	STANDARD ERROR			
X - 1	-19.37985997	5.83990002			
X - 3	-2.24798060	0.87899851			
X - 5	0.17123192	0.07286532			
X - 7	26.48422246	4.97931195			
X - 8	-6.75313855	4.50065900			
X - 10	-0.19265168	0.02703629			
X - 14	-0.09485147	0.03188622			
			LATITUDE (J) COORDINATE OF SQUARE IN MASTER FILE - SEE APPENDIX A)		
			DISTANCE TO THE SEA IN SOUTH EAST DIRECTION - KILOMETERS		
			SLOPE OF SQUARE x ((ft/ft) x 10 <sup>-5</sup> )		
			AVERAGE ELEVATION OF SQUARE -(FEET x 10)		
			AVERAGE BARRIER HEIGHT IN SOUTH EAST DIRECTION -(FEET x 10)		
			(SHORTEST DISTANCE TO THE SEA) <sup>2</sup>		
			(AVERAGE ELEVATION OF SQUARE) <sup>2</sup>		
			ACTUAL	PREDICTED	DEVIATION
4200.00098	4174.14356	25.85742	4410.00098	4730.72266	-320.72174
4200.00098	3798.95752	401.04303	5520.00098	5323.54493	196.45608
4100.00098	3683.64014	416.36041	5330.00098	5783.63184	-453.63092
3620.00049	3856.62598	-236.62551	5790.00098	5489.41602	300.58502
3490.00049	3404.68653	85.31398	5100.00098	5608.96583	-208.96487
5050.00098	5341.57813	-291.57721	6000.00098	5401.83888	598.16223
3610.00049	4025.02149	-415.02105	6250.00098	6185.29298	64.70802
5700.00098	5796.34571	-96.34474	5950.00098	6244.47266	-294.47174
3820.00049	3818.83691	1.16357	4860.00098	5336.83985	-476.83892
3750.00049	3550.36279	199.63772	6030.00098	5787.55469	242.44631
4270.00098	4953.14258	-63.14172			
4350.00098	4887.58302	-537.58215			
5700.00098	5200.62110	499.37994			
5700.00098	5771.25684	-71.25587			
5160.00098	5074.76954	85.23146			
4140.00098	5188.39747	-1048.39673			
5400.00098	4666.82130	733.17981			

$$\text{PRECIP. ( (INCH/YEAR) x 10^2 )} = -19.37985997 x_1 - 19285188 x_2^2 - 2.24798060 x_3 + 0.17123192 x_5 + (26.48422246 - 0.9485147 x_7) x_7 - 6.75313855 x_8 + 5768.4296$$

NOTE:

DATA COMPARING ACTUAL (ESTIMATED) TO COMPUTED PRECIPITATION ARE NOT SHOWN BUT THEY ARE AVAILABLE IN THE COMPUTER FILE.

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND - WESTERN REGION  
FINAL CORRELATION BETWEEN  
PRECIPITATION AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 9  
F LEVEL 3.043  
STANDARD ERROR OF DEP VARIABLE = 435.0842  
CONSTANT 5965.9017

R = .968

VARIABLE	COEFF	STANDARD ERROR/
X = 1	-14.274660.3	5.99644253
X = 4	-7.48731232	2.06793833
X = 5	0.11029791	0.06321889
X = 7	24.82515666	4.47525995
X = 8	-6.08528708	2.01964522
X = 10	-0.37263202	0.08705042
X = 16	0.03206187	0.00927686

LATITUDE (1) COORDINATE OF SQUARE IN MASTER FILE (SEE APPENDIX A)  
DISTANCE TO THE SEA IN SOUTH WEST DIRECTION - KILOMETERS  
SLOPE OF SQUARE  $\times ((1 \text{ FT}) \times 10^{-5})$   
AVERAGE ELEVATION OF SQUARE  $-(\text{FEET} \times 10)$   
AVERAGE BARRIER HEIGHT IN SOUTH EAST DIRECTION  $-(\text{FEET} \times 10)$   
(SHORTEST DISTANCE TO THE SEA)<sup>2</sup>  
(AVERAGE BARRIER HEIGHT IN SOUTH WEST DIRECTION)<sup>2</sup>

ACTUAL	PREDICTED	DEVIATION
4470.00098	4926.27247	-456.27154
5190.00098	5588.69337	-398.69244
4020.00049	3717.66358	302.33697
4330.00098	4387.88282	-57.88184
5920.00098	5642.16407	277.83697
3340.00049	3427.60254	-87.60206
3790.00049	3448.13232	341.86822
3650.00049	3871.79688	-221.79641

$$\text{PRECIP. (INCH YEAR) } \times 10^{-2} =$$

$$-14.27466010 x_1 - 0.37263202 x_2^2 - 7.48731232 x_4$$

$$+ 0.11029791 x_5 + 24.82515666 x_7 - 6.08528748 x_8$$

$$+ 0.03206187 x_9 + 5965.9017$$

NOTE  
DATA COMPARING ACTUAL (ESTIMATED) TO COMPUTED PRECIPITATION IN THE '65 SQUARES ARE NOT SHOWN BUT ARE AVAILABLE IN THE COMPUTER FILE

LABRADOR  
FINAL CORRELATION BETWEEN  
PRECIPITATION AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	3368.00049	3298.22217	69.77833	BATTLE HARBOUR
2	2775.00049	3224.24317	-449.24273	BATTLE HARBOUR LORAN
3	3421.00049	3261.37403	159.62649	BELLE ISLE
4	3194.00049	3188.12744	5.87304	CAPE HARRISON
5	3689.00049	3592.41797	96.58253	CARTWRIGHT
6	3401.00049	3391.18067	9.81982	GOOSE A
7	2998.00049	2916.04639	81.95411	HOPEDALE
8	2663.00049	3242.48242	-579.48205	MENIHEK RAPIDS
9	2071.00049	2801.14600	-730.14563	MAIN
10	3662.00049	3220.74121	441.25933	SANDGIRT LAKE
11	3229.00049	3287.68408	-58.68360	WABUSH LAKE

NOTE: RUNOFF DATA AUGMENTED BY ESTIMATED EVAPOTRANSPIRATION WERE ALSO USED IN THE CORRELATION WITH A WEIGHT ONE HUNDRED TIMES SMALLER THAN THAT OF A RAIN GAUGING STATION HAVING A FULL PERIOD OF RECORD.

COEFFICIENT OF CORRELATION = 0.7650

- X( 1) - LATITUDE ( J NUMBER OF SQUARE IN GRID )
- X( 2) - SLOPE OF SQUARE ( FT/FT)\*100000
- X( 3) - (SLOPE)\*\*2
- X( 4) - AZIMUTH OF SLOPE MEASURED FROM NORTH (RANGE = 0 TO 180 DEGREES)
- X( 5) - AVERAGE ELEVATION OF SQUARE OR STATION (TENS OF FEET)
- X( 6) - (AVERAGE ELEVATION)\*\*2
- X( 7) - DISTANCE TO THE SEA IN EAST DIRECTION (KILOMETERS)
- X( 8) - (DISTANCE TO THE SEA IN EAST DIRECTION)\*\*2
- X( 9) - DISTANCE TO THE SEA IN SOUTH EAST DIRECTION (KILOMETERS)
- X(10) - (DISTANCE TO THE SEA IN SOUTH EAST DIRECTION)\*\*2
- X(11) - BARRIER HEIGHT IN EAST DIRECTION (TENS OF FEET)
- X(12) - (BARRIER HEIGHT IN EAST DIRECTION)\*\*2
- X(13) - BARRIER HEIGHT IN SOUTH EAST DIRECTION (TENS OF FEET)
- X(14) - (BARRIER HEIGHT IN SOUTH EAST DIRECTION)\*\*2
- X(15) - DEPENDANT VARIABLE - PRECIPITATION ( (INCH/YEAR)\*100)

APPLIES ONLY SOUTH OF 56° 30'  
LATITUDE NORTH

STANDARD ERROR OF DEP VARIABLE = 174.5053

CONSTANT		1917.2209	
VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR	
X - 1	33.85341654	0.13109099	
X - 2	-0.12051689	0.00093753	
X - 3	0.00001276	0.00000009	
X - 4	1.31592345	0.00973820	
X - 5	1.05901146	0.08220757	
X - 6	-0.00957492	0.00027037	
X - 7	7.16745282	0.02208624	
X - 8	-0.00487464	0.00002125	
X - 9	-7.13289834	0.02696256	
X - 10	0.00180939	0.00002036	
X - 11	-11.21993258	0.05196910	
X - 12	0.04240909	0.00030366	
X - 13	0.09474858	0.02236134	

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{CONSTANT} + \sum_{i=1}^n RC_i X_i$$

NEWFOUNDLAND AND LABRADOR  
AVERAGE AND EXTREME MEAN MONTHLY PRECIPITATION  
RECORDED AT SELECTED STATIONS

1200- COLINET PERIOD OF RECORD = 1/1967-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	16.88	15.72	15.16	13.30	12.43	10.87	12.13	10.55	12.09	13.97	16.76	16.88
AVERAGE MONTHLY RAINFALL (INCH)	3.73	2.74	2.80	7.61	3.89	3.61	6.11	3.73	6.38	6.87	8.39	6.66
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	20.88	20.78	19.28	7.03	1.16	0.00	0.00	0.00	0.00	0.00	0.00	16.81
AVERAGE MONTHLY PRECIPITATION (INCH)	5.83	4.82	4.77	4.23	3.80	3.61	6.11	3.73	6.38	6.87	8.39	6.61
MAXIMUM MONTHLY PRECIPITATION (INCH)	8.01	8.99	8.72	8.85	8.78	5.11	7.85	6.18	8.94	8.83	11.21	11.99
MINIMUM MONTHLY PRECIPITATION (INCH)	0.22	1.53	0.81	1.83	1.34	0.76	1.44	1.66	2.07	2.21	0.68	2.65
MAXIMUM 24HR RAINFALL (INCH)	2.09	3.88	2.24	2.50	2.66	1.79	3.27	2.94	4.12	2.78	3.03	6.11
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	16.00	16.00	13.00	10.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.09	3.88	2.24	2.50	2.66	1.79	3.27	2.94	4.12	2.78	3.03	6.11

800- BURGED PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	19.11	12.14	10.42	9.88	11.48	11.61	12.34	11.88	11.94	12.37	13.24	16.36
AVERAGE MONTHLY RAINFALL (INCH)	3.16	2.77	2.82	3.22	3.22	4.92	3.21	4.34	3.28	5.45	5.85	6.09
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	19.74	20.30	11.25	6.22	0.52	0.00	0.00	0.00	0.00	0.00	2.24	16.14
AVERAGE MONTHLY PRECIPITATION (INCH)	3.10	4.81	3.72	3.82	4.97	4.92	3.21	4.34	3.28	5.47	6.11	5.92
MAXIMUM MONTHLY PRECIPITATION (INCH)	9.60	9.40	7.22	7.23	13.05	9.13	10.50	8.11	11.21	10.17	12.22	9.71
MINIMUM MONTHLY PRECIPITATION (INCH)	1.92	1.90	0.77	0.71	1.00	2.14	1.87	1.41	1.36	1.68	2.74	2.76
MAXIMUM 24HR RAINFALL (INCH)	2.69	3.38	1.99	3.37	2.97	3.58	2.95	2.78	2.78	3.21	3.21	6.11
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	14.00	14.00	8.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.69	3.38	2.30	3.37	2.97	3.58	2.95	2.78	2.78	3.21	3.21	6.11

810- BURIN PERIOD OF RECORD = 2/1909-10/1931	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	16.88	15.94	15.16	11.92	11.31	9.68	11.28	10.13	12.00	13.88	16.16	16.23
AVERAGE MONTHLY RAINFALL (INCH)	2.60	1.89	2.25	3.23	3.49	3.48	4.97	4.19	4.99	4.10	6.32	6.09
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	20.11	20.19	19.87	6.94	0.41	0.00	0.00	0.00	0.00	0.00	3.68	18.33
AVERAGE MONTHLY PRECIPITATION (INCH)	5.31	5.51	4.67	3.38	3.97	3.48	4.97	4.19	4.99	4.10	6.38	5.93
MAXIMUM MONTHLY PRECIPITATION (INCH)	13.09	11.28	7.13	7.87	8.28	6.70	10.30	7.64	9.12	8.44	11.69	9.92
MINIMUM MONTHLY PRECIPITATION (INCH)	1.67	0.94	0.90	0.75	1.09	0.62	2.31	0.99	2.38	1.94	1.94	1.94
MAXIMUM 24HR RAINFALL (INCH)	1.90	1.84	1.70	1.96	2.30	1.96	2.42	2.42	2.84	2.18	2.23	4.72
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	24.00	24.00	23.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.60	2.60	2.30	1.96	2.38	1.96	2.42	2.42	2.84	2.18	2.23	4.72

900- CARR HARRISON PERIOD OF RECORD = 1/1947-12/1961	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	14.44	12.28	13.97	14.21	12.85	12.44	14.69	13.64	15.21	12.38	13.61	13.64
AVERAGE MONTHLY RAINFALL (INCH)	2.09	2.21	2.27	2.88	3.08	2.23	3.35	3.98	4.42	1.68	0.69	0.36
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	23.23	17.87	23.48	20.10	8.83	0.00	0.00	0.00	0.00	0.00	0.00	18.68
AVERAGE MONTHLY PRECIPITATION (INCH)	2.62	1.97	2.91	2.65	2.82	4.80	3.35	3.98	4.42	2.31	1.18	1.33
MAXIMUM MONTHLY PRECIPITATION (INCH)	6.47	4.56	3.58	4.82	5.76	32.16	5.74	7.33	34.49	6.72	3.67	2.33
MINIMUM MONTHLY PRECIPITATION (INCH)	0.43	0.28	0.74	0.83	1.23	1.34	1.40	1.36	1.00	0.70	0.60	0.70
MAXIMUM 24HR RAINFALL (INCH)	16.30	12.00	11.60	12.60	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	1.63	1.60	1.11	0.96	1.10	0.00	0.00	0.00	0.00	0.00	0.00	1.60
MAXIMUM 24HR PRECIPITATION (INCH)	1.63	1.60	1.11	0.96	1.10	0.00	0.00	0.00	0.00	0.00	0.00	1.60

300- BELLE ISLE PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	12.60	11.94	13.03	12.03	12.44	13.11	12.70	13.45	13.29	12.88	13.13	13.16
AVERAGE MONTHLY RAINFALL (INCH)	0.72	0.80	0.80	1.04	2.28	3.31	3.00	3.63	3.70	3.32	2.89	0.89
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	13.80	15.74	14.59	14.03	3.49	1.87	0.00	0.00	0.00	0.00	0.00	13.87
AVERAGE MONTHLY PRECIPITATION (INCH)	2.07	2.35	2.42	2.47	2.67	3.40	3.00	3.43	3.74	3.32	3.70	2.38
MAXIMUM MONTHLY PRECIPITATION (INCH)	3.68	4.58	7.52	7.14	6.35	6.61	5.98	7.60	5.32	7.74	7.31	4.47
MINIMUM MONTHLY PRECIPITATION (INCH)	0.08	0.07	0.11	0.19	0.34	0.21	0.77	1.93	0.39	1.41	1.44	0.37
MAXIMUM 24HR RAINFALL (INCH)	2.50	1.36	1.10	1.60	3.27	2.60	2.70	2.32	2.26	2.70	2.08	1.80
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	11.00	8.00	13.00	10.00	6.00	3.00	0.00	0.00	0.00	0.00	0.00	11.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.50	1.36	1.10	1.60	3.27	2.60	2.70	2.32	2.26	2.70	2.08	1.80

700- BUEHNS Bay PERIOD OF RECORD = 11/1943- 6/1965	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	16.33	16.32	16.76	13.38	11.27	12.09	12.70	13.31	11.70	13.25	16.80	18.33
AVERAGE MONTHLY RAINFALL (INCH)	1.05	0.84	0.56	1.14	2.10	2.61	3.09	3.48	3.63	3.50	3.11	1.26
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	24.73	27.93	19.40	13.31	2.77	0.52	0.00	0.00	0.00	2.86	10.01	23.34
AVERAGE MONTHLY PRECIPITATION (INCH)	3.47	3.47	2.97	2.42	2.30	2.64	3.09	3.48	3.63	3.65	4.12	3.62
MAXIMUM MONTHLY PRECIPITATION (INCH)	8.68	7.22	6.75	6.10	8.89	5.83	6.82	8.01	6.45	7.35	7.53	7.70
MINIMUM MONTHLY PRECIPITATION (INCH)	3.48	3.15	1.50	0.84	0.90	0.76	1.53	0.99	0.95	0.94	1.80	1.38
MAXIMUM 24HR RAINFALL (INCH)	3.23	3.07	0.98	1.28	3.77	1.38	1.94	2.92	2.64	2.43	3.32	1.83
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	17.00	24.70	14.00	11.30	4.00	0.00	0.00	0.00	0.00	5.70	8.60	14.90
MAXIMUM 24HR PRECIPITATION (INCH)	3.40	2.44	1.08	1.40	4.77	1.38	1.94	2.92	2.64	2.43	3.32	1.83

100- ARGENTIA PERIOD OF RECORD = 1/1947-11/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	17.30	15.28	15.94	13.67	13.11	14.29	13.10	12.90	13.31	12.27	13.35	16.11
AVERAGE MONTHLY RAINFALL (INCH)	1.35	1.08	1.06	1.69	3.26	3.15	3.44	3.79	3.87	2.44	1.92	1.61
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	21.24	18.87	14.27	12.43	3.35	0.00	0.00	0.00	0.00	0.00	0.00	14.64
AVERAGE MONTHLY PRECIPITATION (INCH)	5.45	4.13	3.03	3.14	2.80	3.15	3.44	3.79	3.87	2.44	1.92	4.25
MAXIMUM MONTHLY PRECIPITATION (INCH)	16.15	7.40	7.90	8.64	6.40	5.15	5.88	6.19	6.11	5.44	12.66	8.18
MINIMUM MONTHLY PRECIPITATION (INCH)	2.11	1.47	0.97	0.97	1.00	0.77	1.43	1.38	1.68	1.24	1.34	0.60
MAXIMUM 24HR RAINFALL (INCH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	32.80	14.00	15.00	9.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00
MAXIMUM 24HR PRECIPITATION (INCH)	3.29	2.21	1.39	3.31	3.71	2.52	2.92	3.80	3.90	2.45	1.93	3.03

800- BELLE ISLE PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT 0.1 INCH	8.44	7.92	6.89	6.88	6.29	6.14	5.89	6.03	5.80	6.58	6.41	7.23
AVERAGE MONTHLY RAINFALL (INCH)	0.33	0.74	0.97	1.23	2.27	3.18	3.04	3.34	3.42	3.34	1.81	1.40
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	12.44	16.87	14.27	12.43	3.35	0.12	0.00	0.00	0.00	0.00	0.00	12.44
AVERAGE MONTHLY PRECIPITATION (INCH)	1.40	1.99	1.99	1.69	2.62	3.12	3.14	3.48	3.42	3.34	3.29	3.68
MAXIMUM MONTHLY PRECIPITATION (INCH)	2.90	3.49	3.47	4.92	6.40	6.42	6.24	6.77	6.49	7.14	5.88	3.88
MINIMUM MONTHLY PRECIPITATION (INCH)	0.10	0.10	0.10	0.10	0.10	0.11	0.15	0.17	0.10	0.07	0.42	0.49
MAXIMUM 24HR RAINFALL (INCH)	1.68	3.11	2.44	2.41	4.41	2.97	3.11	2.94	3.11	3.11	2.44	2.60
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	8.00	14.00	14.00	14.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.00	3.11	2.44	2.41	4.41	2.97	3.11	2.94	3.11	3.11	2.44	2.60

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The Shawinigan Engineering Company Limited  
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2688- ST GEORGE'S PERIOD OF RECORD = 1/1808-12/1938	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	20.91	18.12	16.93	11.88	12.52	11.55	11.91	11.82	11.70	15.13	16.91	14.01
AVERAGE MONTHLY RAINFALL (INCH)	3.64	2.27	2.34	1.58	1.70	1.32	1.22	1.33	1.37	1.51	1.65	1.67
AVERAGE MONTHLY SNOWFALL (INCHES)	12.80	28.98	25.98	7.43	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
AVERAGE MONTHLY PRECIPITATION (INCH)	3.67	2.29	2.47	1.32	1.44	1.32	1.22	1.37	1.37	1.51	1.65	1.67
MAX MONTHLY PRECIPITATION (INCH)	6.92	5.31	5.34	3.42	4.45	4.75	5.34	6.03	6.21	4.05	4.01	6.13
MIN MONTHLY PRECIPITATION (INCH)	1.52	1.41	1.54	1.18	1.22	1.22	1.22	1.22	1.22	1.49	1.47	1.54
MAX 24HR RAINFALL (INCH)	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
MAX 24HR SNOWFALL (INCHES)	12.15	28.00	24.00	8.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
MAX 24HR PRECIPITATION (INCH)	14.20	6.30	7.00	4.00	5.20	5.50	6.10	6.80	7.00	4.00	4.00	6.00

2600- ST JOHN'S PERIOD OF RECORD = 1/1809-12/1938	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	15.14	12.80	16.39	13.20	13.16	13.43	13.21	12.29	11.68	17.13	16.03	14.90
AVERAGE MONTHLY RAINFALL (INCH)	3.67	2.15	3.60	3.44	3.67	3.61	3.75	3.55	3.60	3.65	3.78	3.64
AVERAGE MONTHLY SNOWFALL (INCHES)	20.12	26.38	18.57	8.29	1.53	2.00	2.00	2.00	2.00	2.00	2.00	2.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.60	2.15	3.60	3.44	3.67	3.61	3.75	3.55	3.60	3.65	3.78	3.64
MAX MONTHLY PRECIPITATION (INCH)	11.78	12.80	14.8	14.2	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
MIN MONTHLY PRECIPITATION (INCH)	1.48	1.24	1.42	1.30	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
MAX 24HR RAINFALL (INCH)	2.13	4.20	1.80	2.50	1.80	2.50	2.60	2.60	2.60	2.60	2.60	2.60
MAX 24HR SNOWFALL (INCHES)	24.00	24.00	24.00	12.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
MAX 24HR PRECIPITATION (INCH)	24.00	4.20	7.00	4.00	4.80	5.10	5.60	6.20	6.20	6.20	6.20	6.20

2688- POINTE RICHE PERIOD OF RECORD = 1/1909-12/1938	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	8.28	7.13	8.30	7.26	5.78	6.17	6.21	6.43	6.50	7.22	7.38	6.95
AVERAGE MONTHLY RAINFALL (INCH)	2.49	1.61	1.64	1.44	1.27	1.29	1.30	1.38	1.36	1.36	1.36	1.36
AVERAGE MONTHLY SNOWFALL (INCHES)	26.74	28.33	18.90	13.60	1.62	2.00	2.00	2.00	2.00	2.00	2.00	2.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.27	1.72	1.61	1.44	1.24	1.29	1.30	1.38	1.36	1.36	1.36	1.36
MAX MONTHLY PRECIPITATION (INCH)	6.72	6.30	11.80	5.44	6.70	7.25	7.75	8.10	8.10	8.10	8.10	8.10
MIN MONTHLY PRECIPITATION (INCH)	0.95	0.90	1.03	1.16	1.14	1.13	1.13	1.13	1.13	1.13	1.13	1.13
MAX 24HR RAINFALL (INCH)	2.25	4.80	1.40	1.90	1.40	2.20	2.70	2.70	2.70	2.70	2.70	2.70
MAX 24HR SNOWFALL (INCHES)	21.00	24.00	24.00	18.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MAX 24HR PRECIPITATION (INCH)	2.25	2.40	2.40	1.80	1.40	2.20	2.70	2.70	2.70	2.70	2.70	2.70

2975- PORT AUX BASQUES PERIOD OF RECORD = 2/1904- 8/1930	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	21.95	19.76	17.65	16.13	15.00	15.65	15.28	14.94	14.00	14.67	13.67	14.90
AVERAGE MONTHLY RAINFALL (INCH)	2.65	1.10	2.15	2.17	3.30	4.10	4.31	4.03	4.06	3.70	3.20	3.17
AVERAGE MONTHLY SNOWFALL (INCHES)	42.68	29.81	15.29	10.00	1.12	0.10	0.10	0.10	0.10	0.10	0.10	0.10
AVERAGE MONTHLY PRECIPITATION (INCH)	3.12	1.20	2.29	2.24	3.42	4.20	4.41	4.13	4.16	3.80	3.30	3.27
MAX MONTHLY PRECIPITATION (INCH)	10.99	6.11	6.18	7.25	7.09	8.17	7.96	7.28	7.20	6.19	5.60	6.03
MIN MONTHLY PRECIPITATION (INCH)	2.35	1.10	2.40	2.10	2.65	3.40	3.63	3.43	3.43	3.10	2.70	2.69
MAX 24HR RAINFALL (INCH)	2.62	2.00	2.10	2.20	3.40	4.10	4.30	4.00	4.00	3.70	3.20	3.10
MAX 24HR SNOWFALL (INCHES)	13.00	11.00	14.50	1.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
MAX 24HR PRECIPITATION (INCH)	2.62	2.10	2.20	2.20	3.40	4.10	4.30	4.00	4.00	3.70	3.20	3.10

2975- PORT AUX BASQUES PERIOD OF RECORD = 8/1885-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	23.80	14.10	12.50	11.67	12.08	12.10	12.67	12.74	12.75	12.75	12.75	12.75
AVERAGE MONTHLY RAINFALL (INCH)	2.82	2.18	2.34	2.59	3.90	4.05	4.02	4.12	4.08	4.11	4.11	4.11
AVERAGE MONTHLY SNOWFALL (INCHES)	27.27	31.15	18.98	7.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.29	2.38	2.38	2.27	3.90	4.05	4.02	4.12	4.08	4.11	4.11	4.11
MAX MONTHLY PRECIPITATION (INCH)	6.78	4.14	4.08	6.44	7.00	6.75	6.67	6.66	6.66	6.66	6.66	6.66
MIN MONTHLY PRECIPITATION (INCH)	2.10	2.07	2.18	1.70	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
MAX 24HR RAINFALL (INCH)	1.77	2.65	1.34	1.70	2.40	3.10	3.10	3.10	3.10	3.10	3.10	3.10
MAX 24HR SNOWFALL (INCHES)	9.00	12.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAX 24HR PRECIPITATION (INCH)	1.81	2.65	1.34	1.70	2.40	3.10	3.10	3.10	3.10	3.10	3.10	3.10

2030- GRAVE FALLS PERIOD OF RECORD = 5/1909-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	19.82	16.77	16.87	12.24	12.91	11.29	11.29	11.29	11.29	11.29	11.29	11.29
AVERAGE MONTHLY RAINFALL (INCH)	3.42	2.49	2.77	2.12	1.81	1.41	1.41	1.41	1.41	1.41	1.41	1.41
AVERAGE MONTHLY SNOWFALL (INCHES)	22.92	29.18	22.68	10.74	1.15	1.49	1.49	1.49	1.49	1.49	1.49	1.49
AVERAGE MONTHLY PRECIPITATION (INCH)	3.17	2.19	2.45	2.24	2.14	1.49	1.49	1.49	1.49	1.49	1.49	1.49
MAX MONTHLY PRECIPITATION (INCH)	6.21	6.80	6.80	4.00	3.18	2.10	2.10	2.10	2.10	2.10	2.10	2.10
MIN MONTHLY PRECIPITATION (INCH)	1.36	1.74	1.24	1.14	1.17	1.10	1.10	1.10	1.10	1.10	1.10	1.10
MAX 24HR RAINFALL (INCH)	1.31	1.71	1.30	1.40	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
MAX 24HR SNOWFALL (INCHES)	14.00	18.00	14.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAX 24HR PRECIPITATION (INCH)	1.30	1.70	1.30	1.40	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10

2400- HORDALE PERIOD OF RECORD = 1/1942-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	19.82	16.77	16.87	12.24	12.91	11.29	11.29	11.29	11.29	11.29	11.29	11.29
AVERAGE MONTHLY RAINFALL (INCH)	3.14	2.20	2.29	2.34	2.71	3.21	3.21	3.21	3.21	3.21	3.21	3.21
AVERAGE MONTHLY SNOWFALL (INCHES)	24.84	17.29	11.82	5.83	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
AVERAGE MONTHLY PRECIPITATION (INCH)	2.48	1.89	1.77	1.67	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11
MAX MONTHLY PRECIPITATION (INCH)	6.48	5.83	6.48	7.00	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
MIN MONTHLY PRECIPITATION (INCH)	1.60	1.21	1.32	1.18	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
MAX 24HR RAINFALL (INCH)	1.77	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71
MAX 24HR SNOWFALL (INCHES)	14.50	12.00	12.75	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAX 24HR PRECIPITATION (INCH)	1.81	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80

1700- SANDER 44 PERIOD OF RECORD = 1/1939-12/1968	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT (0.1 INCH)	20.34	18.67	17.89	17.25	16.67	16.67	16.67	16.67	16.67	16.67	16.67	16.67
AVERAGE MONTHLY RAINFALL (INCH)	3.15	2.44	1.92	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
AVERAGE MONTHLY SNOWFALL (INCHES)	24.27	24.27	24.27	24.27	24.27	24.27	24.27	24.27	24.27	24.27	24.27	24.27
AVERAGE MONTHLY PRECIPITATION (INCH)	3.15	2.44	1.92	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
MAX MONTHLY PRECIPITATION (INCH)	4.91	4.91	4.91	4.91	4.91	4.91	4.91	4.91	4.91	4.91	4.91	4.91
MIN MONTHLY PRECIPITATION (INCH)	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
MAX 24HR RAINFALL (INCH)	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
MAX 24HR SNOWFALL (INCHES)	12.75	12.75	12.75	12.75	12.75	12.75	12.75	12.75	12.75	12.75	12.75	12.75
MAX 24HR PRECIPITATION (INCH)	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41

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The Shawinigan Engineering Company Limited  
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1400- ALEXWOOD PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	13.75	13.07	13.02	12.08	12.00	12.87	12.96	12.11	12.14	12.66	12.76	12.98
AVERAGE MONTHLY RAINFALL (INCH)	1.15	0.78	1.22	1.62	2.27	2.76	2.85	1.71	1.31	1.83	1.07	1.23
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	22.13	29.08	19.17	13.74	1.23	0.48	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	2.30	3.59	3.19	2.67	2.41	2.70	2.80	1.71	1.31	1.83	1.07	1.23
MAXIMUM MONTHLY PRECIPITATION (INCH)	7.5	8.82	7.37	6.27	5.22	5.31	6.88	7.94	7.53	7.40	6.00	6.83
MINIMUM MONTHLY PRECIPITATION (INCH)	1.4	1.88	1.43	0.76	1.92	2.02	1.03	0.99	0.99	0.86	1.00	1.14
MAXIMUM RAINFALL (INCH)	1.93	1.64	1.94	1.91	2.45	2.92	3.43	3.90	2.93	1.76	1.10	1.13
MAXIMUM SNOWFALL (INCH-SNOW)	1.64	2.45	1.4	1.1	0.1	0.1	0.1	0.00	0.00	0.00	0.00	0.00
MAXIMUM PRECIPITATION (INCH)	1.93	1.64	1.94	1.91	2.45	2.92	3.43	3.90	2.93	1.76	1.10	1.13

1500- GOSB A PERIOD OF RECORD = 12/1941-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	13.45	13.70	13.41	13.04	13.22	13.26	13.37	12.76	13.73	14.12	13.00	13.40
AVERAGE MONTHLY RAINFALL (INCH)	1.11	0.98	0.98	0.67	1.72	1.29	1.28	0.81	0.88	1.74	0.68	0.64
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	25.47	26.11	27.26	17.75	7.53	0.38	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	2.22	2.60	2.70	2.20	2.46	1.47	1.28	0.81	0.88	1.74	0.68	0.64
MAXIMUM MONTHLY PRECIPITATION (INCH)	5.21	5.33	5.17	5.24	5.10	5.37	6.12	7.08	6.61	5.97	5.00	5.27
MINIMUM MONTHLY PRECIPITATION (INCH)	0.50	0.51	0.67	0.49	1.11	1.05	1.05	0.78	0.78	1.27	0.53	0.57
MAXIMUM RAINFALL (INCH)	1.21	1.00	1.26	1.07	1.44	1.74	1.72	1.10	1.70	1.32	1.00	0.97
MAXIMUM SNOWFALL (INCH-SNOW)	1.21	1.00	1.26	1.07	1.44	1.74	1.72	1.10	1.70	1.32	1.00	0.97
MAXIMUM PRECIPITATION (INCH)	1.21	1.00	1.26	1.07	1.44	1.74	1.72	1.10	1.70	1.32	1.00	0.97

1600- GRAND BANK PERIOD OF RECORD = 1/1939-2/1965	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	17.29	14.80	14.28	12.44	11.43	11.79	10.79	10.71	10.58	13.49	15.33	16.72
AVERAGE MONTHLY RAINFALL (INCH)	2.73	2.70	2.65	2.07	3.86	3.59	3.33	3.39	3.82	4.92	3.40	3.89
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	22.99	17.81	15.22	5.15	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	5.03	4.70	4.64	2.64	3.72	3.59	3.33	3.39	3.82	4.92	3.40	3.89
MAXIMUM MONTHLY PRECIPITATION (INCH)	9.53	7.76	6.57	3.74	6.83	6.83	6.26	6.25	6.25	6.25	6.25	6.60
MINIMUM MONTHLY PRECIPITATION (INCH)	1.00	1.57	1.12	1.35	1.85	1.87	1.39	1.04	1.10	0.28	0.27	0.15
MAXIMUM RAINFALL (INCH)	2.97	3.20	2.13	1.40	4.19	1.82	2.57	3.60	4.43	3.90	2.10	2.10
MAXIMUM SNOWFALL (INCH-SNOW)	15.30	12.00	14.10	3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM PRECIPITATION (INCH)	3.10	3.10	2.13	1.40	1.85	1.82	2.57	3.60	4.43	3.90	2.10	2.10

1700- CORNER BROOK PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	24.33	19.95	17.57	15.07	15.16	13.81	14.20	13.07	13.03	14.04	14.34	14.46
AVERAGE MONTHLY RAINFALL (INCH)	3.70	3.08	2.87	2.36	2.37	2.86	3.17	3.40	3.46	3.70	3.53	3.28
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	38.10	32.47	21.29	14.00	2.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	6.93	3.98	2.98	2.60	2.62	2.86	3.17	3.40	3.46	3.70	3.53	3.28
MAXIMUM MONTHLY PRECIPITATION (INCH)	7.3	6.59	6.04	4.78	4.94	4.27	4.48	4.91	4.13	4.89	4.12	4.43
MINIMUM MONTHLY PRECIPITATION (INCH)	2.15	1.86	1.89	0.93	0.94	1.27	1.48	1.91	1.13	1.89	1.12	1.43
MAXIMUM RAINFALL (INCH)	1.40	1.25	1.15	1.89	1.82	1.80	1.70	1.62	1.65	1.34	1.20	1.29
MAXIMUM SNOWFALL (INCH-SNOW)	14.20	12.70	11.60	11.60	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM PRECIPITATION (INCH)	1.58	1.40	1.45	1.89	1.82	1.80	1.70	1.62	1.65	1.34	1.29	1.29

1800- DANIEL'S HARBOUR PERIOD OF RECORD = 1/1948-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	13.76	11.27	11.05	9.58	10.65	10.73	12.66	12.62	11.80	12.66	13.70	14.10
AVERAGE MONTHLY RAINFALL (INCH)	1.23	1.00	0.92	1.03	2.22	3.23	3.13	3.15	3.14	3.13	2.88	2.74
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	20.33	22.47	16.37	12.03	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	2.44	2.91	2.99	2.63	2.41	3.23	3.13	3.15	3.14	3.13	2.88	2.74
MAXIMUM MONTHLY PRECIPITATION (INCH)	6.97	5.67	4.98	3.44	4.42	6.26	5.61	5.93	5.24	7.16	5.67	5.68
MINIMUM MONTHLY PRECIPITATION (INCH)	0.71	0.69	0.65	0.45	0.51	0.98	0.28	0.38	1.22	2.10	0.94	0.72
MAXIMUM RAINFALL (INCH)	1.85	0.95	0.68	1.24	1.59	1.50	1.45	1.59	1.24	1.63	1.49	1.44
MAXIMUM SNOWFALL (INCH-SNOW)	12.00	17.70	12.30	9.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM PRECIPITATION (INCH)	1.90	1.17	1.20	1.24	1.59	1.50	1.45	1.59	1.24	1.63	1.49	1.44

1900- DEER LAKE PERIOD OF RECORD = 1/1939-12/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	14.49	12.76	11.74	11.11	11.20	11.50	11.74	11.90	12.70	13.74	13.24	13.12
AVERAGE MONTHLY RAINFALL (INCH)	0.90	0.97	0.70	1.54	2.72	2.95	3.29	3.49	3.40	3.02	2.84	2.83
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	22.84	22.80	15.17	4.94	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.00	3.17	2.19	2.54	2.31	2.95	3.29	3.49	3.40	3.02	2.84	2.83
MAXIMUM MONTHLY PRECIPITATION (INCH)	5.30	6.18	5.79	5.42	6.72	6.33	6.47	6.40	6.49	7.04	7.54	7.67
MINIMUM MONTHLY PRECIPITATION (INCH)	0.55	0.79	0.88	1.14	1.19	1.31	1.75	1.97	1.21	1.09	0.94	0.67
MAXIMUM RAINFALL (INCH)	1.23	1.00	1.20	1.58	2.15	1.77	1.60	1.61	1.62	1.35	1.10	1.13
MAXIMUM SNOWFALL (INCH-SNOW)	13.60	16.00	11.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM PRECIPITATION (INCH)	1.30	1.20	1.20	1.60	2.00	1.70	1.60	1.60	1.60	1.30	1.10	1.10

1800- FORD PERIOD OF RECORD = 8/1910-12/1915	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	17.40	16.78	16.38	16.00	16.40	17.40	17.65	17.69	17.76	18.74	19.44	17.00
AVERAGE MONTHLY RAINFALL (INCH)	1.56	1.52	1.47	2.18	2.26	2.37	2.55	2.75	2.88	3.36	3.39	3.14
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	33.79	37.94	29.44	12.98	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.29	3.49	3.41	3.43	2.44	2.37	2.55	2.75	2.88	3.36	3.39	3.14
MAXIMUM MONTHLY PRECIPITATION (INCH)	6.29	6.48	6.21	3.94	4.95	4.13	4.40	4.68	4.34	5.29	5.28	4.24
MINIMUM MONTHLY PRECIPITATION (INCH)	1.19	1.35	0.91	0.20	0.54	0.57	0.58	0.74	0.64	1.00	0.90	0.99
MAXIMUM RAINFALL (INCH)	2.40	1.80	1.82	2.22	2.12	2.44	2.49	2.74	2.18	2.80	2.80	1.94
MAXIMUM SNOWFALL (INCH-SNOW)	25.00	30.00	22.00	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM PRECIPITATION (INCH)	2.50	1.90	1.90	2.22	2.12	2.44	2.49	2.74	2.18	2.80	2.80	1.94

1800- CAPE TAIT PERIOD OF RECORD = 1/1939-1/1966	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
AVERAGE DAYS WITH PRECIPIT. 0.1 INCH	16.40	13.61	14.57	15.14	16.13	16.40	16.64	16.60	16.76	16.63	16.34	15.93
AVERAGE MONTHLY RAINFALL (INCH)	1.11	2.00	2.75	3.64	3.95	4.20	4.20	4.20	4.02	3.72	3.27	3.11
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	21.84	17.50	13.35	5.09	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.04	4.00	4.10	4.33	4.08	4.20	4.20	4.20	4.02	3.72	3.27	3.11
MAXIMUM MONTHLY PRECIPITATION (INCH)	6.47	6.90	6.37	6.25	7.37	6.44	6.11	6.00	5.75	5.63	4.40	4.50
MINIMUM MONTHLY PRECIPITATION (INCH)	1.70	1.70	1.10	1.10	1.69	1.60	1.67	1.24	1.27	1.10	0.90	1.00
MAXIMUM RAINFALL (INCH)	1.90	1.90	2.10	2.10	2.40	2.40	2.40	2.40	2.40	2.40	2.10	2.10
MAXIMUM SNOWFALL (INCH-SNOW)	22.00	18.00	14.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM PRECIPITATION (INCH)	2.22	2.00	2.20	2.20	2.70	2.60	2.60	2.60	2.60	2.60	2.20	2.10

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STATION	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
1800 - STEPHENSVILLE PERIOD OF RECORD = 2/1942-12/1966												
AVERAGE DAYS WITH PRECIPITATION (INCH)	23.18	20.05	15.14	13.15	13.48	14.00	13.50	14.00	13.72	12.17	10.34	11.50
AVERAGE MONTHLY RAINFALL (INCH)	2.98	1.02	0.51	0.89	1.65	1.74	1.77	1.77	2.33	2.78	2.82	2.74
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	32.77	28.15	15.63	8.67	1.03	0.05	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	6.93	3.80	2.18	2.23	2.65	2.27	2.27	2.27	2.63	2.63	2.63	2.63
MAXIMUM MONTHLY PRECIPITATION (INCH)	10.77	1.82	1.10	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
MINIMUM MONTHLY PRECIPITATION (INCH)	1.42	1.04	0.35	0.48	0.97	0.25	0.25	0.25	0.25	0.25	0.25	0.25
MAXIMUM 24HR RAINFALL (INCH)	1.25	3.30	1.50	0.80	0.90	2.15	1.80	1.15	2.84	1.87	2.08	1.01
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	21.20	17.40	12.90	8.30	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.12	3.70	1.29	1.24	2.30	2.60	1.80	1.50	3.10	1.90	2.74	1.80
1800 - TULLINGTATE PERIOD OF RECORD = 11/1950-12/1966												
AVERAGE DAYS WITH PRECIPITATION (INCH)	15.66	13.46	12.74	13.00	11.16	12.05	12.20	12.86	11.20	12.80	12.69	14.31
AVERAGE MONTHLY RAINFALL (INCH)	1.88	0.93	1.26	1.44	1.78	2.44	2.79	3.30	2.97	3.19	2.74	1.22
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	21.89	29.32	20.56	12.22	2.15	0.05	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.75	3.80	3.15	2.67	1.94	2.49	2.79	3.30	2.97	3.19	2.74	1.22
MAXIMUM MONTHLY PRECIPITATION (INCH)	7.00	10.87	7.85	6.34	4.10	3.30	4.00	5.73	5.28	6.31	7.23	5.68
MINIMUM MONTHLY PRECIPITATION (INCH)	1.56	1.25	1.15	0.70	0.83	1.10	1.20	1.84	1.17	0.82	1.17	1.48
MAXIMUM 24HR RAINFALL (INCH)	1.23	1.07	1.00	1.01	1.67	1.35	1.95	2.10	2.24	1.41	1.89	1.05
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	11.00	22.11	10.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR PRECIPITATION (INCH)	1.23	2.11	1.68	1.40	1.67	1.35	1.95	2.10	2.24	1.41	1.89	1.15
1800 - ST JOHN'S PERIOD OF RECORD = 1/1900-12/1936												
AVERAGE DAYS WITH PRECIPITATION (INCH)	16.58	15.08	15.19	15.74	15.72	13.14	13.42	13.21	15.43	17.00	18.00	17.80
AVERAGE MONTHLY RAINFALL (INCH)	2.52	1.78	2.69	3.38	3.72	3.23	3.17	3.31	4.22	5.03	5.56	3.75
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	23.29	27.80	15.72	6.77	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	4.76	4.52	4.42	4.03	3.92	3.23	3.17	3.31	4.22	5.03	5.56	3.75
MAXIMUM MONTHLY PRECIPITATION (INCH)	7.40	9.48	7.55	8.76	7.10	6.37	7.72	6.39	11.62	9.13	10.15	6.00
MINIMUM MONTHLY PRECIPITATION (INCH)	2.22	1.30	1.14	1.48	1.43	1.13	1.31	1.82	1.31	2.34	2.39	1.20
MAXIMUM 24HR RAINFALL (INCH)	1.81	1.92	2.36	2.49	2.47	2.49	2.40	1.80	2.40	2.89	2.42	3.14
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	21.00	20.80	12.00	8.40	7.40	1.40	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.10	2.08	2.36	2.19	2.17	2.25	2.00	1.40	2.30	2.89	2.42	3.14
1901 - ST JOHN'S PERIOD OF RECORD = 10/1955-12/1966												
AVERAGE DAYS WITH PRECIPITATION (INCH)	19.50	18.30	15.90	0.00	0.00	0.00	0.00	11.30	0.00	16.10	18.20	18.36
AVERAGE MONTHLY RAINFALL (INCH)	3.69	2.75	2.03	0.00	0.00	0.00	0.00	2.71	0.00	4.91	5.47	3.88
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	30.76	34.90	27.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	4.70	5.22	4.91	0.00	0.00	0.00	0.00	2.71	0.00	4.91	5.47	3.88
MAXIMUM MONTHLY PRECIPITATION (INCH)	9.44	11.82	9.11	0.00	0.00	0.00	0.00	5.13	0.00	6.00	8.08	12.11
MINIMUM MONTHLY PRECIPITATION (INCH)	3.84	2.52	2.44	0.00	0.00	0.00	0.00	0.76	0.00	1.82	3.01	3.06
MAXIMUM 24HR RAINFALL (INCH)	2.00	3.80	1.55	0.00	0.00	0.00	0.00	1.77	0.00	3.00	2.44	2.50
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	15.00	23.00	13.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.80	18.20
MAXIMUM 24HR PRECIPITATION (INCH)	2.00	1.95	1.85	0.00	0.00	0.00	0.00	1.79	0.00	3.00	2.44	2.50
1900 - TORBAY A. PERIOD OF RECORD = 1/1942-12/1966												
AVERAGE DAYS WITH PRECIPITATION (INCH)	21.32	21.40	27.40	15.10	15.98	12.16	13.84	14.08	14.04	17.16	19.04	22.08
AVERAGE MONTHLY RAINFALL (INCH)	3.03	2.54	2.43	3.15	3.41	3.24	3.47	4.04	4.42	5.24	5.37	4.00
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	31.29	35.17	26.95	11.40	3.72	0.03	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	4.05	5.08	5.40	4.46	3.11	3.24	3.47	4.04	4.42	5.24	5.37	4.00
MAXIMUM MONTHLY PRECIPITATION (INCH)	11.47	9.21	8.69	11.79	7.61	7.61	7.42	6.58	10.46	8.92	12.59	11.61
MINIMUM MONTHLY PRECIPITATION (INCH)	2.78	2.48	2.14	1.24	1.27	1.03	0.73	0.85	1.19	2.74	1.60	2.67
MAXIMUM 24HR RAINFALL (INCH)	3.38	1.58	2.11	3.61	2.00	2.96	4.77	2.36	2.60	3.97	2.94	3.30
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	19.17	30.20	17.40	11.40	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR PRECIPITATION (INCH)	3.38	2.00	2.10	3.61	2.10	2.96	4.77	2.36	2.60	3.97	2.94	3.30
1800 - ST JOHN'S (B) PERIOD OF RECORD = 11/1950-12/1966												
AVERAGE DAYS WITH PRECIPITATION (INCH)	20.14	18.00	17.75	15.46	14.53	11.53	11.73	11.93	12.00	15.40	16.54	17.88
AVERAGE MONTHLY RAINFALL (INCH)	4.45	3.17	3.20	3.88	3.70	3.04	3.13	4.00	3.77	5.21	5.71	4.39
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	35.59	35.23	29.17	17.46	5.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	7.89	6.76	6.24	5.07	4.17	3.04	3.13	4.00	3.77	5.21	5.71	4.39
MAXIMUM MONTHLY PRECIPITATION (INCH)	12.05	11.82	11.45	12.38	7.05	7.10	6.28	5.73	6.97	9.33	12.01	11.98
MINIMUM MONTHLY PRECIPITATION (INCH)	4.16	3.21	3.75	2.77	1.81	0.93	0.90	1.37	1.78	1.52	2.11	3.08
MAXIMUM 24HR RAINFALL (INCH)	2.70	2.17	2.24	2.66	2.08	1.75	2.03	2.33	2.65	2.65	2.84	3.00
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	30.80	19.20	21.20	14.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR PRECIPITATION (INCH)	3.08	2.17	2.40	2.66	2.08	1.75	2.03	2.33	2.65	2.65	2.84	3.00
1300 - ST ANTHONY PERIOD OF RECORD = 11/1943-12/1966												
AVERAGE DAYS WITH PRECIPITATION (INCH)	20.34	17.27	14.17	12.36	11.43	12.14	11.58	12.08	13.40	14.54	17.16	20.34
AVERAGE MONTHLY RAINFALL (INCH)	2.54	2.20	1.29	2.03	2.03	3.02	3.04	3.70	3.79	3.75	4.61	3.00
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	18.74	17.78	11.62	4.89	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	4.51	3.83	2.43	2.51	3.12	3.02	3.04	3.70	3.79	3.75	4.61	3.00
MAXIMUM MONTHLY PRECIPITATION (INCH)	10.32	12.85	5.42	6.78	7.30	6.41	5.47	6.85	7.37	8.23	10.70	8.87
MINIMUM MONTHLY PRECIPITATION (INCH)	1.98	1.00	0.10	1.00	1.10	1.00	1.20	1.80	1.46	1.69	1.31	1.88
MAXIMUM 24HR RAINFALL (INCH)	2.31	4.18	1.22	1.99	2.63	1.61	2.99	2.69	2.19	2.13	2.67	3.11
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	12.00	16.80	9.00	6.80	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR PRECIPITATION (INCH)	2.51	4.18	1.22	1.99	2.63	1.61	2.99	2.69	2.19	2.13	2.67	3.11
1300 - ST ANTHONY PERIOD OF RECORD = 8/1945-12/1966												
AVERAGE DAYS WITH PRECIPITATION (INCH)	13.05	21.52	11.77	9.88	10.41	10.40	10.42	12.42	11.05	12.25	13.70	12.26
AVERAGE MONTHLY RAINFALL (INCH)	1.24	3.46	0.99	0.84	1.75	2.97	2.92	3.53	3.07	3.00	2.80	0.71
AVERAGE MONTHLY SNOWFALL (INCH-SNOW)	27.41	25.26	29.93	17.18	3.44	0.03	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE MONTHLY PRECIPITATION (INCH)	3.75	3.20	3.46	2.35	1.50	2.97	2.92	3.53	3.07	3.00	2.80	0.71
MAXIMUM MONTHLY PRECIPITATION (INCH)	5.84	5.72	6.57	5.11	3.35	6.51	6.59	6.75	7.52	5.51	3.81	3.06
MINIMUM MONTHLY PRECIPITATION (INCH)	0.25	0.45	1.20	1.31	0.35	0.70	0.46	1.08	0.55	1.19	1.42	0.80
MAXIMUM 24HR RAINFALL (INCH)	0.97	0.48	1.35	1.48	1.46	1.72	2.08	1.83	2.62	1.57	2.28	1.80
MAXIMUM 24HR SNOWFALL (INCH-SNOW)	13.00	18.00	19.00	17.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAXIMUM 24HR PRECIPITATION (INCH)	1.30	1.45	1.90	1.70	1.45	1.72	2.08	1.83	2.62	1.57	2.28	1.80

The Shawinigan Engineering Company Limited  
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NEWFOUNDLAND

Storm Center	Date	Greatest Rainfall in Storm Center (inches)	Duration of Storm (hours)	Maximization Factor	Storm Center	Date	Greatest Rainfall in Storm Center (inches)	Duration of Storm (hours)	Maximization Factor
Port aux Basques	1925 May 1-3	3.3	60	1.72	Cape Race	1944 July 4-6	5.8	48	1.56
Cape Race	June 16-19	3.2	96	1.94	Cape Race	Aug 4-7	4.4	78	1.17
Port aux Basques	1927 Jan 2-3	3.5	36	1.69	Burgeo	Sept 3-6	4.4	96	1.75
Cape Race	1933 Aug 12-13	4.1	36	1.65	Fogo	Sept 14-15	4.1	48	1.15
Grand Falls	1934 July 15-17	2.9	54	1.43	Grand Bank	Oct 2-4	3.2	48	1.28
Cape Race	Oct 12-14	3.7	60	1.78	Burgeo	Oct 9-11	4.3	72	1.32
Corner Brook	1935 Aug 2-3	3.4	36	1.57	Harrington Harbour	Nov 12-15	3.9	84	1.12
Cape Race	Sept 27-29	4.9	36	1.48	Channel	1945 Jan 15-18	3.4	90	2.55
Grand Bank	Oct 1-2	2.2	30	1.69	Burgeo	May 5-7	3.1	54	1.17
St. John's	Oct 14-16	3.9	66	1.41	Burgeo	Nov 4-6	3.9	60	1.29
Corner Brook Lake	Nov 28-29	3.2	40	1.55	St. John's Torbay	1946 Nov 12-14	3.9	72	1.46
Grand Bank	1936 June 15-17	3.3	60	1.53	St. John's Torbay	1947 Sept 25-29	5.1	90	1.27
Channel	July 14-15	3.2	54	1.43	Burgeo	1948 May 18-21	7.3	102	1.35
Ramea	Dec 11-14	2.6	72	1.66	Corner Brook	Sept 1-2	4.7	48	1.48
Glenwood	1937 May 28-29	2.4	36	1.72	Burgeo	1951 Jan 24-27	2.8	66	1.07
Channel	Sept 16-18	4.8	66	1.05	St John's Torbay	April 10-12	6.7	72	1.67
Buchans	Oct 6-9	2.8	72	1.25	Gander Airport	Aug 4-6	4.7	72	1.24
Ramea	1938 April 18-19	3.1	42	1.65	Burgeo	Nov 7-8	4.6	42	1.43
Cape Race	1939 July 20-22	2.7	42	1.72	Burgeo	1952 Feb 5-6	3.4	36	1.70
St. John's	Aug 6-8	4.5	72	1.36	Grand Bank	Nov 4-6	3.6	54	1.26
Grand Bank	Dec 11-12	3.2	48	1.28	Burgeo	1953 June 15-18	4.3	96	1.20
Channel	1940 April 9-10	3.18	38	1.28	Grand Bank	Oct 6-8	4.1	72	1.41
Burgeo	Dec 8-9	3.3	48	1.75	Colinet	Dec 26	4.1	36	1.28
Howley	1941 July 12-14	3.0	54	1.51	St. Johns	1954 Mar 10-11	3.7	42	1.16
Grand Bank	Aug 2-4	3.9	66	1.23	Burgeo	May 19-22	5.0	72	1.04
Cape Norman	Aug 16-18	3.4	60	1.49	Grand Bank	Oct 21-25	4.6	96	1.34
Burgeo	1942 July 19-21	5.2	72	1.17	Burgeo	Dec 19-21	4.2	66	1.34
Burgeo	Nov 1-4	3.3	84	1.10	St. John's West	1955 Jan 4-7	2.5	66	1.93
St. John's Torbay	Dec 2-3	3.1	24	1.60	Stephenville Airport	Sept 19-22	4.0	72	1.15
Channel	1943 Sept 23-26	3.6	96	1.27	Tor's Cove	1956 Sept 7-11	6.0	96	1.57
Grand Bank	Nov 16-17	3.9	48	1.64	Argentia	Nov 9-10	5.6	48	1.44

NEWFOUNDLAND AND LABRADOR

SUMMARY OF STORM  
PRECIPITATION DATA

NEWFOUNDLAND

LABRADOR

Storm Center	Date	Greatest Rainfall in Storm Center (inches)	Duration of Storm (hours)	Maximization Factor	Storm Center	Date	Greatest Rainfall in Storm Center (Inches)	Duration of Storm (hours)	Maximization Factor
Bonavista	1957 Mar 9-12	5.0	48	1.56	Belle Isle	1954 June 29-30	4.9	45	1.91
Badger	July 15-17	3.5	66	1.30	Nataashquan	1957 June 4-7	2.5	78	1.73
Terra Nova	Sept 8-10	3.2	48	1.56	Belle Isle	1941 Sept 1-3	3.8	90	1.48
Petty Harbour	1959 Nov 1-3	6.4	72	1.30	Belle Isle	1943 Oct 19-23	4.3	114	1.53
St. John's Torbay	Nov 7-11	3.82	102	1.43	Belle Isle	1948 July 5	2.7	24	1.65
Daniels Harbour	Nov 28-29	3.4	48	1.77	Belle Isle	1949 May 28	3.27	18	1.75
Burgeo	1960 Sept 12-14	4.5	72	1.00	Hebron	July 14-17	5.27	96	1.77
St. John's	Oct 17-18	3.61	48	1.11	Asuhanipi	1950 June 16-17	3.25	48	1.50
Cape Broyle	1961 Mar 25-27	2.94	54	1.75	Asuhanipi	July 18-19	3.96	48	1.75
St. Andrews	May 30	2.63	12	1.96	Hopedale	1952 Aug 24	3.8	24	1.58
Daniels Harbour	Aug 12-13	2.99	54	1.51	Goose	1953 Aug 15-16	5.7	48	1.66
Cape Race	Aug 12-13	2.39	24	1.51	Hebron	Sept 8	4.18	24	1.30
Baie Verte	Sept 25-27	3.5	36	1.18	Menik Rapids	1958 Aug 8-10	3.2	72	1.89
Port aux Basques	Oct 3-4	3.53	42	1.48	Clunys	1960 Feb 20-22	3.5	54	1.65
West Brook	1962 Feb 9-12	6.1	72	1.21	Cape Harrison	Sept 1-3	7.49	72	1.53
Gander	Mar 1-3	4.9	78	1.24	Hopedale	1961 June 25	3.65	18	1.62
Burgeo	April 1-2	3.66	48	1.11	Goose	1963 June 29-30	2.97	30	1.59
Pierre's Brook	Oct 21-22	3.66	30	1.19	Wabush Lake	1964 May 24-25	3.41	42	1.43
Colinet	Nov 19-20	3.21	36	1.67	Cartwright	1966 Oct 5-6	2.82	42	1.71
St. John's West	1962/63 Dec 31-Jan 3	3.92	96	1.98					
Burgeo	1963 Jan 13-14	2.83	42	1.77					
St. John's West	April 9-11	3.2	72	1.62					
Grand Bank	May 15-16	3.2	54	1.45					
Grand Bank	Sept 9-11	3.3	48	1.32					
Burgeo	Sept 28-30	3.5	72	1.21					
St. Andrews	Nov 3-4	2.27	36	2.04					
Petty Harbour	Nov 14	3.13	24	2.03					
St. John's	Dec 3-4	2.64	30	1.58					
St. Andrews	Dec 10	2.14	24	1.78					
Colinet	1964 April 2-4	3.3	66	1.39					
Daniels Harbour	April 16-17	2.13	54	1.64					
Burgeo	June 10-13	4.7	72	1.42					
Burgeo	June 24-25	2.39	48	1.65					
Burgeo	July 4-9	5.1	108	1.22					
Colinet	July 26-27	3.36	42	1.57					
Cape Broyle	Aug 4-5	3.3	30	1.90					
Burgeo	Sept 14-15	1.94	30	1.84					
West Brook St. Lawrence	Oct 9-11	4.3	66	1.25					
Norris Arm	Oct 22-24	3.36	72	1.42					
Hearts Content	Oct 30	2.0	24	1.66					
Torbay	Nov 5	2.6	30	1.74					
West Brook	Dec 17-18	3.39	30	1.57					
St. Andrews	1965 Feb 26-28	6.56	54	1.31					
Grand Falls	June 3-4	2.44	42	1.60					
Bonavista	June 30-July 1	3.04	54	1.58					
Colinet	July 4	2.7	24	1.70					
Daniels Harbour	Aug 19-20	4.04	48	1.62					
Tor's Cove	Sept 7	2.56	24	1.60					
Burgeo	Oct 1-2	2.78	36	1.24					
Port aux Basques	Nov 16-19	5.53	66	1.56					
St. Andrews	Dec 4-5	1.89	18	1.97					
Seal Cove	1966 Jan 28	3.57	24	2.42					
Burgeo	July 21-22	3.08	48	1.30					
West Brook	Aug 18	2.9	30	1.63					
Burgeo	Sept 5	2.15	24	1.39					
Buchans	Oct 5-6	2.82	36	1.73					
Port aux Basques	Oct 30	2.57	18	1.50					

NEWFOUNDLAND AND LABRADOR

SUMMARY OF STORM  
PRECIPITATION DATA

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

RIVER BASIN SNOW COURSE	Elevation feet	Latitude ° ' "	Longitude ° ' "	Years of Record	NOTES No. of observations representative of each sub area	RIVER BASIN SNOW COURSE	Elevation feet	Latitude ° ' "	Longitude ° ' "	Years of Record	NOTES No. of observations representative of each sub area
<b>NEWFOUNDLAND</b>						<b>Grand Lake Basin</b>					
Badger	(1) 350	48 58	56 01	6	15 x 100'	Whetstone Point (NE end)	(2) 400	49 05	57 24	25	9
Beaver Brook	(1) 50	50 55	56 09	5	15 x 100'	Coal Brook	(2)			10	9
Cochrane Pond	(1) 450	47 28	52 52	6	16 x 100'	Hinds Plain (on Hill)	(2) 1300	49 00	57 03	39	10
Gander River	(1) 100	49 01	54 51	9	15 x 100'	Hinds Plain (Camp 10)	(2) 500			10	10
Garnish River	(1) 50	47 13	55 20	2	"	N. Plateau (Is. Cove Bk)	(2) 1200			88	10
Goobies	(1) 250	47 55	53 57	7	"	Valley of Lakes	(2) 1300	48 52	57 43	38	
Grey River	(1) 830	48 10	56 49	2	"	Glover Island (N end)	(2) 700	48 46	57 43		9
Hodgewater Pond	(1) 330	47 26	53 25	6	"	South Shore (Camp 17)	(2) 600	48 39	57 36		9
Holyrood	(1) 250	47 22	53 07	6	"	Little Grand Lake (E. S1)	(2) 750	48 39	57 36	33	9
Indian Brook	(1) 50	49 31	56 07	8	"	Little Grand Lake (W. S1)	(2) 750	48 39	57 36	33	9
Isle aux Morts	(1) 250	42 37	59 01	3	"	Grand Lake (Stray Pond)	(2) 400	48 40	58 05	37	9
Middle Brook	(1) 100	48 48	54 14	7	13 x 100'	Grand Lake (SW end)	(2) 400	48 40	58 05	37	11
Northeast Pond River	(1) 450	47 38	52 50	9	15 x 100'	Sandy Lake (Camp 8)	(2) 750	49 19	57 03	39	10
Pipers Hole River	(1) 125	47 57	54 17	8	"	Sandy Lake (Beaton Bk)	(2) 500	49 19	56 41	39	10
Rattling Brook	(1) 400	49 03	55 15	5	"	Sandy Lake (Camp 55)	(2) 500	49 11	56 56	36	11
Rocky River	(1) 100	47 13	53 54	8	"	Birchy Lake (E. Slope)	(2) 500	49 15	56 49	37	9
Salmon River	(1) 650	48 07	56 01	1	"	Sheffield Lake (N Shore)	(2) 800	49 15	56 49	37	9
Terra Nova National Park	(1) 100	48 32	53 59	4	"	Sheffield Lake (S Shore)	(2) 700	49 15	56 49	37	9
Terra Nova River	(1) 350	48 27	54 22	9	"	Glide Brook	(2) 600	49 05	57 25	39	9
Torrent	(1) 50	48 27	57 09	5	"	Indian Brook	(2) 800	49 26	56 38	5	10
Upper Humber River	(1) 100	49 14	57 22	6	"	<b>Labrador</b>					
White Bear River	(1) 900	49 05	57 22	2	"	Muskrat Falls	(1) 75	53 15	60 45	8	15 x 100'
Windsor Lake	(1) 525	47 37	52 46	7	"	Flour Lake	(1) 1450	53 45	64 38	7	"
Gander International Airport	(3) 482	48 57	54 34	5	5	Goose Airport	(3) 144	53 19	60 25	5	10
St. John's - Torbay Airport	(3) 463	47 37	52 45	2	5						

SOURCE: 1 Water Resources Branch, Department of Energy, Mines and Resources  
2 The Bowater Power Company Limited.  
3 Meteorological Branch, Department of Transport.

NEWFOUNDLAND AND LABRADOR  
SNOW COURSE LOCATION  
AND RECORD LENGTH

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

Station	Years of Record	Max	Mean	Min	1940		1944		1945		1949		1950		1954		1955		1959		1960		1964		1965		1966				
					Days				Days				Days				Days				Days				Days						
NEWFOUNDLAND																															
Argentia Airport	18	18	20	8							11	14	14	15	18	14	14	16	15	14	11	12*	20	19	11	15	8	10	12		
Buchans Airport	21	22	12	7						11	9	12	10	17	17	15	11	8	14	10	8	10	9	13	12	22	12	11	10	7	
Burgeo	26	16	12	6	16	6	14	14	15	16	10	11	12	16	13	16	12*	9	8	13	10	10	9	7	13	12	14	13	7	10	10
Cape Race	26	21	12	7		11	11	11	12	7	8	11	18	10	14	10	13	15	12	8	11	15	9	13	21	13	13	11	16	7	8
Colinet	27	19	12	7	10	12	15	13	13	9	10	17	7	15	19	9	16	14	10	9	9	11	9	10	12	13	12	15	7	12	9
Corner Brook	23	22	10	7					11	9	12	10	11	10	14	8	9	9	15	7	8	8	8	10	13	9	22	11	9	12	10
Daniels Harbour	20	17	12	8								9	15	8	13	10	15	14	17	9	12	11	12	12	13	10	13	9	10	10	12
Deer Lake	27	22	12	8	12	9	13	11	11	12	12	10	16	13	13	9	14	11	17	10	15	8	10	9	13	9	22	12	8	14	13
Gander Intl. Airport	27	23	12	5	15	11	11	11	13	12	9	8	12	15	16	13	12	10	23	12	9	10	8	13	9	22	12	7	5	16	11
Glenwood	27	23	13	7	12	10	12	11	14	13	11	20	13	15	18	14	12	13	23	12	19	9	8	13	9	17	19	8	7	16	16
Grand Bank	23	26	14	7	12	11	20	13	12	10	9	20	11	14*	14*	15*	12	15	13	16	15	12	10	8	26	18	22	15	7	11	12*
St. Andrews	22	20	13	8					12	20	9	10	11	16	19	17	12	9	15	10	8	20	8	9	11	10	12	9	12	17	12*
St. Anthony	21	27	14	8							23	12	18	11	18	16	15	21	15	9	27	12	10	9	11	15	18	12	10	12	8
St. John's Torbay A.	25	17	12	8		13	12	13		9	14	16	10	11	17	11	13	11	15	13	9	11	9	10	17	14	11	12	7	16	9
Stephenville Airport	19	22	12	7								15	10	14	13	11	9	13	8	9	11	9	7	19	10	22	9	7	12	13	
Twillingate	16	19	12	7											10	11	10	14	11	19	14	9	19	10	10	14	7	8	11	11	
LABRADOR																															
Belle Isle	27	23	12	8	8	9	12	8	11	9	17	16	12	15	16	15	11	10	14	20	23	10	9	10	10	12	14	10	11	10	13
Cartwright	27	18	11	6	8	6	11	13	12	10	15	9	8	12	8	10	9	8	16	12	12	18	9	12	16	10	12	10	10	12	9
Goose Airport	25	17	11	8		12	17	11		12	12	8	10	13	14	17	8	9	8	16	12	9	12	16	8	15	12	10	10	9	10
Hopedale	19	20	12	8								11	10	9	9	8	18	16	15	10	12	10	12	12	20	17	15	10	9	13	

\* Estimated values from neighbouring stations

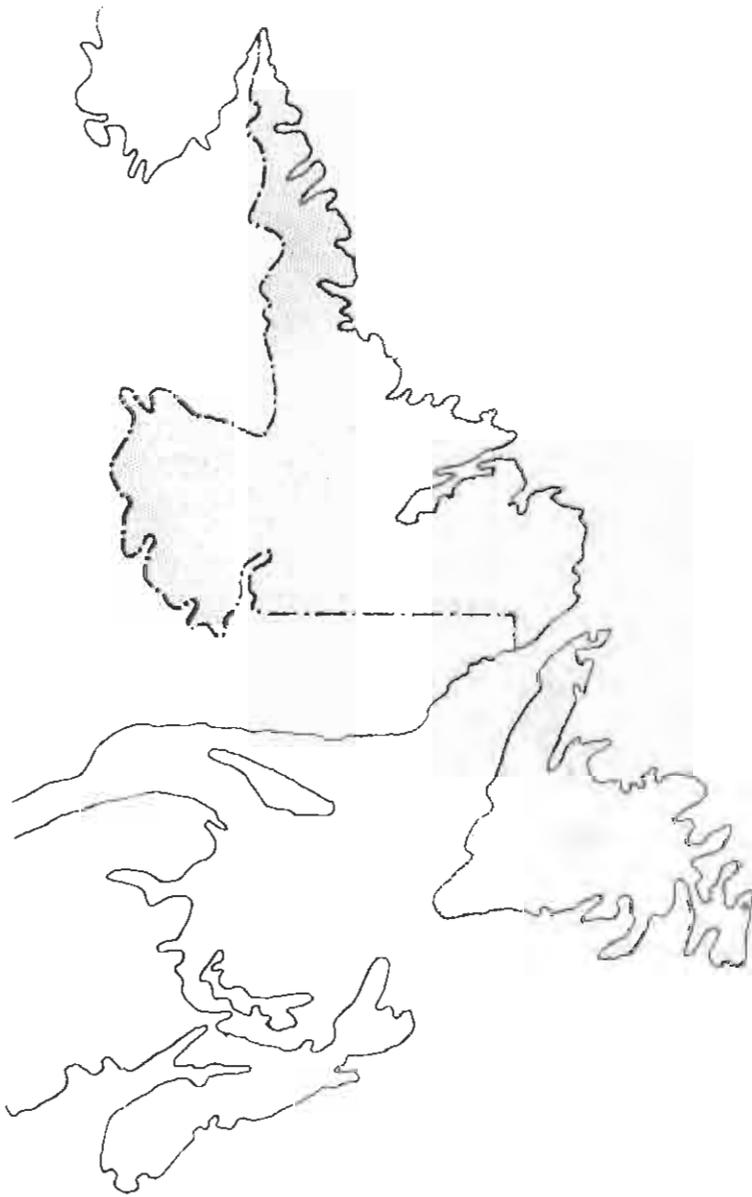
NOTE: Drought is defined as a period of at least 5 consecutive days with total precipitation less than 0.1 inches.

NEWFOUNDLAND AND LABRADOR

JULY TO OCTOBER DROUGHT  
DURATION DATA

NEWFOUNDLAND AND LABRADOR  
MAIN CLIMATIC CHARACTERISTICS OF CLIMATIC REGIONS

CLIMATIC REGION	MEAN ANNUAL				MAXIMIZED		DROUGHT DURATION (1 in 10 years) days
	PRECIPITATION inches	TEMPERATURE degrees F	RELATIVE HUMIDITY percent	POTENTIAL EVAPORATION inches	STORM (300 sq. mi. - 24 hrs) inches	SEASONAL SNOWFALL (8 days interval) inches water equivalent	
1	33 to 105	32 to 39	84 to 85	18.5	6.2	44.5	16 to 18
2A	30 to 95	33 to 39	84 to 85	13.0	10.1	35.2	16 to 25
2B	25 to 55	37 to 40	83 to 85	19.0	10.1	45.2	18 to 20
3A	30 to 95	36 to 41	83 to 86	19.0	6.6	41.6	16 to 17
3B	30 to 60	37 to 41	84 to 85	19.0	6.6	41.6	18 to 19
4A	40 to 95	36 to 42	84 to 85	19.0	10.4	45.4	18 to 19
4B	50 to 75	36 to 41	81 to 84	19.5	10.4	45.4	18 to 19
4C	40 to 65	36 to 39	83 to 84	19.0	10.1	45.4	19 to 20
5A	40 to 70	37 to 42	83 to 84	19.5	10.4	45.9	19 to 20
5B	50 to 70	39 to 45	84 to 86	20.0	10.4	45.9	17 to 20
6A	45 to 70	39 to 42	84 to 90	20.0	10.1	31.5	16 to 17
6B	45 to 65	39 to 42	84 to 85	19.5	10.1	31.5	18 to 19
7A	25 to 45	28 to 33	80 to 85	17.5	9.3	36.4	14 to 15
7B	20 to 40	22 to 28	70 to 80	16.0	8.9	36.4	15 to 17
8A	25 to 35	25 to 31	75 to 85	15.0	9.4	36.4	16 to 17
8B	15 to 25	25 to 27	70 to 75	10.0	9.4	36.4	17 to 18



VOLUME TWO-A - PART III — SECTIONS 9-13

MAN'S ACTIVITY CAUSING CHANGES  
IN WATER QUANTITY AND/OR QUALITY



PART III - MAN'S ACTIVITY CAUSING CHANGES  
IN WATER QUANTITY AND/OR QUALITY

9 CHANGES DUE TO NON-WITHDRAWAL  
(NON-CONSUMPTIVE) USES

Only two non-withdrawal uses have a significant influence on river flow and river and lake levels in the Province; and these are production of hydro-electric power and log driving. On the Island both are important; in Labrador, at the present time, only hydro-electric power production is significant from this viewpoint.

9.1 Changes Due to Hydro-electric Power Production

At the present time, the two hydro-electric plants in Labrador and the larger hydro-electric plants on the Island (Bay D'Espoir, Deer Lake, and Grand Falls) are operating as base load plants. These plants tend to regulate the natural flow, decreasing the maximum and increasing the minimum. This effect is illustrated in Figure 9-1 which compares the regulated outflow of the Deer Lake plant to the natural inflow which was computed from the outflow and changes in storage. This comparison indicates that plant regulation is able to increase the minimum natural mean monthly flow from about 800 to 2300 cfs, and to reduce the maximum outflow from 18,900 to 8800 cfs. A similar regulating effect is obtained on the Exploits River where the minimum mean monthly flow does not generally drop below 4000 cfs, whereas the natural mean monthly flow could reach 500 cfs and even less.

In analyzing these figures, it should be noted that the corrections for storage of controlled lakes are computed as if the lake were an artificial reservoir (discussed in Section 15.2.2). The total change in storage is therefore considered to be artificial and is removed. In fact the lake uncontrolled had a natural regulating capacity which is now ignored in these computations, and the regulating effect shown above is actually exaggerated to some extent.

Besides this general regulating effect, these power plants can also produce sharp variations of the daily flows related to their load. For example, at the Deer Lake plant, before seven-day operation was introduced, there was a sharp drop in the flow from 5000 cfs or more to slightly above 1000 cfs every Sunday during the summer. Also, as a consequence of flow regulation operations, the water levels upstream of the power plants generally have a larger variation than would occur under natural conditions.

On the other hand, at the present time the small power plants on the Island are often used only for peaking. The outflow from such power plants, for example, Pierres Brook plant, is extremely variable and often zero for extended periods or for part of a day, depending upon the operation of the plant. Generally, when data on outflow and change in storage were available, the estimation of the mean monthly natural flow was possible, although some errors, discussed in Section 15.2.2, could not be completely avoided in these estimates. However, at many small hydro-electric plants, these data were not available or were unreliable, and therefore the natural flows could not be computed.

In addition to the changes related to the change of the flow regime, the development of hydro-electric power also generates withdrawal demand and use (diversions) which changes not only the regime but also the average flow of the rivers affected.

At the present time the following diversions for hydro-electric power production have been developed in the Province:

- a) The Indian River diversion (92 square miles) into the Humber River to increase the production of the Deer Lake plant.
- b) The diversion of the upper Grey River (375 square miles) into the Salmon River, and of the Salmon River (1020 square miles) into the Northwest Brook as part of the Bay D'Espoir development (Volume Six A, Figure 4-5).

At the present the following diversions are under construction:

- i) The diversion of the Victoria River (408 square miles) into the White Bear River, and of the upper White Bear River (456 square miles) into the Grey River in the framework of the Bay D'Espoir development (Volume Six A, Figure 1-9):
- ii) The diversion of the Canairiktok River and the Naskaupi River (4384 square miles) into the Churchill River, and of the Julian River (357 square miles) into the Churchill River in the framework of the Churchill River development.

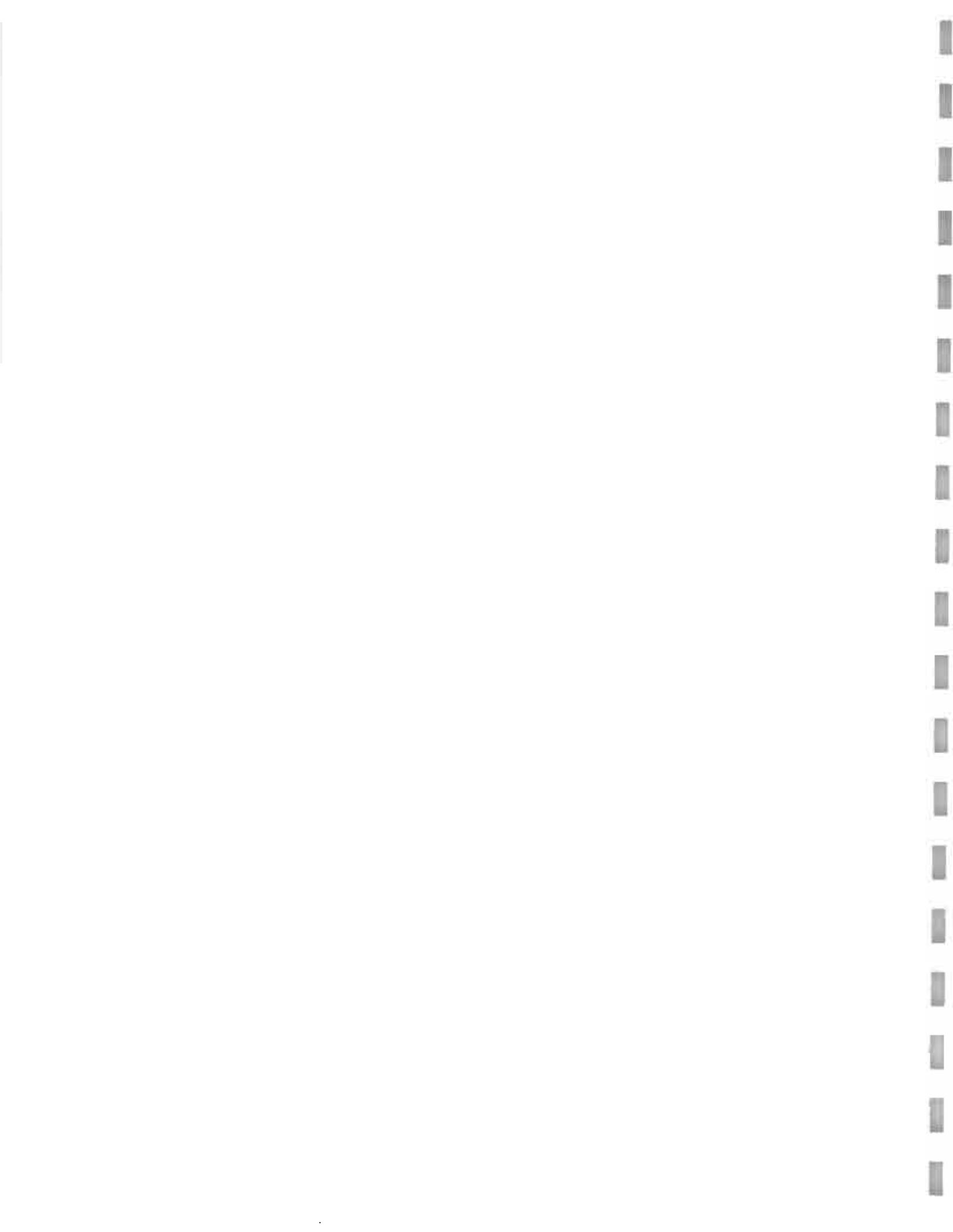
The closing of one of the outlets of the Unknown (Atikonak) River to provide all the flow of this river above the Churchill Falls plant is also a special case of diversion (Volume Six B, Figures 28-1 and 28-3).

9.2 Changes Due to Log Driving

Log driving occurs extensively on the Island, although the activity has declined of late. There is no organized log driving in Labrador.

With a few exceptions, during the period of average and low flows on the Island through most of the summer and fall, log driving requires the release of a surge of water to increase both the velocity and the water depth in the river to carry along the bulk of the logs. In order to obtain the water and head required for these surges, small logging dams are usually built on the rivers used for logging. An illustration of the effect of operating such a dam during the summer-fall period is indicated by the daily flow regime of the Victoria Lake River shown in Figure 9-2. A comparison with the daily flow regime of the neighbouring White Bear River, also shown in the figure, indicates the significance of the regime changes produced by the operation of dams for log driving.

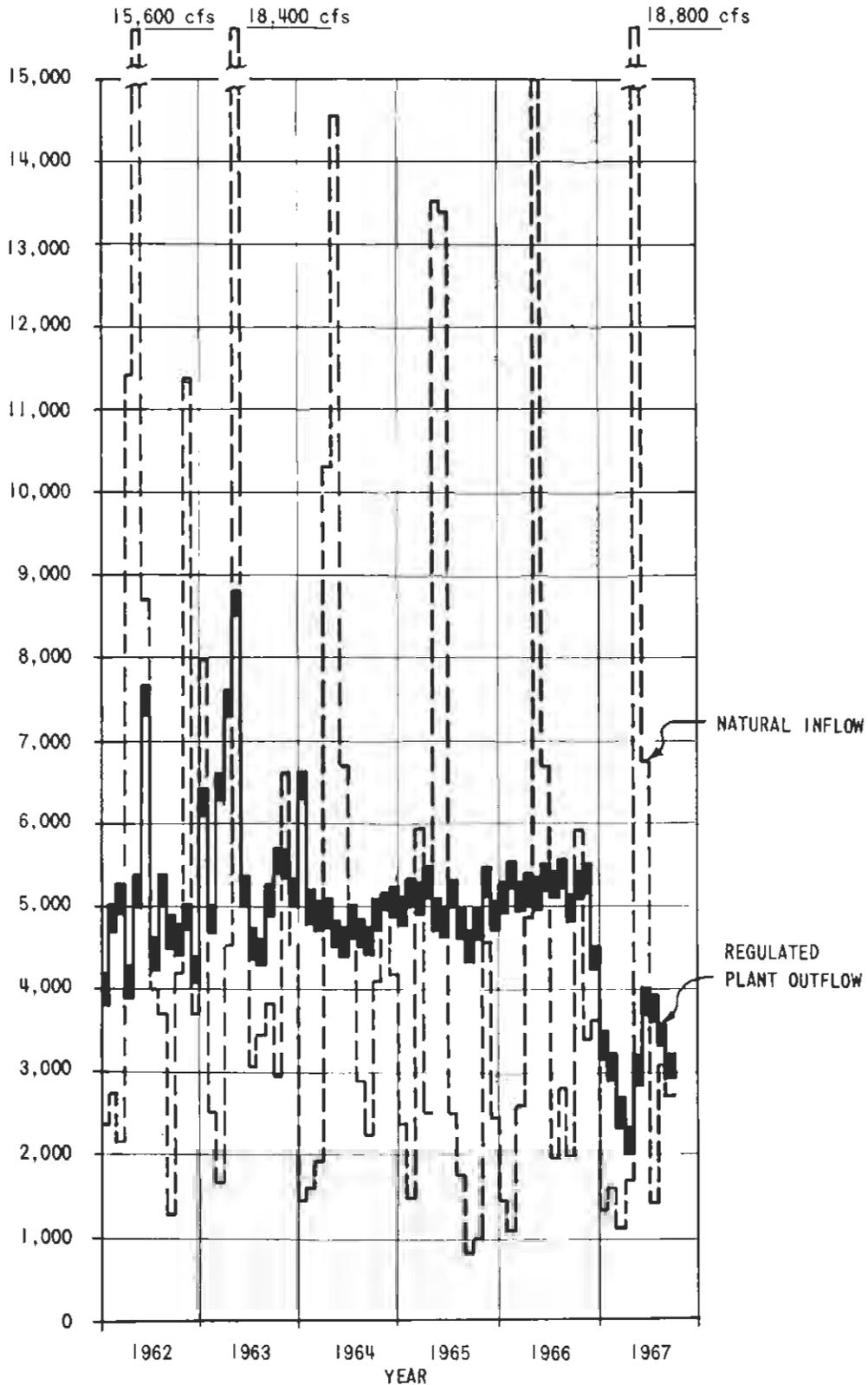
The changes due to water storage and release for log driving affect the natural regime of many rivers on the Island. It is also obvious that some of the river level and flow records and measurements are affected by rapid changes in the river's hydraulic conditions during the surge. However, no records of the operations of these dams are known to be available. In addition, the operation of the dams is related to the woods operations in the area, and is initiated or discontinued according to the requirements of these operations. Therefore, it is not possible to account for these effects and synthesize the natural flows which would have occurred if these changes had not occurred. Log driving is discussed in some detail in Volume Four, Section 3, as well as in the river basin studies in Volume Six.



NEWFOUNDLAND

CHANGES IN RIVER FLOW REGIME DUE  
TO HYDRO-ELECTRIC POWER OPERATION  
HUMBER RIVER AT DEER LAKE

FLOW (CFS)



NEWFOUNDLAND  
EXAMPLE OF CHANGES IN RIVER FLOW  
REGIME DUE TO LOG DRIVING

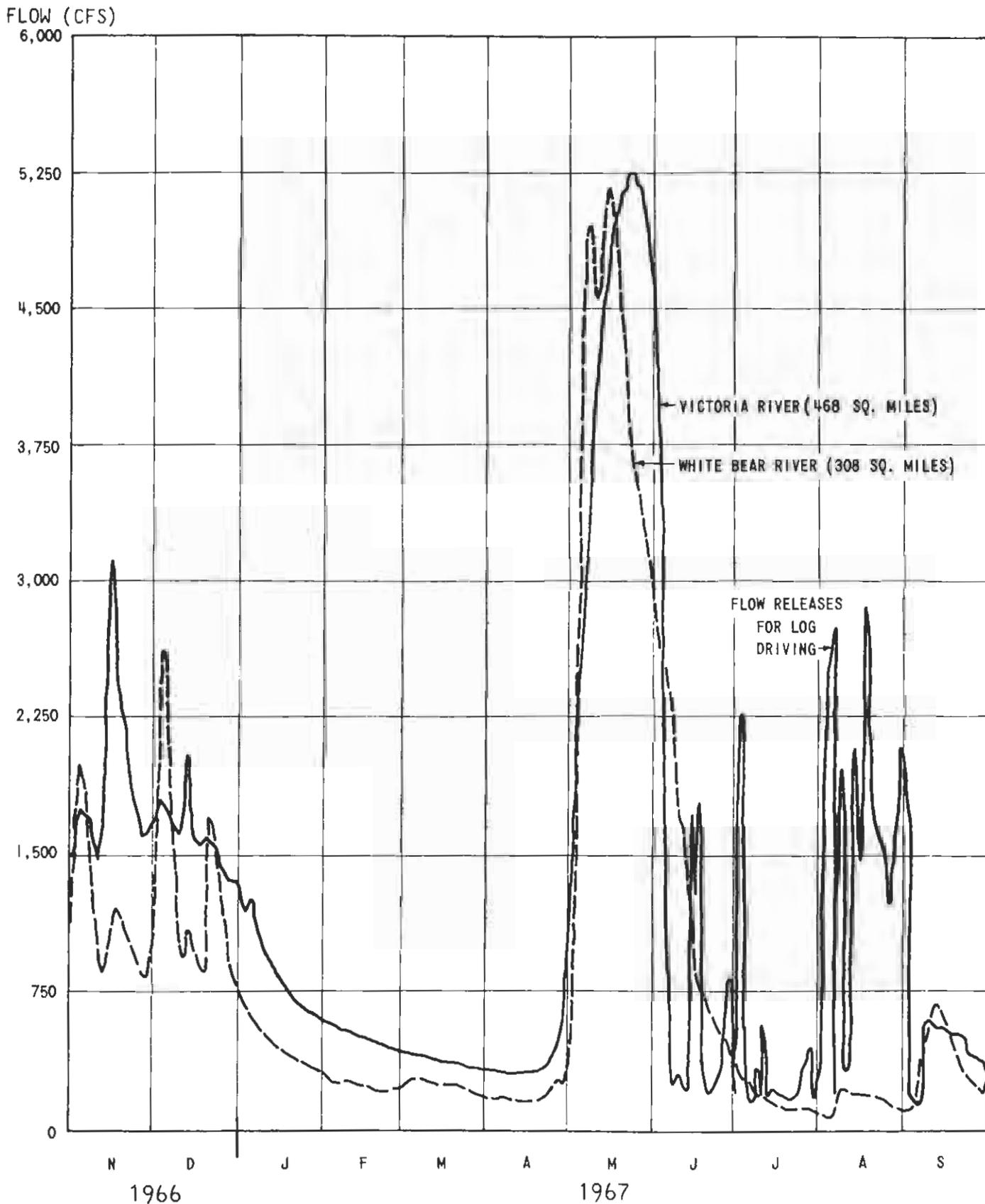


FIGURE 9-2

10 CHANGES DUE TO INDUSTRIAL  
AND DOMESTIC WATER SUPPLY

10.1 Changes in Water Quantity

Changes in water quantity caused by man's activities relative to obtaining domestic and industrial water supplies come under the following four principal headings :

10.1.1 Diversion of Water from One Stream into Another

Diversion of one stream into another is normally carried out when the drainage area of the primary stream is inadequate to provide the required volume of water, and physical and economic conditions are such that an adjacent drainage area can be diverted into the primary stream to augment its flow.

To date no significant drainage area in Newfoundland has been diverted to augment another stream for either industrial or domestic water consumption although a number of minor diversions have been carried out. One of these minor diversions is now under construction at Marystown where the Black River is being diverted into Clam Pond to provide an adequate water supply for industrial and domestic purposes.

10.1.2 Withdrawal of Groundwater

Although withdrawal of groundwater and return to surface water takes place in many inhabited areas of the Island, this is generally of little significance to groundwater availability. However, the pumping for mine dewatering may significantly reduce the water table in the area around the mine, and the amount of groundwater available for various uses. The amount of water involved in the mine dewatering operations is indicated in Volume Three A, Section 7.5.2. No instance has been noted of artificial recharge of the groundwater in order to increase its supply.

10.1.3 Depletion Uses

Loss by evaporation through the use of water for cooling, and the incorporation of water into products such as in the beverage industries and other food processing, reduce the natural quantity of water by the difference between the quantity of wastewater discharge and the total quantity of process water utilized. However, nowhere in Newfoundland does such consumptive use exert any significant influence on the quantity of water downstream of such a plant. Volume Three A and B, Sections 8 to 16, indicate the estimated amount of water depleted by various industrial uses.

#### 10. 1. 4 Construction of Storage Reservoirs

The increased water surface resulting from man-made storage reservoirs represents a potential change in the quantity of water available. Since evaporation from water surface is slightly larger than that from land, an increase in water area may result in the reduction of the amount of water available under natural conditions. However, as shown in Section 16. 1, the difference between the evaporation from water surface and that from land surface does not amount to more than 2 to 4 inches annually. Therefore the relatively minor changes in water surface produced by the existing developments have not affected in any significant way the average quantity of water, although it has reduced it to some degree.

#### 10. 2 Changes in Water Quality

Changes in water quality caused by man's activities relative to obtaining domestic and industrial water supplies are principally as follows :

##### 10. 2. 1 Temperature Variation Through Storage

Withdrawal in summer of stored surface water from shallow depths will result in an increase of water temperature over that which would have been obtained without storage. Conversely, withdrawal in summer of stored water from a considerable depth will result in a decrease of water temperature compared to that which would have been obtained without storage.

Withdrawal of stored water in winter from depths exceeding fifteen to twenty feet will result in an increase in water temperature.

Although no data are available on the temperature of domestic or industrial water withdrawn from storage, it is very likely that, because of the relatively shallow storage reservoirs constructed, the temperature of the water supply will be somewhat above that which would have prevailed without storage.

#### 10.2.2 Turbidity Variation Through Storage

It is generally assumed that storage reservoirs, either natural or man-made, reduce turbidity through long-term storage. It has been shown, however, that this is not always true in that storage reservoirs moderate the peak turbidity but they extend the time period during which highly turbid waters are discharged from the reservoir, in comparison to the time period which would have prevailed without storage. No data are available to substantiate this observation with respect to changes in turbidity as a result of man-made reservoirs.

#### 10.2.3 Variation in Chemical Content Through Diversion

Diversion of one stream into another can cause significant changes in the quality of the receiving stream if the diverted stream is of a markedly different chemical content. As a general rule, however, adjacent streams in Newfoundland will have similar chemical characteristics, and can be diverted without adversely affecting the quality of the receiving stream. This would obviously not be the case if the diverted stream were polluted as a result of man's activities; that is, through disposal of untreated domestic or industrial wastewaters.

#### 10.2.4 Intrusion of Salt Water into Fresh Groundwater

Excessive rates of withdrawal or long-term withdrawal in excess of recharge capability, particularly in coastal areas, can result in the intrusion of salt water which will materially affect the quality of the groundwater, rendering it unfit for either domestic or industrial use. The incidence of salt water intrusion into groundwater in Newfoundland is extremely low and very localized. At Holyrood wells serving the Golden Eagle Refinery experienced intrusion of salt water through fissured granite; with reduced rates of groundwater withdrawal, intrusion was eliminated. A few similar instances have been noted elsewhere in Newfoundland where drilled wells serving houses adjacent to the seacoast have been rendered useless by salt water intrusion through fissured rock.

From the foregoing it can be stated that, with respect to obtaining either domestic or industrial water supplies in Newfoundland, man's activities have had only minor effects on the quality of the water resource. Variations in temperature and turbidity as a result of storage have not been apparent, and variation in chemical content through diversion of one stream into another has not been observed. Some evidence of salt

water intrusion has been noted, but instances of this are limited to a few isolated wells located immediately adjacent to the ocean and these do not indicate a large scale problem.

11 CHANGES DUE TO INDUSTRIAL  
AND DOMESTIC WASTEWATER DISPOSAL

11.1 Water Quantity

Changes in water quantity caused by man's activities relative to the disposal of domestic and industrial wastewaters result in general from the following:

- a) Disposal of wastewaters to a receiving body other than the source of supply.
- b) Addition of dilution water to the receiving stream through diversion.

No instances have been encountered in the study of either domestic or industrial wastewaters being discharged directly to groundwater regardless of the origin of the water supply; that is, either from surface water or from groundwater. On the other hand, the study has shown that generally the wastewater derived initially from groundwater is discharged to a receiving body other than the source of supply, with the exception of the disposal of domestic wastes by means of septic tank and tile bed systems.

Generally, domestic and industrial wastewaters resulting from man's activities at the seacoast are disposed of directly into the sea without treatment. This method of disposal of wastewaters reduces the quantity of water available for other uses in the original source of supply but only insignificantly; more important, however, is that disposal of wastewaters into the sea eliminates changes in quality which certainly would result from discharge of such wastes with or without treatment into the source of supply.

Inland from the seacoast, disposal of wastewaters to a receiving body other than the source of surface supply does not occur to any appreciable extent. At Gander, although the source of supply is Gander Lake and disposal is to Beadly Creek, flow from this creek is eventually returned to Gander Lake.

There are a number of instances where municipal and industrial wastewaters originating from groundwater have been disposed of into surface receiving bodies. For example, at Badger and Bishops Falls wastewaters originating from groundwater sources are discharged into the Exploits River. However, these discharges of groundwater into surface water bodies have no significant effect on the quantity of the

receiving body. Similarly, the discharge of the wastewaters from dwellings served by individual wells into surface receiving bodies has no appreciable effect on the quantity of such bodies.

No diversion of flow from one stream into another to effect dilution of pollution has yet been carried out in Newfoundland.

From the foregoing it may be concluded that, for all practical purposes, the changes in water quantity caused by man's activities associated with the disposal of domestic and industrial wastewaters are not significant.

## 11.2 Water Quality

Changes in water quality caused by man's activities in connection with the disposal of domestic and industrial wastewaters can be very marked, and in general they result from the direct discharge of such wastewaters into the receiving body.

Wastewaters from individual dwellings not served by municipal sewerage systems are generally disposed of by means of septic tank systems or cesspools. Properly operated septic tanks complete with tile beds in overburden and not in close proximity (less than 50 feet) to dug wells will have no adverse effect on the quality of groundwater. Where septic tank systems or cesspools are installed in rock or areas of very thin overburden, they can contaminate groundwater for some distance, and in fact do so in some of the more congested communities. This study has revealed at least one case of widespread contamination of the groundwater through the disposal of wastewaters by means of septic tanks or cesspools; but, as previously stated, localized contamination does occur.

Seacoast municipalities with sewerage systems discharge their wastewaters directly to the sea without treatment; this practice avoids pollution of the freshwater resource but does bacteriologically pollute the adjacent sea water. In Part VI of this volume a detailed discussion of estuary and sea water quality is presented with particular reference to bacteriological pollution.

Inland municipalities, by reason of their location, must discharge their wastewaters into freshwater receiving bodies. With the exception of the municipalities of Gander, Glenwood, Badger, Wabush, and Labrador City which operate sewage treatment plants, all inland municipalities in the Province discharge untreated domestic wastewaters directly into adjacent receiving bodies. The major inland

municipalities discharging untreated wastes are Buchans, discharging into Buchans Brook; Deer Lake, discharging into Deer Lake; Windsor and Grand Falls, each of which discharge into the Exploits River. The study has not revealed any problems of organic pollution in Buchans Brook, nor in Deer Lake; but has confirmed the presence of organic pollution in the Exploits River below the pulp and paper mill at Grand Falls (Volume Six A, Part I).

This discharge of untreated municipal wastewaters increases the bacteriological pollution of the receiving stream, making such waters unsuitable for human consumption without a minimum of chlorination and possibly filtration as well. When municipal wastewaters are discharged in conjunction with industrial liquid wastes, they can have the effect of seeding such liquid wastes bacterially which results in a more rapid deterioration of water quality.

Changes in water quality caused by man's activities associated with the disposal of industrial wastewaters are evident in a number of significant instances in Newfoundland and in many minor instances throughout the populated areas of the Province.

On the Island, industrial wastewaters generated by industries located on the seacoast are invariably discharged to the sea without treatment. The most noteworthy example of this is the disposal of the wastewaters from the pulp and paper mill at Corner Brook into the Humber Arm. In order to establish if the disposal of these untreated wastewaters into the Humber Arm is deleterious, it is essential that pertinent data be collected on an annual basis starting at the earliest opportunity since these untreated wastes could be limiting the use of the river by sea run salmon. This problem is discussed in detail in Volume Six A, Part II.

Inland the disposal of industrial wastewaters into receiving bodies has generally been carried out without prior treatment. In recent years, in order to reduce the concentration of copper and zinc in receiving streams to a level less than that lethal to fish, the tailings from copper and zinc concentrating operations have been impounded. This inexpensive form of treatment may have reduced the concentration of heavy metals but does not necessarily ensure the ultimate reduction of the pollution effect on the receiving body. It remains to be seen whether or not the copper and zinc emanating from the tailings which have settled out on the lake bottoms over many years of untreated disposal will produce a lethal concentration in the lakes. A more detailed discussion of this situation is presented in Volume Six A, Part I.

The disposal of untreated wastewaters from the pulp and paper mill at Grand Falls into the Exploits River adversely affects the quality of this river to a marked degree. The major pollutants added by this industry are sulphite waste liquor which has an extremely high biochemical oxygen demand as well as being toxic itself to fish; and bark and fibre which upon decomposition, albeit slow, can create a serious biochemical oxygen demand due to the large quantities of wastes involved. There is no doubt that continued discharge of untreated wastewaters from the pulp and paper mill at Grand Falls will ultimately limit the use of the Exploits River below Grand Falls to the disposal of industrial wastes to the exclusion of all other uses.

In Labrador the disposal of tailings from the iron ore mines at Wabush and Labrador City into Flora Lake and Wabush Lake, respectively, has resulted in some pollution of these lakes in that fish are adversely affected by the resultant increased turbidity. The increased turbidity destroys spawning beds through siltation, smothers plant and invertebrate growth on the lake bottom, reduces penetration of sunlight thus decreasing general food production, and directly affects respiratory and other tissues of the fishes exposed to this turbidity. The Canada Department of Fisheries are hopeful that excessive turbidity can be confined to Flora Lake and a small area of Wabush Lake to be converted to an impoundment basin thus sparing a large portion of the balance of Wabush Lake from the adverse effects of this turbidity.

From the foregoing it may be concluded that, in general, the disposal of domestic wastewaters has a limited effect on the quality of the fresh water resource mainly because most of the disposal is to the sea. Where this is not the case, disposal is into inland water affording more than adequate dilution to mask bacteriological pollution. On the other hand, disposal of industrial wastewaters in some localities causes serious deleterious effects on the quality of the inland receiving waters and will continue to do so until such time as these wastewaters are treated.

Man's activities in the primary industries may also affect the water quality. This is particularly true of forest spraying and, to a lesser extent, agricultural practices as discussed in Volume Three A.

12      CHANGES DUE TO ACTIVITIES AFFECTING  
          PHYSIOGRAPHIC CHARACTERISTICS

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Apart from the direct influence on river flow and level regime, man's activity in the river basins is liable to produce many changes in the hydrologic cycle and also in the water quality. Main activities which can induce changes in the natural hydrologic regime are (in the Province's conditions) forest exploitation, bog reclamation, the construction of roads and other construction activity, urbanization, and agriculture.

Generally speaking man's activity in the Province's basins, and especially in Labrador, has changed little of the natural regime of the bigger watersheds, but it is possible that here and there the regime of small brooks has been changed significantly. The following comments are intended to point out possible causes of such changes, but any figures quoted should be considered as an order of magnitude indication only. This is because most of the comments on the changes in the natural regime included in the present section are based on results obtained from the statistical processing of data by multiple correlation analysis only.

It is recognized that physical inferences drawn from the multiple correlations are very approximate and subject to misinterpretation because of intercorrelation of the so-called independent variables or lack of knowledge of the real relationship between the dependent and independent variables. For example, if a multiple correlation indicates an increase of runoff in basins with larger forest areas, it is hard to state whether the runoff increased because of the forests, or the forest area is larger because of more humidity in the area. A more accurate statistical inference requires more sophisticated analysis (factor analysis, principal components, etc). Because of the scarcity of data, such analyses were not considered to be warranted for this stage of the study; nevertheless, these should be included whenever special problems such as the effect of forest fire on hydrologic conditions are considered. This would require collecting more information, both on the historic and present conditions, than was available for the present study.

12.1      Forest Exploitation

An analysis of the influence of forest areas on hydrologic conditions, as indicated by the correlations between hydrologic and physiographic characteristics is included in Volume Three A, Section 8.4. This analysis, which is subject to the above reservations on the possible weaknesses of physical inferences from multiple correlations, indicated that:

- a) The average runoff is not significantly influenced by the area of the forest.
- b) Summer maximum flows, and the flow variation generally is influenced by the area of forest. This is confirmed by the correlations discussed in Section 18.1.1, and is well illustrated by the flow hydrograph of the Pipers Hole River before and after a forest fire occurred in the basin, as shown on Figure 12-1 and discussed in Volume Six B, Part VII.
- c) Although there are indications of soil erosion and sediment load increasing sometimes after forest clear cut and forest fires, there are insufficient data to determine this increase numerically. Thus, forest cutting and forest fires are liable to increase the maximum flows and sediment load in the affected basin, at least in some areas, but the available data are not sufficient to provide quantitative estimates of these changes.

## 12.2 Bog Reclamation

Bog reclamation including drainage has been carried out in several areas on the Island but only during the last decade and on a small experimental scale. Although the draining of bogs may contribute locally to the increase of the flows, no direct data on this problem were available for the purpose of this report. The location and area of bogs which are presently drained is shown on Figure 12-2.

The runoff multiple correlations (Tables 16-2 to 16-4) indicate a decrease of runoff with increase of swamp area in eastern Newfoundland, while the reverse is true for Labrador. Although the increase in Labrador is relatively small (0.4 inches per year more runoff in an area completely covered by bogs, over the runoff which would occur in an otherwise similar area without bogs) the statistical significance of the Labrador coefficient is much higher than that obtained for the Island. While one could speculate on the climatologic and vegetation differences in the two areas to explain the contradictory result, this points out again that statistical inference based on multiple correlation only is not conclusive. Although other evidence on the Island, as for example the correlation between minimum summer flow and physiographic characteristics (Table 19-1), also indicates a decrease of flow with increased bog area, thus confirming the result obtained for average flow in the Island, quantitative estimates of effect of bog reclamation on flows is difficult to make. In any case it can be stated that given the small scale of bog draining in the past, the effect of this activity on the river flows has been extremely limited.

12.3 Construction of Roads, Construction Activity,  
and Urbanization

Although at the scale of the Island this activity is relatively small when compared to that in more populated areas, circumstantial evidence indicates that road construction may occasionally increase local runoff concentration and may lead to soil erosion. This has some significance in the intensively exploited forest areas. Local extreme concentration of runoff in ditches opened for construction purposes have been reported, especially in periods with significant snow cover and unstable weather. Borrow pits and quarries may have similar effects. Obviously urbanization accelerates the runoff concentration due to reduction of infiltration and evaporation. However, this is not a significant factor at the present time on the Island outside of St. John's and Corner Brook, and even there the topographical and geological conditions indicate that the changes in the river flow regime have not so far been significant except for the areas where storm precipitation is collected in sewer systems having their outfall directly into the sea.

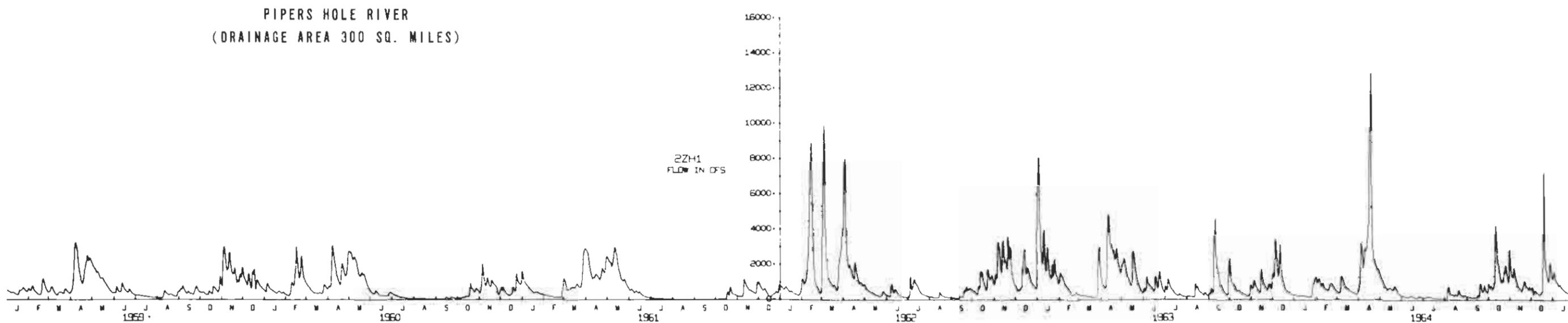
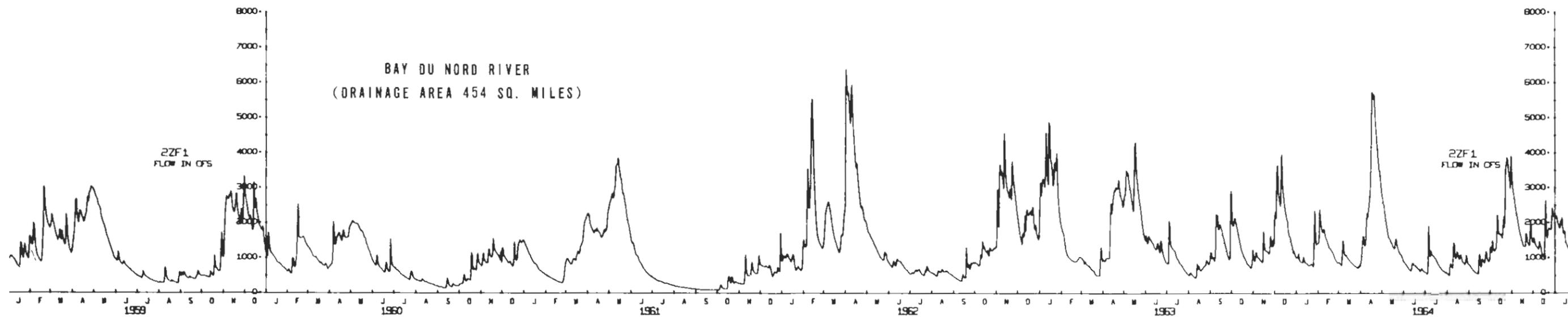
12.4 Agriculture

Historically the regime of some rivers on the Island was affected by deforestation related to land clearing for agricultural purposes. The changes induced by this deforestation cannot be estimated because of lack of hydrologic data or information on initial extent of forest cover. Agriculture as practised today undoubtedly contributes to soil erosion, but on a very small scale. Data on this subject are not available. Irrigation has not been carried out in an extensive way; according to the available information, only two farms practise irrigation at the present time, and that on a moderate scale. It can therefore be concluded that irrigation does not affect the hydrologic regime in the Province in any significant way. Farm sewage and consequent pollution is also of little significance, except for the local small streams which receive these waters. Problems of this nature are reported in some detail in Volume Three A, Section 9.

Regime changes due to bog reclamation which is mainly done for agricultural purposes were discussed under Section 12.2.

In summary, at an earlier stage agriculture may have induced some minor changes in the hydrologic regime of the Island, but has little influence on it at the present time.





NEWFOUNDLAND  
DAILY FLOW HYDROGRAPHS  
OF THE PIPERS HOLE AND  
BAY DU NORD RIVERS  
(PRODUCED BY COMPUTER-PLOTTER)



13      WEATHER MODIFICATION

Weather modification is attempted at the present time in water deficient areas mainly in two ways: by cloud seeding and through evaporation control especially from lake surfaces. While neither the Island of Newfoundland nor Labrador can be generally considered as water deficient, in certain periods emergency conditions may develop when additional water is required (forest fires or low flow periods coinciding with high power demand).

13.1      Cloud Seeding

Cloud seeding operations were attempted both on the Island and in Labrador in 1966 by Weather Engineering Company of Canada Limited.

In Newfoundland the target area comprised 2000 square miles in the Humber River basin above the Deer Lake hydro-electric plant, and the cloud seeding operation was intended to increase the flow and storage available at this plant. Comparisons with meteorologic stations outside the target area indicated an increase of 15 percent in the precipitation in the basin. It is even more significant that correlations of the flows of the Humber River with the average flow of two other rivers, Gander and Bay du Nord, far enough from the target area to assume that they were not affected by the seeding operation, seem also to indicate an increase in runoff (Figure 13-1). Although neither the precipitation nor the runoff comparisons can be considered as conclusive, the possibilities of increasing the precipitation and runoff by cloud seeding should not be dismissed without further investigation.

The increases in runoff obtainable by cloud seeding range between 6 and 8 percent in areas with significant orographic lift, as indicated in an unpublished study by The Shawinigan Engineering Company Limited on the effects of cloud seeding in the Gatineau River basin, and by other authors, for example, Elliot and Lang<sup>1</sup>.

An interesting application of cloud seeding techniques for conditions in the Province could be the control of cold fog, as indicated by Schleusener<sup>2</sup>.

In Labrador, cloud seeding operations were conducted on an emergency basis for forest fire purposes. Although it is claimed that

the operation was successful, statistical evidence was not available for an evaluation of the results obtained. In the Shawinigan study for the Gatineau River basin, it was not possible to show any significant reduction in the forest fire frequency or intensity during the cloud seeding operations. It is true that the cloud seeding operation in this basin was not oriented toward forest fire containment, its purpose being mainly to increase the precipitation during favourable weather conditions, which more often than not did not coincide with periods favouring forest fire occurrences.

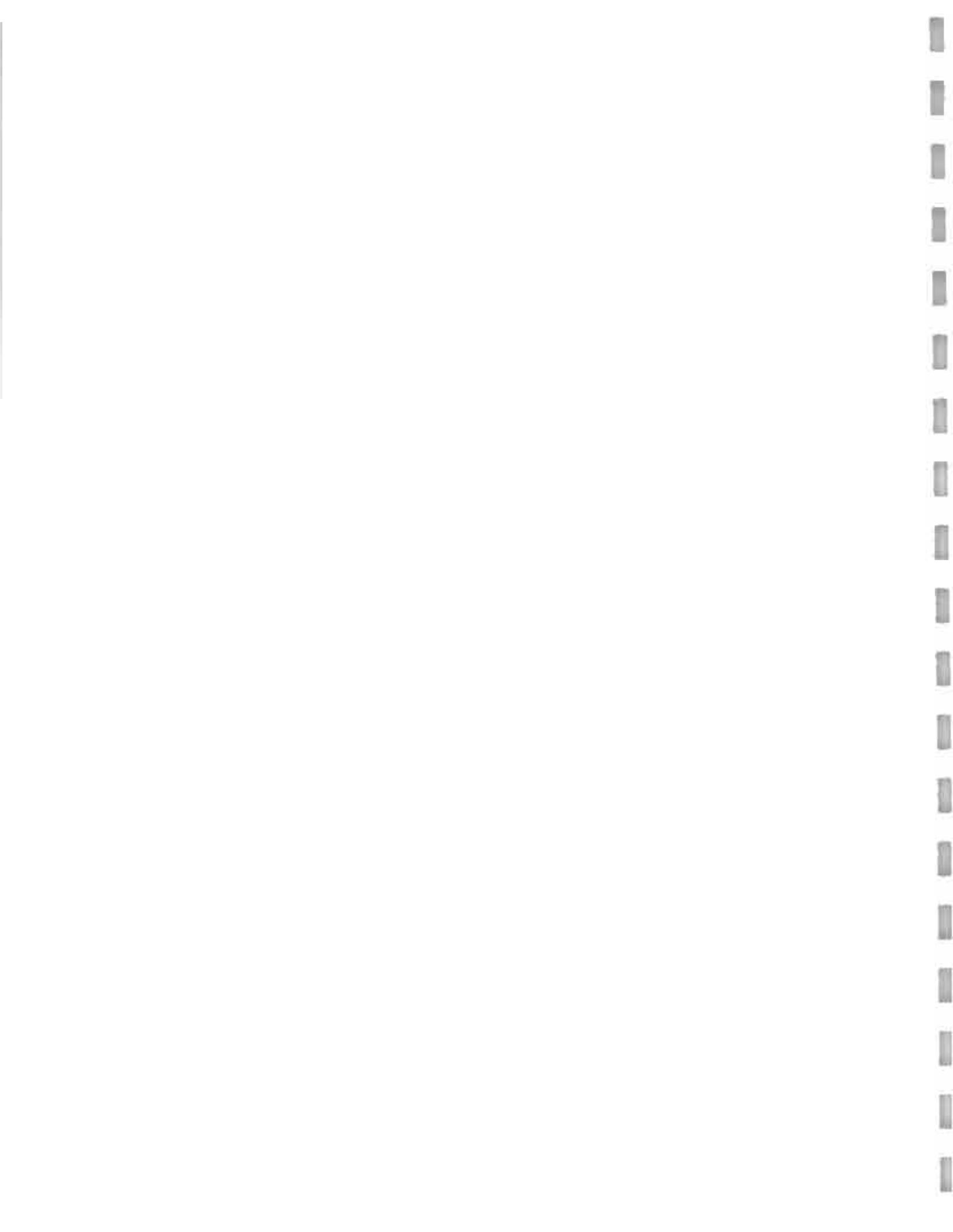
### 13.2 Lake Evaporation Control

According to the information available, no attempts have been made to reduce evaporation from lakes in the Province. A cursory examination of the possibilities of controlling evaporation from lakes by means of monomolecular films indicated that it does not appear to be a practical way of increasing water availability for the following reasons:

- a) The evaporation is low, probably 15 to 20 inches per year on the average with fluctuations to a maximum of about 25 to 30 inches.
- b) Because of the frequent and strong winds, maintaining the monomolecular films would be very difficult and expensive.
- c) The temperature differential created by accumulated energy in the lakes because of inhibited evaporation would increase the frequency and velocity of winds, thus creating additional problems in maintaining the films.
- d) Because of the availability of storage possibilities over the whole area, increases in storage which would supplement the flow during droughts would probably be cheaper, more effective, and more reliable.
- e) Side effects of evaporation control, including effects on surrounding vegetation and wildlife, are not completely ascertained and may produce undesirable effects, such as increased chances of forest fires.

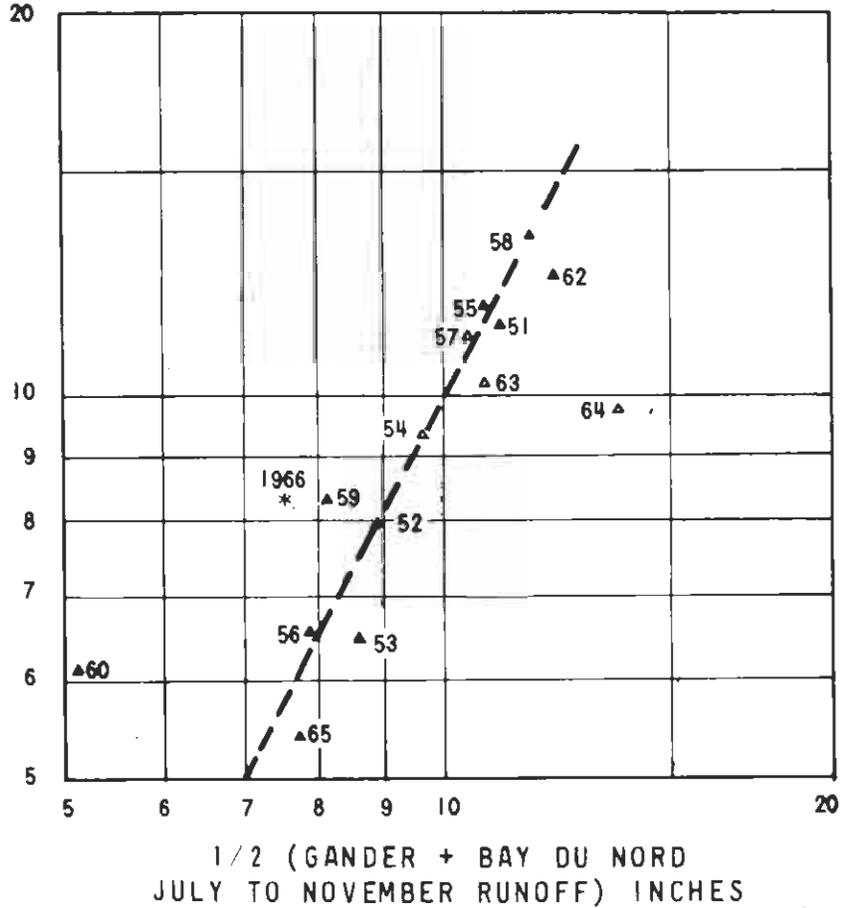
REFERENCES

- 1 Elliot, R. D., and Lang, W. A. Weather Modification in the Southern Sierras. ASCE. Irrigation and Drainage Division. Journal. Vol. 93, No. 1R4, 1967.
- 2 Scheusener, R. A. A Perspective on Weather Control. ASCE. Irrigation and Drainage Division. Journal. Vol. 94, No. 1R 1, 1968.



NEWFOUNDLAND  
CORRELATION OF THE HUMBER RIVER RUNOFF  
TO THE AVERAGE RUNOFF OF THE  
GANDER AND BAY DU NORD RIVERS

HUMBER RIVER JULY TO NOVEMBER  
RUNOFF IN INCHES



- LEGEND
- △ FLOWS UNAFFECTED BY CLOUD SEEDINGS
  - \* FLOW AFFECTED BY CLOUD SEEDING





VOLUME TWO-A - PART IV SECTIONS 14-22

INLAND SURFACE WATER - QUANTITY

PART IV - INLAND SURFACE WATER - QUANTITY

14 HYDROGRAPHIC NETWORK

The hydrographic network of the Province is the result of the complex interaction of its topography and glaciated geology on one hand and its humid and cold climate on the other. This interaction has produced different types of rivers, lakes, and marshes in the Island and in Labrador. In addition, there are bog formations which represent a combination of vegetation and hydrologic systems characteristic of northern areas. A discussion on bogs is included in Section 7.

In general, the whole Province has a "glaciated" hydrographic network in the sense that runoff drainage occurs according to the topographic pattern which resulted from the glaciation, the contribution of erosion by rivers to the general hydromorphology being very limited. Therefore, in some cases, delineating the river basin drainage area is difficult since some areas have no definite drainage pattern, and lakes and marshes sometimes have outlets in two different basins. In many cases the rivers actually consist of a string of glacial lakes of various sizes joined by narrower portions, including rapids and falls. It is only near the seacoast and in areas with significant slopes (the Long Range, the Avalon, and Northern Labrador) that erosional activity of the rivers made a larger contribution in shaping the hydrologic network.

14.1 Island of Newfoundland

The main rivers and lakes of the Island are shown on Figure 8-1 which also includes a list of the drainage basin areas of the rivers shown on the figure. Because of the special topographic conditions, namely, the closeness of the divide to the ocean, the rivers in the Island with only a few exceptions have relatively small drainage basins; that is, from a few miles to a thousand miles. A multitude of small rivers have drainage areas under 100 square miles and usually drain into fjord-like estuaries. These are especially characteristic of the Avalon and Burin Peninsulas where the basins rarely exceed a hundred square miles. There are many small lakes on the two peninsulas but none larger than a few square miles.

On the south seacoast the river drainage basins vary between less than a square mile and less than a thousand square miles, with one exception, the Salmon River which has a drainage area of 1,080 miles. Other significant drainage basins on this seacoast are, from

east to west, Pipers Hole River (300 square miles), Long Harbour River (334 square miles), Bay du Nord River (484 square miles), Conne River (239 square miles), Grey River (947 square miles), White Bear River (772 square miles), Grandys Brook (228 square miles), and La Poile River (204 square miles).

Besides a myriad of small lakes dotting the drainage basin, there are a few large lakes in the area, such as Gisborne (11 square miles) in Long Harbour River basin; Kaegudeck (10 square miles); Jubilee (11 square miles) in the Bay du Nord River basin; Island Pond (12 square miles); Great Burnt Pond-Crooked Lake (24 square miles); Round Pond (18 square miles) in the Salmon River basin; Maelpaeg-Pudops (40 square miles) in the Grey River basin; and Granite (14 square miles) in the White Bear River basin.

Because of the closeness of the Long Range Mountains, the west coast generally drains only small rivers, with one exception, the Humber River with a total drainage basin of 3077 square miles above the river mouth. The largest of the numerous other small river basins of the west coast are, from south to north, the Codroy River (298 square miles); Harrys River (322 square miles); Portland Creek (372 square miles); Torrent River (240 square miles); and Castors River (211 square miles).

The largest lakes in the west coast area are found in the Humber River basin: Grand Lake-Sandy Lake (179 square miles), the largest lake complex of the Island; and Deer Lake (25 square miles). In addition, a series of lakes inland or near the seacoast are included mainly in the drainage basins of the rivers on the west side of the Great Northern Peninsula. The largest inland lake complex is Ten Mile Lake-Round Lake (18 square miles), and Portland Creek Pond is the largest lake on the seacoast. The southern part of the west coast has fewer large lakes.

The rivers drained by the east coast of the Great Northern Peninsula are similar to the rivers of the west coast and their basins are also relatively small. The largest rivers in this area are, from north to south: Cloud (198 square miles); Cat Arm (325 square miles); and Main (390 square miles). No very important lakes can be found in this area.

The drainage pattern of the north and east coasts is dominated by a few larger rivers. The development of bigger drainage areas was possible in this case because of the longer distance to the divide produced by the general tilting of the Newfoundland Plateau. The rivers draining to the north and east coasts have the direction of their main stems parallel to the general direction of the geologic formations. The main rivers flowing to the north are the Exploits (4420 square miles above the mouth, excluding the Exploits Arm drainage), the largest in the Island; and the Gander (2070 square miles). In addition, there are many smaller basins, the largest from west to east being Indian Brook (376 square miles, from which 92 square miles are diverted into the Humber River basin); Barneys Brook (198 square miles); and South Brook (244 square miles). The main lakes in these river basins are Red Indian (72 square miles); North Twin (16 square miles); and South Twin (14 square miles) in the Exploits River basin; and Gander (47 square miles) in the Gander River basin. Some of the lakes in the river systems flowing to the north are very deep.

The east coast rivers are dominated by the Terra Nova River basin (740 square miles), and the Gambo-Mint Brook basin (443 square miles). There are two other smaller rivers which should be mentioned: the Indian Bay Brook (230 square miles; and the North West River (265 square miles), both flowing into Bonavista Bay. There are numerous lakes in these river basins; the largest are in the Terra Nova River basin-Terra Nova Lake (10 square miles) and Maccles Lake (11 square miles).

A summary of the chief physiographic characteristics of the main drainage basins of the Island and of some of the more important tributaries is shown in Table 14-1. This table gives the drainage area, the average elevation, slope (index), area of forest, lakes, bogs and swamps, and other physiographic characteristics used further in the hydrologic section.

The profile of the most important rivers and some of their tributaries as obtained from the 1:250,000 scale maps are shown in Volume Six A and B, Figures 1-7, 6-5, 10-6 to 10-9, 18-5, and 24-8. The hypsographic curves of the main rivers are shown in Figure 3-3.

## 14.2 Labrador

There are two main drainage areas in Labrador, one to the Gulf of St. Lawrence and the other to the Atlantic Ocean.

The rivers which drain to the St. Lawrence have their upper basins in Labrador, and their lower basins in Quebec. None of the river basins flowing into the south has a very large drainage basin at Labrador's scale except the Little Mecatina with a drainage basin of about 2500 square miles. Although there are many lakes in the area, none is of important size.

The rivers flowing into the Atlantic Ocean have drainage areas ranging from a few square miles to the 31,500 square mile drainage area of the Churchill River. Because of flat topography, marshy land, and lakes having more than one outlet, the delineation of the watersheds is not always possible and the size of the drainage areas indicated below may be considered as approximate.

The drainage areas of the rivers flowing to the Atlantic Ocean are shown on Figure 8-2. As indicated, besides the big drainage area of the Churchill River, four other rivers have sizeable drainage areas; namely, from south to north, the Eagle (4160 square miles); Naskaupi (7880 square miles); Canairiktok (4520 square miles); and the Adlatok (4800 square miles). All these larger rivers are in southern Labrador. Towards the north, because of the decreasing distance between the divide and the ocean, the drainage areas and the length of the rivers tend to decrease.

There are many large lakes, especially in the southern part of Labrador, the largest being Lake Michikamau (685 square miles) in the Naskaupi River basin. The Churchill River basin has a series of big lakes including the Lobstick-Sandgirt lake system (315 square miles), the Gabbro-Ossokmanuan lake system (189 square miles), Attikamagen (126 square miles), the Petitsikapau-Dyke-Astray lakes (153 square miles), Menihek lake system (113 square miles), Shabogamo-Wabush (117 square miles), Ashuanipi (167 square miles), and many others. The more northern region has only smaller lakes, the Mistastin (53 square miles) in the Kogaluk River basin being the most noteworthy.

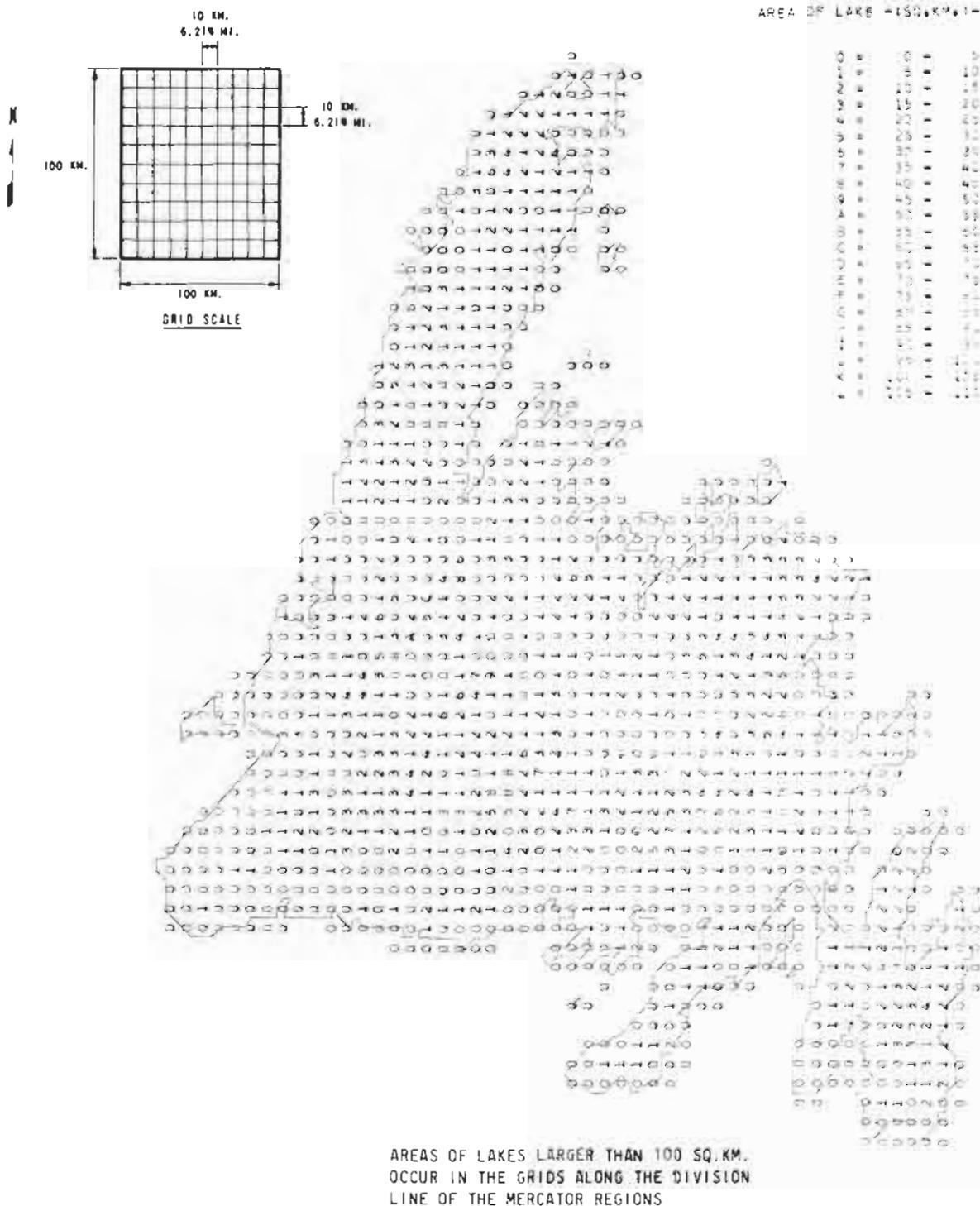
Table 14-2 is a list of the most important southern river basins, their drainage areas, average elevations, slope (index), areas of forests, lakes, swamps and marshes, and other physiographic characteristics

which were used in the hydrologic studies. Figure 14-2 shows the square grid distribution of the Labrador Lake area.

The profiles of most of the southern rivers are shown in Volume Four, Figures 1-11 to 1-14. The hypsographic curve of the Churchill River is shown on Figure 3-3.



NEWFOUNDLAND  
 SQUARE GRID DISTRIBUTION OF  
 LAKE AREA



## LABRADOR SQUARE GRID DISTRIBUTION OF LAKE AREA

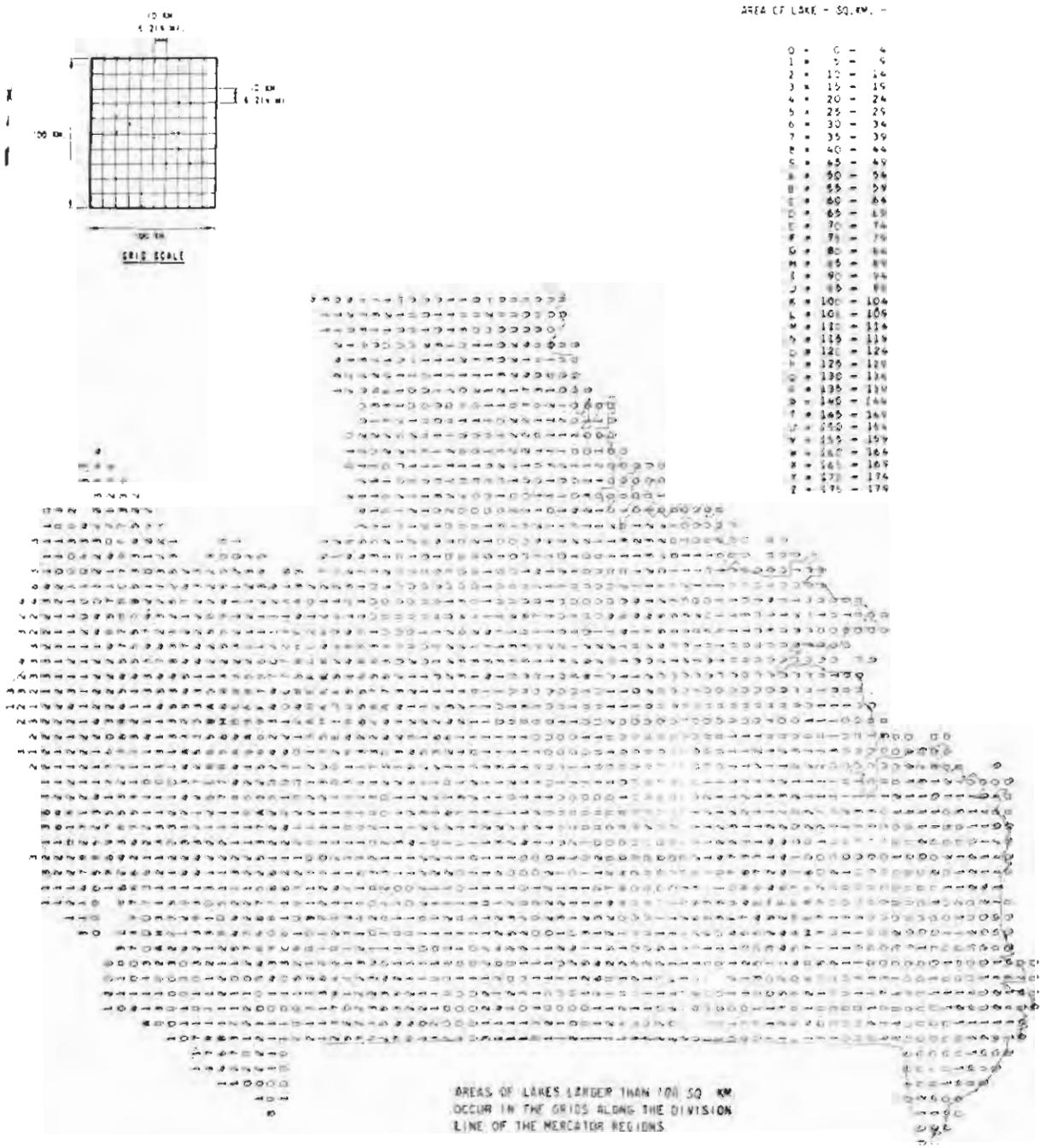


FIGURE 14-2

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NEWFOUNDLAND  
PHYSIOGRAPHIC CHARACTERISTICS OF RIVER BASINS

		BASIN AREA	LAKE AREA	FOREST AREA	SWAMP AREA	SHORT DIST. SEA KM.	DIST. -SE- SEA KM.	DIST. -SW- SEA KM.	SLOPE FT/1000FT	ALTIMUTH SLOPE NORTH DEGREES	ELEV. FTX10	E.M. -SE-	B.M. -SW-	COEFF. OVERBRN
EXPLOITS	BAY OF EXPLOITS	12870.0	1007.2	7998.4	2098.4	52	257	168	1396	25	99	25	58	232
EXPLOITS	ORANG FALLS(ZYD1)	9684.0	910.7	8809.8	1818.4	73	253	177	1176	47	95	22	54	225
EXPLOITS	RED INDIAN L. OUTLET	9845.0	638.2	255.0	1402.0	76	275	140	1574	125	112	19	44	226
LLOYD'S	RED INDIAN L. INLET	1024.0	119.0	455.1	60.2	38	177	103	1569	60	121	20	36	243
SHANADITHIT	RED INDIAN L.	432.0	28.9	142.7	91.9	77	242	173	1939	163	132	14	36	200
STAR LAKE R.	RED INDIAN L.	433.0	28.4	98.5	175.9	74	240	163	1739	144	132	16	38	200
BUCHAN'S BRK	RED INDIAN L.	356.0	29.8	83.0	204.4	88	317	194	1527	153	115	10	47	199
BUCHAN'S LAKE	DAM	167.0	6.8	67.4	63.3	84	332	170	1747	115	119	10	46	197
VICTORIA	RED INDIAN LAKE	1826.0	204.4	968.6	291.0	76	203	103	1351	311	115	12	35	253
MARY MARCH'S	RED INDIAN L.	626.0	22.1	207.9	177.8	72	269	206	1284	143	95	14	59	203
MOEL PAUL'S ABOVE EXPLOITS		998.0	79.5	192.6	185.8	88	257	150	1004	8	91	13	46	232
JOE'S LAKE ABOVE EXPLOITS		748.0	98.4	601.2	90.0	34	333	225	1501	335	57	35	91	203
SANDY BRK ABOVE EXPLOITS		1524.0	35.2	403.8	90.7	63	322	175	919	19	71	23	59	281
SANDY BRK	NORFOLK(ZYDNT)	518.0	33.9	363.4	81.6	64	322	174	912	17	72	22	57	282
GREAT RATTILING BRK	EXPLOITS	1404.0	82.3	1083.1	121.5	71	293	172	1163	346	63	25	50	275
RATTILING BRK	RATTILING L.(ZYD)	179.0	22.7	283.3	60.4	20	263	217	1061	434	66	23	46	261
HUMBER	HUMBER ARM	2154.0	651.2	1279.4	520.5	45	345	191	3344	16	97	68	138	161
HUMBER	DEER LAKE OUTLET	755.0	616.8	4031.4	620.5	51	353	177	3247	25	98	65	136	181
HUMBER	GRAND L. OUTLET ZYK1	4782.0	614.0	2695.0	491.2	57	313	204	3370	331	101	60	113	205
LEWASRECHJECH	GRAND L.	488.0	41.7	210.4	43.0	71	354	155	3955	32	116	35	67	200
LEWASRECHJECH	NEAR GRAND L.	438.0	39.1	193.0	40.1	58	254	147	3992	36	117	35	64	200
HINDS BRK	GRAND LAKE	504.0	50.2	172.3	149.2	76	349	208	2120	77	133	19	52	191
HINDS BRK	NEAR GRAND L. ZYK4	528.0	52.1	177.0	161.1	76	346	207	2111	74	133	19	52	192
MAIN BRK	GRAND LAKE	1403.0	176.9	1627.9	175.1	65	332	247	2426	310	91	55	114	213
SHEFFIELD	SHEFFIELD L. ZYK3	361.0	29.8	226.8	57.2	55	321	255	2425	20	96	27	93	234
UPPER HUMBER	DEER LAKE	2338.0	111.9	1540.0	127.6	42	444	186	2772	129	101	60	140	128
UPPER HUMBER	SEAL POND ZYK1	2087.0	96.9	1375.1	113.3	43	446	187	2792	130	102	57	141	124
UPPER HUMBER	NORTH OF ADIES BR.	961.0	64.1	549.7	110.0	42	459	161	3233	116	132	27	195	103
ADIES BRK	ABOVE UPPER HUMBER	620.0	23.2	426.0	15.0	37	445	165	3044	118	107	55	186	116
CAT ARM R.	CAT ARM	855.0	51.5	669.3	0.9	29	443	205	1782	102	149	6	218	100
BEAVER BROOK	NEAR RODDICKTON	236.0	19.4	194.1	5.9	24	37	121	1416	47	73	15	150	162
TORRENT	BRISTOL POOL ZYK1	619.0	80.6	216.1	16.2	21	407	84	2452	247	95	52	93	205
GANDER	GANDER BAY	5372.0	381.3	4077.9	409.1	47	239	146	1123	355	50	26	58	220
GANDER	GANDER L. OUTLET	4397.0	288.9	3259.8	434.4	54	250	170	1176	9	57	25	50	222
GANDER	BIG CHUTE ZYK2	4350.0	284.8	3216.1	428.7	54	249	170	1179	6	57	25	50	221
NORTHEAST GANDER	GANDER L.	2317.0	116.2	1534.2	221.4	62	267	151	1015	54	63	22	47	236
SOUTHWEST GANDER	GANDER L.	987.0	32.9	746.0	140.5	59	237	164	1099	327	63	22	38	200
INDIAN	INDIAN FALLS ZYK1	982.0	79.9	746.7	59.7	39	383	208	2100	142	72	31	160	231
INDIAN	DIVERSION (ZYK2)	240.0	21.7	143.2	34.4	53	393	277	1309	142	60	31	182	254
ISLE AUX MORTS	HIGHWAY 22B1	205.0	5.7	18.0	6.4	15	20	20	2409	170	97	5	16	195
WHITE BEAR	WHITE BEAR BAY	2227.0	149.5	360.5	244.4	43	161	58	1945	134	109	12	18	262
WHITE BEAR	W.B. LAKE ZYK1	794.0	71.0	151.7	94.2	48	169	61	1424	80	121	15	22	285
BURNT POND R.	WHITE BEAR L.	621.0	55.5	126.8	79.5	48	176	61	1466	68	118	16	25	283
GRANITE BRK	WHITE BEAR L.	583.0	51.4	160.6	17.1	64	173	75	1205	165	119	10	21	290
GREY	SOUTHEAST ARM	2672.0	305.3	933.8	32.5	46	159	67	1407	145	93	11	17	242
GREY	NEAR BUDORS L. ZYK11	983.0	221.6	295.7	13.2	57	174	100	999	129	99	10	24	289
GREY	BUDORS L. OUTLET	958.0	215.5	237.8	13.2	69	174	100	998	125	99	9	24	289
SALMON	NORTHERN ARM	2861.0	382.5	949.7	59.1	51	204	100	904	120	79	12	30	257

TABLE 14-1  
Page 1 of 2

NEWFOUNDLAND  
PHYSIOGRAPHIC CHARACTERISTICS OF RIVER BASINS

	BASIN AREA	LAKE AREA	FOREST AREA	SWAMP AREA	SHORT DIST. SEA	DIST. SEA	DIST. SEA	SLOPE FT/1000FT	AZIMUTH SLOPE NORTH DEGREES	ELEV. FTA10	B.H. FTA10		COEFF. OVERBURD.
											B.H. SEA	B.H. SEA	
SALMON LONG POND ZZE1	2665.0	369.2	914.0	63.3	53	211	104	916	115	80	31	31	262
SALMON ROUND POND ZZE2	1870.0	273.4	660.0	55.2	59	221	113	774	118	85	8	29	266
NORTH SALMON ROUND POND INLT	1061.0	157.9	474.3	58.9	69	257	126	631	136	87	0	20	270
WEST SALMON ROUND POND INLET	615.0	66.2	123.9	0.0	40	160	96	721	100	87	9	25	244
CONNIE BAY DIESPOIR	706.0	42.4	323.4	30.7	40	225	77	977	129	62	16	20	270
PIPERS HOLE SWIFF CURRENT	826.0	88.1	104.7	171.3	33	174	147	1230	94	63	14	17	268
PIPER'S HOLE MOTHER'S BRK	761.0	88.9	91.3	196.2	38	176	139	820	98	64	14	15	283
TERRA NOVA GLOVERTOWN SOUTH	1918.0	272.8	1054.0	323.1	55	200	147	1128	100	61	16	29	208
TERRA NOVA AT LAKE INLET	1193.0	115.6	566.4	221.4	67	216	131	960	111	70	14	20	212
TERRA NOVA 8 MILES BRIDGE	1187.0	113.7	566.0	221.4	67	216	131	960	109	70	14	20	211
COME BY CHANCE SEA	62.0	1.9	36.3	0.0	16	122	164	1016	167	35	36	27	194
COME BY CHANCE-GOONIES ZZNZ	34.0	1.5	23.0	1.0	16	122	169	1757	177	37	37	30	177
NORTH HARBOUR TO SEA	86.0	3.2	42.0	0.0	16	125	165	1656	160	42	31	25	195
BLACK R. TO SEA	206.0	15.5	40.0	2.3	18	137	172	1696	131	62	15	17	190
PETTY HARBOUR AT 2ND POND ZZN1	141.0	9.3	48.1	0.0	0	11	35	1704	69	44	2	29	161
PIERRE'S BRK GULL POND ZZN2	114.0	13.2	47.5	10.0	12	14	71	1511	74	58	5	15	183
BAY DU NORO BEE FALLS ZZF1	1166.0	187.8	244.2	36.5	35	213	86	804	190	65	12	10	263
ROCKY POND NEAR COLINET ZZK1	292.0	29.4	33.9	2.7	13	75	61	967	166	31	35	33	249
MOBILE 1ST POND ZZM3	111.0	10.0	9.9	3.2	12	15	52	1200	29	60	4	7	178
SEAL COVE WHITE HILL POND	51.0	7.0	8.3	0.8	8	25	82	1703	319	51	23	18	163
GARNISH R. NEAR GARNISH ZZG1	234.0	12.0	20.3	0.0	5	17	56	2513	166	33	9	24	158
NORTHEAST POND NE POND ZZM6	4.0	1.2	3.0	0.0	5	14	141	2872	257	27	20	46	136
MIDDLE BRK NEAR GAMBO ZYRL	272.0	33.8	22.7	14.4	32	199	190	1301	31	39	29	34	200
HEART'S CONTENT S. COVE POND	92.0	10.8	12.2	0.3	5	69	68	1876	323	46	25	10	164
SOUTHWEST-BOTTOM GEORGE R.	767.8	87.8	327.0	23.7	40	246	129	2637	232	106	41	91	231
HARRY'S STEPHENVILLE	615.0	42.2	632.0	39.6	20	201	113	2450	194	79	63	130	152
SALTER'S POND MARYSTOWN	5.0	0.2	1.0	0.0	14	14	42	754	214	15	13	41	200
BAY BULLS R. BAY BULLS	26.0	2.0	14.1	1.6	7	7	77	2560	108	45	7	17	177
BANNERMAN L. CHAMOUR GRACE	25.0	2.7	0.0	0.0	10	56	70	859	129	40	27	17	153
FRENCHMAN'S POND (ST. ANTHONY)	4.2	0.3	1.6	0.0	4	13	211	3129	73	28	0	149	199
QUARRY BROOK SEARHOLYWOOD	13.0	0.3	1.9	0.0	5	42	96	1337	58	17	36	46	173
RATTLING BRK LONG HARBOUR	32.4	2.7	0.9	0.0	5	97	14	1768	355	32	31	10	156
SALMONIER LAMALINE BAY	125.0	5.5	0.6	0.0	7	7	7	1190	146	26	2	0	165
SOUFFLETS R. ST. HARBOUR DEEP	407.0	22.8	202.9	9.8	21	333	153	2666	131	111	5	200	170
GULL POND OUTLET (GULL BRIDGE)	179.0	13.6	148.8	16.7	30	324	224	1458	91	71	23	81	227
HALFWAY POND PORT UNION	74.0	3.4	35.3	1.2	1	17	250	1327	73	25	4	39	130
DEER POND OUTLET (WHALESBACK)	17.0	0.3	19.3	0.0	5	353	311	1687	96	29	61	160	100
UPPER DUCK I. COVE BAY VERTS	27.0	0.3	25.7	0.0	4	379	326	3519	130	46	32	150	100

\* NOTE: SMALL AREAS OF OPEN WATER WERE DISREGARDED.

\*\* NOTE: B.H. = BARRIER HEIGHT

\*\*\* NOTE: COEFF. OVERBURDEN:  
0-100 LITTLE OVERBURDEN; 100-200 AVERAGE OVERBURDEN;  
200 DEEP OVERBURDEN

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LABRADOR  
PHYSIOGRAPHIC CHARACTERISTICS OF RIVER BASINS

	BASIN AREA	LAKE AREA	FOREST AREA	SWAMP AREA	DIST. EAST SEA	DIST. WEST SEA	SLOPE	ALZIMUTH SLOPE NORTH	ELEV.	B.M. EAST	B.M. WEST
	SQ.KM.	SQ.KM.	SQ.KM.	SQ.KM.	AM.	KM.	FT/1000FT	DEGREES	FTA10	FTA10	FTA10
CHURCHILL AT LAKE MELVILLE	52370.0	12816.1	63583.7	5427.2	570	445	1053	63	167	65	67
CHURCHILL AT MUSKRAT FALLS	79809.0	12616.8	61311.0	5382.3	574	446	1035	65	168	65	67
CHURCHILL AT HUDON LAKE	36406.0	8555.9	29360.1	2157.4	620	541	867	21	178	38	50
ASHUANUPI AT MELVINEK RAPIDS	19216.0	2920.3	15063.8	987.5	665	492	1015	24	190	38	60
UNKNOWN ABOVE CHURCHILL	24246.0	4151.5	17782.1	2203.3	617	400	924	56	182	42	51
UNKNOWN AT TWIN FALLS	22942.0	3932.9	16768.0	2154.6	640	393	909	53	183	42	50
UNKNOWN AT ATIKONAK RAPIDS	21591.0	3721.9	15853.6	1928.2	623	390	934	66	184	41	50
FIG ABOVE CHURCHILL	4448.0	339.6	3779.6	325.2	524	398	1262	8	157	30	65
MINIPI ABOVE CHURCHILL	2975.0	346.6	2604.0	26.3	355	231	1267	240	132	40	22
WATERSHED 52 ABOVE CHURCHILL	1158.0	130.7	884.5	142.4	349	316	951	152	124	62	40
CACHE ABOVE CHURCHILL	1034.0	124.6	844.1	83.2	436	340	746	168	135	48	29
SHDAL ABOVE CHURCHILL	714.0	74.2	614.3	26.7	458	347	1614	355	145	33	30
NASKAUPI RIVER DISCHARGE ST. J.	19406.0	3629.6	10919.7	847.1	392	408	1030	295	148	39	62
NASKAUPI AT FREMONT LAKE	9808.0	3045.9	5953.6	802.6	446	485	543	265	163	43	28
MED-MINE AT NASKAUPI	2744.0	184.7	2296.3	74.1	318	397	1625	27	150	29	41
CROOKED R. AT GRAND LAKE	2223.0	191.3	2007.7	24.2	216	402	1098	255	102	18	87
BEAVER AT GRAND LAKE	1897.0	119.3	1636.1	119.7	373	356	1411	101	140	128	32
SUSAN R. AT GRAND LAKE	350.0	14.3	328.0	6.8	326	361	2261	112	108	120	66
KANAIRIKTOK AT KANAIRIKTOK BAY	11866.0	1124.1	10147.0	577.9	326	501	1681	137	142	34	57
SHIPISSAAY ABOVE KANAIRIKTOK	3981.0	285.4	3630.4	49.8	315	528	1620	162	164	35	31
EAGLE AT SANDWICH BAY	10749.0	1900.1	8336.5	271.6	207	222	1186	114	137	20	25
KAIPOKOK AT KAIPOKOK BAY	2778.0	194.3	2520.8	58.7	210	455	1976	356	73	60	145
BIG RIVER TO SEA	2910.0	163.1	2755.6	135.2	149	380	1160	13	99	16	77
ALPIS AT ALEXIS BAY	3344.0	116.4	3155.9	119.2	97	112	1334	81	95	7	22
BOBBY'S BRK AT ALEXIS BAY	234.0	11.7	218.0	4.1	86	80	1277	9	55	12	61
PINWARE TO SEA	2447.0	99.2	1452.4	103.6	54	34	1664	122	101	11	9
PARADISE AT SANDWICH BAY	5879.0	674.7	6437.7	220.3	126	165	1409	352	96	34	36
HAWKE R. AT HAWKE BAY	1777.0	88.7	1663.1	39.1	61	113	1773	117	71	19	11
ST LEWIS R. AT ST LEWIS INLET	2429.0	138.0	1929.6	360.1	97	76	878	63	110	7	19
SAND HILL R. AT SAND HILL COVE	1247.0	76.2	1175.9	26.0	65	102	1303	21	56	11	11
BLACK BEAR AT BLACK BEAR BAY	623.0	24.7	550.1	45.4	37	51	1025	95	38	4	5
DYKES R. AT SANDWICH BAY	334.0	27.7	292.0	6.5	80	125	1704	353	39	21	29
GILBERT R. AT GILBERT BAY	547.0	22.4	352.3	10.4	55	94	1767	118	54	17	23
ENGLISH AT LAKE MELVILLE	874.0	57.4	565.1	14.2	146	281	4491	0	126	34	80
KENEIGH AT LAKE MELVILLE	680.0	37.3	492.0	15.5	254	287	2399	289	134	68	66
WATERSHED 40 AT DOUBLE MER	1380.0	85.5	1264.5	28.0	142	373	1447	104	107	24	143
NORTH R. AT SEA	2299.0	157.2	1958.5	95.0	100	228	2203	41	86	16	37
KENARD AT LAKE MELVILLE	4393.0	339.0	3966.6	94.8	495	237	1847	339	125	43	41
GOOSE R. AT LAKE MELVILLE	3455.0	232.2	3026.9	192.1	344	338	4434	122	133	101	39
SOUTHWEST BRK AT SANDWICH BAY	376.0	24.2	357.9	8.5	137	210	1655	45	80	16	65
WHITE BEAR AT SANDWICH BAY	1133.0	96.4	458.7	75.4	154	228	1059	100	112	6	18
PAMILUK AT PAMILUK BAY	468.0	25.6	354.1	2.5	45	312	1033	60	66	10	22
TOM LUSCOMBE AT SEA	1021.0	53.7	946.0	19.5	87	307	1137	123	72	4	40
MULLIGAN AT LAKE MELVILLE	971.0	41.0	915.6	7.8	189	366	1863	161	95	34	101
WATERSHED 37 AT SAND HILL COVE	358.0	36.7	308.3	4.0	61	83	1358	55	32	11	18
HETCHIN ABOVE CHURCHILL	2524.0	301.3	2571.6	147.0	483	399	1106	145	156	60	23

\* SMALL AREAS OF OPEN WATER WERE DISREGARDED

\*\* B.M. = BATHYMETRIC



15      HYDROMETRIC DATA

The hydrometric data for the Province are collected, processed, and published by the Canada Department of Energy, Mines and Resources, Inland Waters Branch, in co-operation with the Province and other agencies, especially companies operating hydro-electric plants. However, there are some hydrometric data which, for various reasons, are not currently transmitted to the Inland Waters Branch. Since this latter information is neither very significant nor reliable, the hydrologic investigations for this report were based almost exclusively on the data collected and processed by the Inland Waters Branch.

15-1      Hydrometric Network

Hydrometric data are obtained in the Province at two types of hydrometric stations, conventional river gauging stations and flow reporting hydro-electric power plants (Figures 8-1 and 8-2, and Tables 15-1 and 15-2).

Most of the conventional river gauging stations were introduced in the Province in 1949. The extension of hydrometric surveys was one of the conditions under which the Province entered Confederation, and an agreement, dated March 24, 1950, for co-operative continuation of these operations was ratified by the Canada Department of Resources and Development and the Provincial Department of Natural Resources. The Department of Energy, Mines, and Resources and the Newfoundland and Labrador Power Commission are respectively the successors to the agreement.

A list showing the index number, river, gauging station, drainage area, period of record, length of record, and the type of station is presented in Table 15-1. The total number of river gauging stations is 34, with 27 in the Island and 7 in Labrador. The total area of gauged river basins is 7800 square miles for the Island or 18 percent of the area, and 37,700 square miles for Labrador or 33.4 percent of the area.

The flow-reporting hydro-electric plants have, in a few cases, longer periods of record than the conventional stream gauging stations because of the early hydro power development. These hydro-electric plants are listed in Table 15-2.

The total number of flow-reporting plants is 14, with 12 on the Island and 2 in Labrador. The drainage area above the Island's flow-reporting plants is about 6000 square miles, of which 950 square miles are gauged by river gauging stations inside these basins, so that the net area gauged by flow-reporting plants represents 5050 square miles or about 11 percent of the Island's area. The drainage area above the flow-reporting plants in Labrador is 16,200 square miles, but this area is actually a part of the conventionally gauged river basins.

Thus the total area for which there are flow data in the Province represents 12,850 square miles in Newfoundland or about 29 percent of the Island's area, and 37,700 square miles in Labrador or about 33.4 percent of the region's area.

The density of total gauging stations (river gauging plus flow-reporting plants) is, considering all stations including the discontinued ones, one station for about 1100 square miles in Newfoundland and one station for about 12,500 square miles in Labrador. According to the World Meteorological Organization<sup>1</sup> guidelines, mountainous regions of temperate zones should have a minimum network of one station for each 110 to 370 square miles (300 to 1000 square kilometers), the range provisionally tolerated in difficult conditions being one station in 370 to 1830 square miles (1000 to 5000 square kilometers), the latter figure corresponding to exceptionally difficult conditions. For arid and polar zones the range of minimum network is one station for 1800 to 7300 square miles (5000 to 20,000 square kilometers). It may be concluded that, according to these guidelines, the density of the hydrometric network is acceptable in the Island but is much too small in Labrador. Actually the needs for an expanded network station in the Island are related mainly to an improved areal distribution, rather than for increasing the density. However, in Labrador both an increased density and a better areal distribution are required as discussed in Section 22.1.

## 15.2 Analysis of Available Data

The hydrometric data available are generally of acceptable quality. However, at the river gauging stations, privately operated before 1949, the flow data are of doubtful value, and in at least one case the flows reported by the flow-reporting power plants are affected by significant errors.

### 15. 2. 1 River Gauging Stations

At these stations (Table 15-1) the Inland Waters Branch maintains stage discharge relationships and the mean daily flows are computed from the water level records. At stations with recording gauges, indicated in the table, the flow can be computed for any required time interval. The daily flows of these stations are published by the Department of Energy, Mines and Resources. Prior to 1949, gauging stations were operated on the Humber, Gander, and Salmon Rivers by interested parties and the data were published as received. Subsequent studies have indicated that some of the information may be inaccurate, and the Department has elected to discard these for several years on the Gander River below Weirs Brook and the Upper Humber River at Seal Pond. A compilation of the flows at the river gauging stations was included on a magnetic tape and made available for this study.

The Water Survey of Canada reviews its historical data for accuracy from time to time. However, to date no review has been carried out on data for the Province of Newfoundland and Labrador. There are some gaps in the data for the winter months, because of the difficulty in computing flows when levels are affected by ice and no metering was carried out. The magnetic tape was completed in December 1967 with the addition of flows for the period from October 1964 to September 1966.

As a result of the analysis of data, it was decided to disregard all daily flows prior to 1949/1950, and all monthly flows prior to 1939/1940, because of their doubtful nature and the difficulty of checking the data reliability. The most doubtful data used in the present study are the mean monthly flows of the Upper Humber River at Seal Pond which seem to have been overestimated during the winter in the period 1939 to 1951 and possibly up to 1953. A correlation analysis of the annual flows of the Upper Humber at Seal Pond, and Humber River at Deer Lake, however, has not indicated a significant shift in the correlation. A monthly correlation was also attempted with similar results. However, as shown in Section 15. 2. 2, since the monthly flows at Deer Lake may also be affected by some errors, the results of the annual flow correlations are considered as more conclusive. A simple ratio comparison of the flows at the two stations in various periods has indicated that the maximum error which might be expected in the estimation of the Upper Humber mean annual flow is 6 percent on the high side. Since measurement errors are generally larger than this error and there was no means of ascertaining and correcting the flows, the Upper Humber flows have been accepted for the period 1931 to 1966 as included on the magnetic tape.

Other errors which are less important may have occurred at various stations for the winter flows, but these were considered as not being significant for this general study. Actually, corrections of these individual flows would have required data which are not available (such as ice thickness and conditions), and any corrections based on simple correlations would probably not have improved the accuracy of the data.

The general examination of the winter flows indicates that average values of runoff are not significantly affected by these occasional errors, but the flow variation in some months may be distorted to some extent.

In addition to the above-mentioned errors, the runoff investigations reported in Section 16 indicated that the flows of the Terra Nova River at Eight Mile Bridge may be overestimated. However, flow measurement by the Department of Energy, Mines and Resources in the summer of 1968 have failed to prove or disprove this indication, and further investigations will be required to elucidate the problem. The possibility that this inconsistency in the generalized relationship for runoff obtained in Section 16 is related to an erroneous delineation of the Terra Nova River watershed should not be completely dismissed.

#### 15. 2. 2 Flow Reporting Power Plants

The flows reported by the hydro-electric plants are based on relationships between flow, sometime including head, and power, and on rating curves for gates, spillways, and other wasted flows.

The data reported by the power plants are corrected for changes in storage in appurtenant reservoirs and controlled lakes; however, this information includes errors which, in some cases, are significant for the following causes:

- a) Computations of the flow through the turbines and spilling facilities are often approximate due to unchecked co-efficients in hydraulic formulae, neglect of the variable efficiency with head and flow, possible decrease in efficiency due to temporary or persistent deterioration of facilities, and uncontrolled leakage.
- b) The method of computing the change in storage is usually based on the assumption that the level in the lake or reservoir is horizontal. Actually where the reservoir has intermediary control section, the lake surface will have a complicated slope and the actual storage variation may be different from the assumed one. For large lakes, ice and seiches can also influence the storage-elevation relationship.

- c) The corrections in storage of controlled lakes are computed as if the lake were an artificial reservoir, and the total change in storage is considered as artificial and is removed. Actually the controlled lake had a natural regulating capacity which is now discarded by the correction applied.

It should be noted that the errors in (a) may lead to a false assessment of the average flow; whereas those in (b) and (c) have no effect whatsoever on this important hydrologic characteristic. Errors (b) and (c) distort the actual distribution in time of flow, and error (c) affects the assessment of the effect of basic physiographic characteristics on flow variation.

Because the assessment of the average runoff was one of the main objectives of this study, a check of the relative importance of the errors of type (a) was required. The possibility of a significant error of this type at the Grand Falls power station on the Exploits River was detected in an earlier hydrologic study of the Island<sup>2</sup>.

The error was assessed to be of the order of 700 to 800 cfs or approximately 10 percent of the reported mean annual flow. Checks made on the flows reported by the Bishops Falls power plant, also on the Exploits River, indicate completely unreliable data, and therefore could not be used in assessing the errors at the Grand Falls station.

Further checks of type (a) errors by the Inland Waters Branch in co-operation with the Shawinigan-MacLaren study team were conducted at two power plants, Pierres Brook and Petty Harbour, and the results are shown in Figures 15-1 and 15-2.

As seen from Figure 15-1, Pierres Brook, the average flow is probably slightly overestimated if the single unit of the power plant is usually operated in the zone considered by the operators to be that of maximum efficiency (2500 to 2900 kw). If the checking results are correct, the zone of maximum efficiency seems to range from 2600 to 3600 kw. It is possible that either the measurements were in error or the plant uses an efficiency test made many years ago although the runner and penstock were replaced in recent years. The flow-output relationship used is a straight line which assumed a constant efficiency. As expected, the measurements indicate a variable efficiency resulting in an underestimation of the flow in the zones of lower efficiency and vice versa.

Figure 15-2 indicates a similar pattern at Petty Harbour, but this is more difficult to evaluate because of the complications introduced by the operation of two or more units.

It can be concluded that the curves presently in use at the two power plants are accurate enough for estimating average monthly flows. Daily flows may be affected by errors which are, however, less than 10 percent.

A general evaluation of the flow of the Humber River at the Grand Lake outlet reported by The Bowater Power Company indicates that their accuracy is generally satisfactory with a slight overestimation of the computed outflows<sup>3</sup> following the replacement of 7 of the 9 units.

Special checks of the type (b) and (c) errors have not been initiated since extensive surveys would be required which are outside the terms of reference of this study.

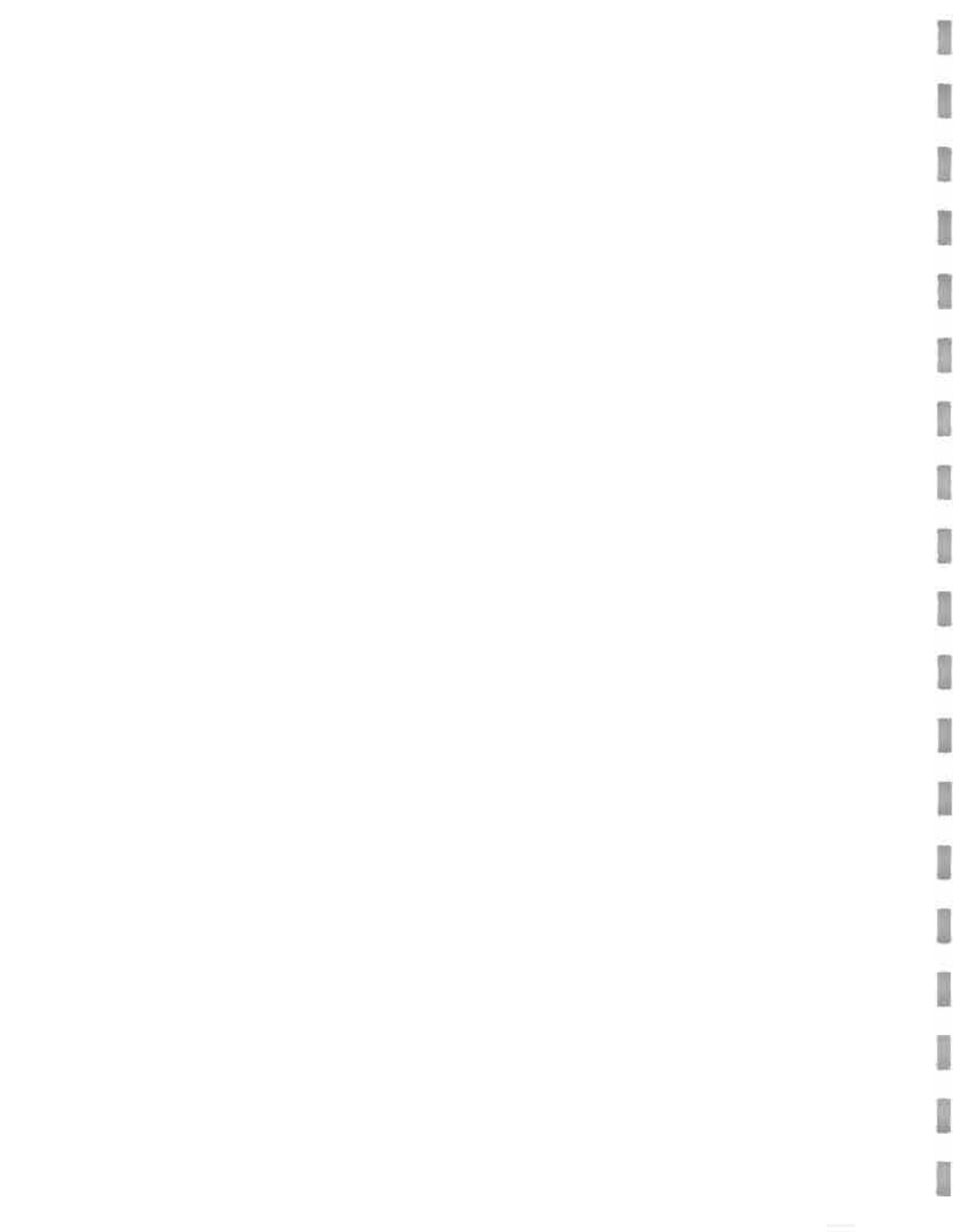
Because of the multiple errors affecting the flow data reported by power plants which short periods of time are considered, it is generally not possible to compute daily flows at these locations. Consequently, as a rule, data at flow-reporting plants were not included on the magnetic tape which was designed to store daily flow records only, although daily flows were computed and included on the tape for a few of the years. For reasons discussed above, these flows have not been considered in this study.

The monthly flows for the whole period of record at the flow-reporting power plants are published in the Water Resources Papers<sup>4</sup>. The daily flows are also published at some flow-reporting power plants.

Apart from the hydro power plants listed in Table 15-2, there is a series of hydro power plants for which partial data on flows are available but which require an intensive critical evaluation before being used in hydrologic computations. Efforts made during the present study to obtain an evaluation of these data were not successful.

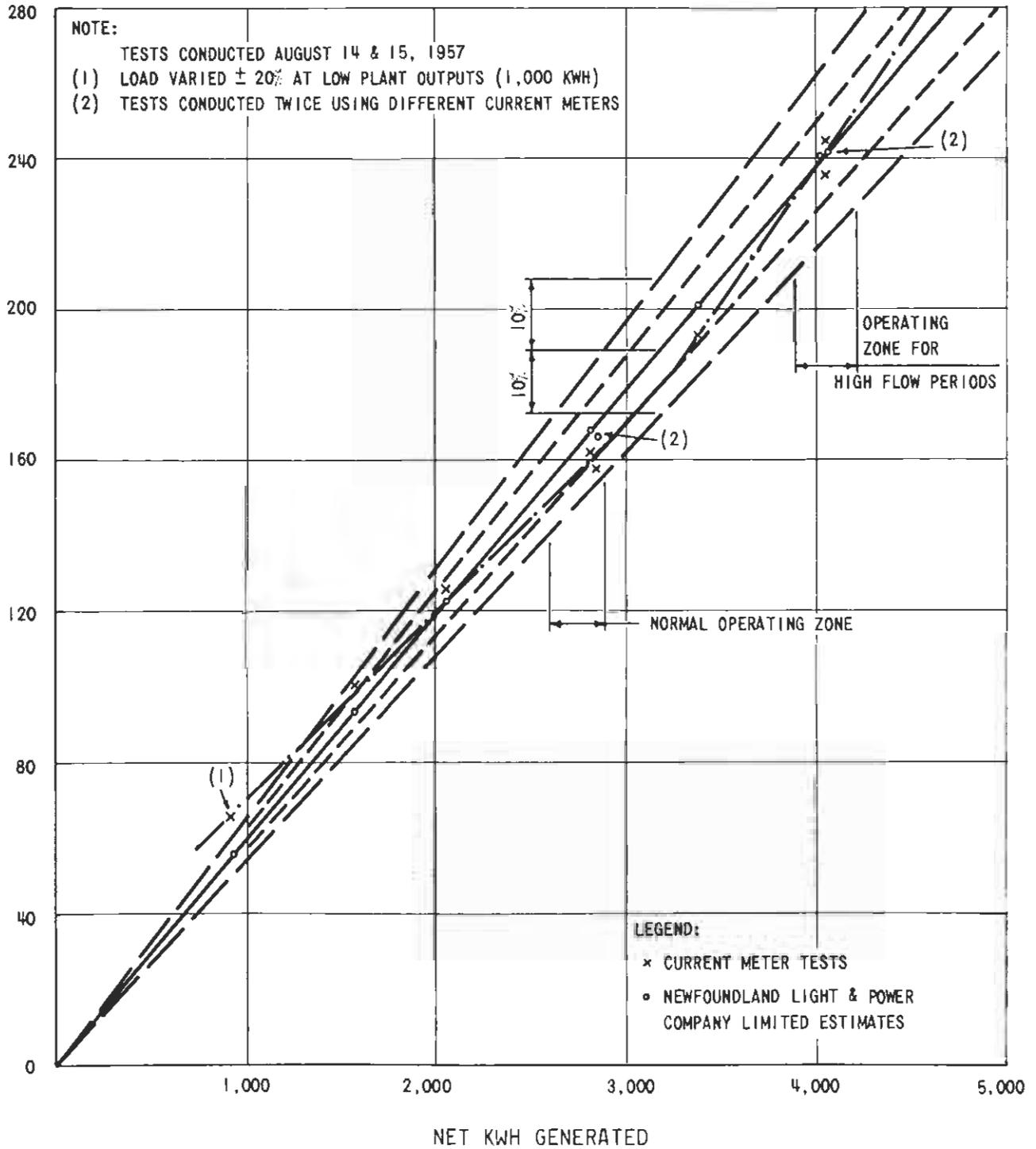
REFERENCES

- 1 World Meteorological Organization. Guide to Hydrometeorological Practices. WMO No. 168 TP 82. Geneva. 1965.
- 2 The Shawinigan Engineering Company Limited. Newfoundland Power Studies - Summary Report on Hydrology. Montreal, 1966.
- 3 Hooper, L. J. Report on Efficiency Tests, Generating Unit No. 1, Deer Lake Power Plant. The Bowater Power Company. 1962.
- 4 Canada. Department of Energy, Mines and Resources. Water Resource Paper. (Series) Ottawa, Queen's Printer.



PIERRES BROOK PLANT COMPUTED  
AND MEASURED PLANT OUTFLOW  
VERSUS NET KWH GENERATED

PLANT OUTFLOW (CFS)



PETTY HARBOUR PLANT COMPUTED  
AND MEASURED PLANT OUTFLOW  
VERSUS NET KWH GENERATED

PLANT OUTFLOW (CFS)

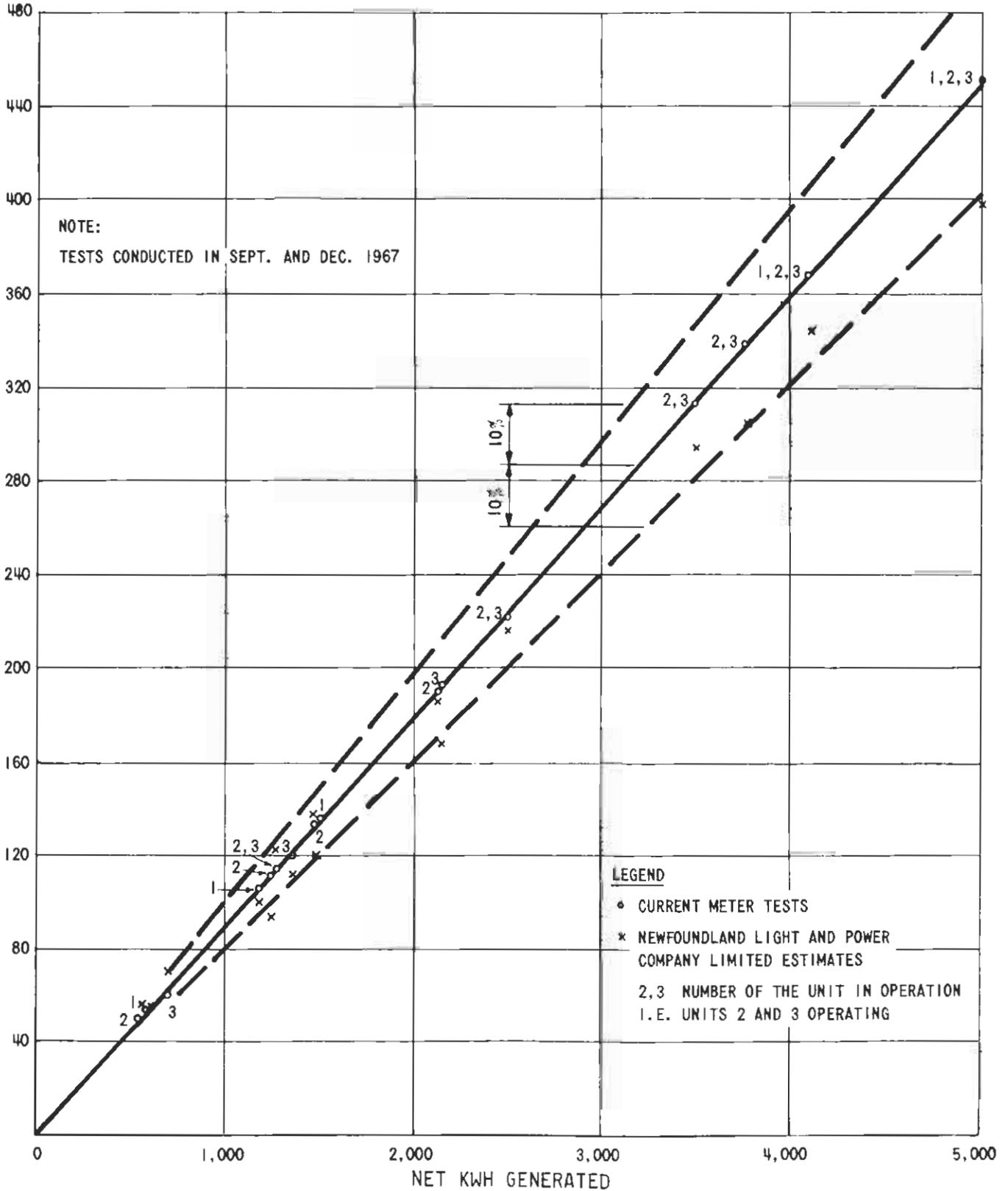


FIGURE 15-2

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND AND LABRADOR  
RIVER GAUGING STATIONS

INDEX NO.	RIVER	STATION	DRAINAGE OF (SQ. MI.)	PERIOD OF RECORDS (WATER YEAR)						LENGTH OF RECORDS (YRS)	TYPE OF STATIONS
				1900	1910	1920	1930	1940	1950		
(1)	(2)	(3)	(4)	(5)						(6)	(7)
2Y <sub>1</sub>	TONYENT R.	BRYSTOLS POOL	240							9	R
2Y <sub>2</sub>	BEAVER R.	RODDICKTON	92.2							9	R
2Y <sub>3</sub>	LIMASECON-JEECH R.	LITTLE GRAND LAKE	190							15	R
2Y <sub>4</sub>	SHEFFIELD R.	SHEFFIELD LAKE	140							13	R
2Y <sub>5</sub>	HINDS R.	NEAR GRAND LAKE	200							12	R
2Y <sub>6</sub>	UPPER NUMBER R.	SEAL POND	812							40	R
2Y <sub>7</sub>	INDIAN R.	INDIAN FALLES	284							13	R
2Y <sub>8</sub>	INDIAN R.	DIVERSION CANAL INLET	81							5	R
2Y <sub>9</sub>	VICTORIA R.	BELOW HIGHWAY BRIDGE	440							2	M
2Y <sub>10</sub>	GANDER R.	BIG CHUTE	1,090							13	R
2Y <sub>11</sub>	GANDER R.	OUTLET GANDER LAKE	1,610							17	M
2Y <sub>12</sub>	GANDER R.	BELOW MILL BARRA	2,000							5	M
2Y <sub>13</sub>	MIDDLE R.	GAMB	106							3	R 1950-1959M 1960 TO DATE W
2Y <sub>14</sub>	TERRA NOVA	EIGHT HILL BRIDGES	454							4	R 1951-1959M 1960 TO DATE W
2Y <sub>15</sub>	ROCKY POND R.	ROCKY POND	0.8							3	R
2Z <sub>1</sub>	TELE-MAIL-MORTIS R.	ABOVE HIGHWAY BRIDGE	79.5							6	R
2Z <sub>2</sub>	WHITE BEAR R.	WHITE BEAR LAKE	308							4	R
2Z <sub>3</sub>	GREY R.	PHIPPS LAKE	379							10	R
2Z <sub>4</sub>	SALMON R.	LIME POND	1,000							24	R 1934-1939M 1940 TO DATE W
2Z <sub>5</sub>	SALMON R.	ROUND POND	7.8							3	R
2Z <sub>6</sub>	SEA IN WORD R.	RID FALLS	454							15	R 1950-1959M 1960 TO DATE W
2Z <sub>7</sub>	PIPER'S HOLE R.	MOTHER'S BARRAGE	300							6	R
2Z <sub>8</sub>	CONE-BY-CHURCH R.	GOOBLES	11.8							2	M
2Z <sub>9</sub>	GARWICK R.	GARWICK	78.8							10	R
2Z <sub>10</sub>	ROCKY R.	COLIBET	110							20	R
2Z <sub>11</sub>	NORTHEAST POND R.	NORTHEAST POND	5.4							15	M
2Z <sub>12</sub>	NORTHWEST POND R.	NORTHWEST POND	20.8							2	R
3C <sub>1</sub>	CHURCHILL (HAMILTON)	FLOUR LAKE	13,000							14	R
3C <sub>2</sub>	UNKNOWN (ATHORAN)	ATHORAN RAPIDS	7,700							3	R
3C <sub>3</sub>	CHURCHILL (HAMILTON)	NEAR CHURCHILL FALLS	22,200							2	M
3C <sub>4</sub>	UNKNOWN (ATHORAN)	LAKE ST	7,700							14	R
3C <sub>5</sub>	CHURCHILL (HAMILTON)	MUSKRAT FALLS	30,400							0	R 1948-1953 1954 TO DATE W
3P <sub>1</sub>	NASKAPII R.	FREMONT LAKE	3,470							14	R
3C <sub>6</sub>	EROLE R.	ABOVE FALLS	3,900							2	R

R RECORDING GAUGE  
M MANUAL GAUGE  
COMPLETE DAILY NATURAL FLOW RECORDS  
INCOMPLETE DAILY NATURAL FLOW RECORDS  
INCOMPLETE RECORDS WITH ESTIMATED MONTHLY RUNOFF

TABLE 15-1

NEWFOUNDLAND AND LABRADOR  
FLOW REPORTING POWER PLANTS

INDEX NO.	RIVER	STATION	DRAINAGE AREA (SQ. MI.)	PERIOD OF RECORDS (WATER YEAR)						LENGTH OF RECORDS (YRS.)	REMARKS	
				1900	1910	1920	1930	1940	1950			1960
(1)	(2)	(3)	(4)	(5)						(6)		
2YK <sub>1</sub>	HUMBER R.	GRAND LAKE OUTLET	1,942	-----	-----	-----	-----	-----	-----	-----	64	
2Y0 <sub>1</sub>	EXPLOITS R.	GRAND FALLS	3,650	-----	-----	-----	-----	-----	-----	-----	48	
2Y0 <sub>2</sub>	RATTLING B.	NORRIS ARM	148	-----	-----	-----	-----	-----	-----	-----	3	
2Y0 <sub>3</sub>	RATTLING B.	RATTLING LAKE	146	-----	-----	-----	-----	-----	-----	-----	9	
2Y0 <sub>4</sub>	SANDY B.	POWER HOUSE	196	-----	-----	-----	-----	-----	-----	-----	4	
2ZL <sub>1</sub>	HEARTS CONTENT R.	SOUTH WEST COVE POND	35.5	-----	-----	-----	-----	-----	-----	-----	19	
2ZL <sub>2</sub>	NEW CHELSEA B.	SEAL COVE POND	28	-----	-----	-----	-----	-----	-----	-----	11	
2ZM <sub>1</sub>	PETTY HARBOR JR R.	SECOND POND	53.4	-----	-----	-----	-----	-----	-----	-----	37	
2ZM <sub>2</sub>	PIERRE'S B.	GULL POND	45.1	-----	-----	-----	-----	-----	-----	-----	37	
2ZM <sub>3</sub>	MOBILE R.	MOBILE FIRST POND	43.4	-----	-----	-----	-----	-----	-----	-----	17	
2ZM <sub>4</sub>	HORSE CHOPS R.	CAPE BROYLE	34	-----	-----	-----	-----	-----	-----	-----	2	
2ZM <sub>5</sub>	SEAL COVE R.	WHITE HILL POND	30	-----	-----	-----	-----	-----	-----	-----	21	
30A <sub>1</sub>	ASHUANUPI R.	MENIHEK RAPIDS	7,400	-----	-----	-----	-----	-----	-----	-----	16	
30A <sub>2</sub>	UNKNOWN (ATI KOWAK) R.	TWIN FALLS	8,800	-----	-----	-----	-----	-----	-----	-----	6	

 MONTHLY NATURAL FLOW ESTIMATED FROM HYDRO-PLANT RECORDS  
 INCOMPLETE HYDRO PLANT RECORDS  
 HYDRO PLANT DAILY OUTFLOW RECORDS

TABLE 15-2

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

Index No.	River	Station	Period of Record	Monthly Flow cfs												Average Annual Flow		Extreme Daily Flows		
				January	February	March	April	May	June	July	August	September	October	November	December	cfs per sq. mi.	cfs	Date		
NEWFOUNDLAND																				
ZYC <sub>1</sub>	Torrent River	Bristol's Pond	1952-66	Max	474	553	840	1,023	1,224	1,068	1,270	1,219	1,140	1,267	1,269	1,245	8.57	5.26	8,400	21/5/66
				Mean	291	296	257	348	2,361	2,339	731	729	591	811	847	578			78	9/3/61
				Min	181	109	80	209	1,625	1,500	511	297	292	227	339					
ZYD <sub>1</sub>	Beaver River	Riddickton	1959-66	Max	355	129	260	332	1,631	1,418	408	271	240	444	738	347	4.15	3.40	5,790	29/5/61
				Mean	111	65	107	257	1,275	825	182	154	111	196	342	160			11	23/8/60
				Min	39	25	21	68	350	356	45	17	43	90	139	72				
ZYK <sub>2</sub>	Lewasa-techjeech Brook	Little Grand Lake	1952-66	Max	1,131	392	688	1,225	1,918	1,155	670	533	1,008	863	1,290	1,194	5.62	5.12	3,420	4/10/57
				Mean	454	233	260	602	1,414	807	343	301	387	599	742	602			40	22/8/60
				Min	175	82	82	218	665	409	174	77	193	288	485	361				
ZYK <sub>3</sub>	Sheffield River	Sheffield Lake	1955-66	Max	575	323	444	639	1,654	1,447	309	280	371	499	678	455	3.56	2.41	3,260	11/5/60
				Mean	269	186	196	572	1,180	64	196	138	160	228	296	222			23	12/9/60
				Min	131	89	99	191	496	295	125	56	40	101	174	173				
ZYK <sub>4</sub>	Hinds Brook	Near Grand Lake	1956-66	Max	699	397	435	864	1,780	1,896	831	448	670	664	1,204	868	5.20	2.60	3,960	6/6/63
				Mean	171	225	214	458	1,498	923	333	246	290	452	347	567			39	11/9/60
				Min	168	104	127	191	829	512	192	89	93	232	320	407				
ZYL <sub>1</sub>	Upper Harriner River	Seal Pond	1928-66	Max	3,827	3,648	3,631	10,170	13,198	12,491	9,525	3,495	4,815	3,868	6,259	4,165	2,976	5.65	28,100	30/11/35
				Mean	1,777	1,415	1,597	3,610	5,689	5,667	1,866	1,306	1,106	2,312	3,423	2,301			56	31/8/30
				Min	528	377	408	873	4,810	1,691	527	138	484	871	1,621	521				
ZYM <sub>1</sub>	Indian Brook	Indian Falls	1954-66	Max	2,850	593	1,017	1,678	4,059	2,040	783	850	833	1,342	1,281	1,199	7.49	2.64	8,280	11/5/60
				Mean	762	347	483	1,038	2,382	905	336	268	333	560	689	626			29	11/9/60
				Min	197	124	141	307	1,099	459	171	76	86	242	496	396				
ZYM <sub>2</sub>	Indian Brook	Diversion Canal Inlet	1963-66	Max	218	125	261	474	867	348	204	155	162	180	173	180	1.78	1.94	1,350	18/4/66
				Mean	127	68	136	286	605	190	101	92	86	131	145	137			8	6/9/65
				Min	45	24	37	94	475	61	61	22	8	98	146	137				
ZYD <sub>2</sub>	Gander River	Big Chute	1949-66	Max	11,794	5,801	5,394	15,709	14,484	8,482	5,024	5,169	4,344	5,579	8,335	7,765	1,017	2.37	25,300	19/8/61
				Mean	4,181	3,120	3,424	7,558	9,261	3,659	1,821	1,720	1,692	2,398	4,772	4,599			98	25/9/61
				Min	1,170	653	809	4,141	3,188	1,515	754	289	147	349	1,315	2,247				
ZYQ <sub>2</sub>	Gander River	Outlet Gander Lake	1923-39	Max	7,179	8,023	8,699	20,824	22,574	6,247	5,689	2,661	3,545	8,940	7,288	7,135	3,111	2.56	41,500	12/5/26
				Mean	3,027	2,507	3,410	8,490	10,046	3,436	2,381	1,219	1,602	3,916	4,737	4,653			100	30/9/33
				Min	895	934	743	3,252	3,034	1,631	825	523	270	829	1,374	1,940				
ZYR <sub>1</sub>	Middle Brook	Garbo	1959-66	Max	687	289	620	765	790	382	161	100	140	226	496	296	2.28	2.16	1,410	5/1/63
				Mean	241	193	266	497	333	243	106	56	64	102	241	196			25/9/61	
				Min	120	66	76	358	354	161	60	17	5	8	38	116				
ZYS <sub>1</sub>	Ferra Nova River	Eight Mile Bridge	1951-66	Max	3,766	3,315	2,921	5,100	8,597	1,894	1,197	2,313	2,485	1,790	3,319	2,737	1,390	3.03	11,400	20/4/64
				Mean	1,705	1,198	1,188	2,752	2,191	894	631	808	808	1,029	1,806	1,668			84	27/7/57
				Min	485	340	536	546	490	322	95	152	151	217	472	888				
ZYP <sub>1</sub>	Isle aux Morts	Above Highway Bridge	1962-66	Max	425	209	374	673	1,361	342	448	437	604	645	304	408	4.53	5.70	5,070	18/11/65
				Mean	222	141	241	429	1,112	621	332	164	408	424	719	429			32	7/4/64
				Min	121	84	47	198	972	412	178	231	264	199	548	377				

NEWFOUNDLAND AND LABRADOR

SUMMARY OF FLOW DATA AT  
SELECTED RIVER GAUGING STATIONS

NOTE: The flows in this table are recorded flows.  
Data abstracted from Water Resources Papers, Surface Water Data for Atlantic Drainage, Department of Energy, Mines and Resources.

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Index No.	River	Station	Period of Record		Monthly Flow cfs												Average Annual Flow		Extreme Daily Flows	
					January	February	March	April	May	June	July	August	September	October	November	December	cfs	sq. mi.	cfs	Date
NEWFOUNDLAND																				
22D <sub>1</sub>	Grey River	Fudops Lake	1958-66	Max	2,454	920	1,442	1,690	2,754	1,457	1,055	755	1,225	1,339	2,484	1,905	965	2.54	3,540	17/5/61
				Mean	876	850	860	1,211	2,020	1,034	623	486	397	774	1,408	1,222				
				Min	95	358	370	778	1,527	633	485	185	97	333	745	743				
22E <sub>1</sub>	Salmon River	Long Pond	1944-65	Max	7,725	4,942	5,468	9,278	10,067	5,999	2,821	3,182	3,211	3,964	6,877	6,647	2,754	2.70	13,800	26/12/54
				Mean	3,080	2,424	2,048	4,218	5,535	2,609	1,420	1,258	1,214	1,705	3,642	3,890				
				Min	1,274	711	716	2,289	2,365	1,187	643	252	147	186	512	1,887				
22F <sub>1</sub>	Bay du Nord	Big Falls	1950-65	Max	5,295	2,890	2,814	5,819	2,882	1,181	1,092	2,148	1,601	2,155	2,993	2,858	1,352	2.95	6,490	2/4/62
				Mean	1,700	1,474	1,349	2,143	1,782	973	677	713	727	865	1,648	1,929				
				Min	824	411	762	854	1,011	538	306	189	87	219	508	734				
22G <sub>1</sub>	Garnish River	Garnish River	1958-66	Max	655	483	555	807	553	244	220	269	382	594	489	523	265	5.40	2,680	12/10/64
				Mean	288	303	314	520	301	190	129	140	156	219	338	318				
				Min	131	128	96	358	111	136	48	7	8	69	167	205				
22H <sub>1</sub>	Pipers Hole River	Motheas Brook	1952-66	Max	2,637	2,260	2,303	3,364	1,002	1,203	599	392	1,408	1,471	2,118	1,585	846	2.81	12,900	15/4/64
				Mean	902	855	877	1,797	978	514	317	294	455	726	1,277	1,078				
				Min	372	240	458	630	395	190	65	16	6	202	525	425				
22K <sub>1</sub>	Rocky River	Colinet	1948-66	Max	1,005	1,018	668	1,243	496	477	391	308	498	722	864	1,033	575	5.41	6,000	11/2/62
				Mean	565	482	431	578	317	194	149	189	207	331	573	545				
				Min	246	134	113	352	124	72	29	18	22	131	139	266				
22M <sub>6</sub>	Northwest Pond	Northwest River	1953-66	Max	14	13	11	18	15	9	5	5	6	10	14	13	5	5.57	190	19/12/64
				Mean	6	5	6	9	7	3	2	2	2	4	7	6				
				Min	2	1	2	4	2	1	0	0	0	1	2	3				
LABRADOR																				
20B <sub>2</sub>	Churchill (Hamilton) River	Flour Lake	1955-66	Max	19,132	13,318	11,510	11,740	32,184	97,780	105,484	62,665	47,377	40,545	43,810	32,352	26,990	2.06	134,000	3/7/56
				Mean	11,456	8,701	7,477	6,844	17,947	73,451	59,732	37,072	31,700	30,483	23,761	15,929				
				Min	8,216	6,497	5,222	4,829	6,825	45,759	39,181	24,155	15,740	19,555	14,600	9,000				
20D <sub>3</sub>	Unknown (Atkinson) River	Lake 51	1958-64	Max	8,960	7,920	7,280	7,660	17,513	48,167	32,929	25,271	25,711	23,245	16,840	11,019	11,670	1.51	52,700	17/6/59
				Mean	5,315	4,273	3,536	2,893	8,802	32,265	25,403	15,618	13,249	12,150	9,733	7,127				
				Min	1,450	1,160	892	854	1,150	16,451	7,794	5,324	2,045	2,226	2,110	1,700				
20E <sub>1</sub>	Churchill (Hamilton) River	Muskrat Falls	1948-66	Max	28,713	25,346	24,916	25,989	90,671	189,233	187,548	106,048	95,533	79,545	70,917	57,010	36,318	1.85	241,000	27/6/57
				Mean	23,030	18,392	16,047	15,620	62,199	147,901	110,418	72,124	71,272	64,985	46,770	30,872				
				Min	18,026	12,957	9,796	9,879	19,949	101,903	59,881	31,259	24,057	27,616	27,173	19,582				
20F <sub>1</sub>	Naskaupi River	Fremont Lake	1955-66	Max	7,050	6,360	6,240	5,950	7,316	11,730	14,865	13,710	12,675	12,023	8,780	7,690	7,292	2.10	14,800	19/6/59
				Mean	5,730	5,034	4,580	4,288	5,345	10,782	10,154	10,058	9,510	7,775	7,794	6,680				
				Min	4,468	3,970	3,543	3,177	3,114	7,563	7,804	6,465	5,288	4,188	5,723	5,067				

NOTE: The flows in this table are recorded flows.  
Data abstracted from Water Resources Papers, Surface Water Data for Atlantic Drainage, Department of Energy, Mines and Resources.

NEWFOUNDLAND AND LABRADOR

SUMMARY OF FLOW DATA AT  
SELECTED RIVER GAUGING STATIONS

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Index No	River	Station	Period of Record	Monthly Flow cfs												Average Annual Flow		
				January	February	March	April	May	June	July	August	September	October	November	December	cfs	cfs per sq. mi.	
NEWFOUNDLAND																		
2YK <sub>1</sub>	Humber River	Grand Lake Outlet	1898-04	Max	8,990	6,550	11,300	13,600	22,500	13,014	9,560	7,480	8,590	10,994	9,290	8,990	4,790	2.46
			1906-08	Mean	2,995	2,423	2,564	6,112	14,794	5,994	2,964	2,839	2,944	5,814	4,039	2,995		
			1914-66	Min	1,060	617	1,010	2,090	5,360	2,750	1,350	740	730	2,210	1,530	1,060		
2YO <sub>1</sub>	Exploits River	Grand Falls	1914-21	Max	16,300	14,300	16,178	21,400	35,800	16,700	8,460	12,800	11,200	18,798	17,400	15,000	7,518	2.06
			1928-66	Mean	6,269	4,654	4,769	11,064	21,326	7,644	4,151	4,096	4,300	9,922	6,743	5,274		
				Min	1,640	0	20	3,150	6,650	3,640	188	226	0	1,560	1,720	1,110		
2YO <sub>3</sub>	Rattling Brook	Rattling Lake	1959-66	Max	775	680	735	1,012	2,570	1,110	370	575	505	758	845	1,084	372	2.55
				Mean	267	237	254	540	1,244	371	167	167	201	446	302	270		
				Min	80	35	55	140	295	140	15	0	0	75	85	60		
2ZL <sub>1</sub>	Hearts Content River	South West Cove Pond	1949-66	Max	340	202	283	423	314	123	93	83	157	232	230	210	110	3.10
				Mean	140	127	131	197	141	74	32	33	52	94	160	140		
				Min	47	15	49	68	46	19	5	0	0	2	37	96		
2ZL <sub>2</sub>	New Chelsea Brook	Seal Cove Pond	1957-66	Max	239	177	179	301	221	70	58	42	94	162	205	154	76	2.71
				Mean	80	79	129	162	115	35	19	15	25	54	109	98		
				Min	26	1.2	27	85	19	17	0	0	0	0	34	71		
2ZM <sub>1</sub>	Petty Harbour River	Second Pond	1931-66	Max	321	484	394	794	582	337	130	201	303	574	402	608	197	3.69
				Mean	173	222	261	379	255	109	58	68	99	259	245	234		
				Min	33	73	81	158	93	8	11	0	1	64	121	73		
2ZM <sub>2</sub>	Pierre's Brook	Gull Pond	1931-66	Max	296	398	390	530	382	243	136	169	262	438	400	477	159	3.53
				Mean	150	179	205	295	171	95	51	64	92	217	198	186		
				Min	42	57	57	129	55	11	8	0.3	3	77	54	40		
2ZM <sub>3</sub>	Mobile River	Mobile First Pond	1931-66	Max	448	394	393	676	386	236	169	188	263	344	548	444	192	4.44
				Mean	185	212	233	308	215	125	89	103	126	249	235	227		
				Min	106	88	87	150	88	55	45	0	9	82	117	134		
2ZM <sub>5</sub>	Seal Cove River	White Hill Pond	1947-66	Max	336	280	327	413	272	150	73	126	144	212	274	242	116	3.87
				Mean	100	138	150	204	129	69	44	51	65	149	145	147		
				Min	49	47	58	91	53	24	12	0	0	16	58	66		
LABRADOR																		
3OA <sub>1</sub>	Ashuanipi River	Menihok Rapids	1954-66	Max	6,790	7,240	6,260	6,280	38,090	56,640	35,790	22,340	25,340	21,300	16,000	9,220	13,907	1.81
				Mean	5,435	5,042	4,681	4,681	18,864	39,886	22,889	17,120	16,222	14,981	10,094	6,988		
				Min	4,040	2,990	2,720	3,060	4,380	18,660	11,080	7,320	5,800	8,320	6,410	4,900		
3OD <sub>2</sub>	Unknown (Atikonak)	Twin Falls	1962-66	Max	8,979	10,604	6,212	7,601	19,713	54,554	51,550	35,053	24,411	21,257	16,446	11,290	16,571	1.88
				Mean	7,321	7,059	5,317	5,624	15,386	42,436	37,635	25,513	19,458	14,098	10,262	8,747		
				Min	4,681	3,925	3,338	3,202	10,489	39,967	27,816	17,322	16,078	9,238	4,615	5,473		

NEWFOUNDLAND AND LABRADOR

SUMMARY OF FLOW DATA  
AT FLOW REPORTING  
HYDRO-ELECTRIC PLANTS

NOTE: Data abstracted from Water Resources Papers, Surface Water Data for Atlantic Drainage, Department of Energy, Mines and Resources.

16 AVERAGE RUNOFF DISTRIBUTION

The average runoff and flow is an important hydrologic characteristic, especially under the conditions prevailing in the Province, since it is frequently possible to obtain storage for regulation. Although data on average flow of most of the major rivers and some of the smaller ones are available or can be estimated by correlation, very little is known of the distribution of the runoff; this makes it very difficult to assess properly the variation of the flow along the major rivers, the significance of the tributaries, and consequently the availability of water even in basins gauged at their outlet or somewhere along the main stem.

16.1 Combined Use of Meteorologic and Hydrologic Data  
for Obtaining Average Runoff Distribution Results

It was shown in Section 8.5 that, because of lack of meteorological stations in the interior of the Island and generally in Labrador, it is very hard to estimate with any degree of accuracy the mean annual precipitation distribution in the Province. As an illustration of the difficulty of assessing the precipitation from rain gauging stations only, Figure 8-12A reproduces the average annual isohyets in the Island, as suggested by a recent unpublished study of the Department of Transport, Meteorological Branch. Data on mean runoff at stations with long records are superimposed. The comparison indicates that in a few places the precipitation is lower than the recorded runoff. If consideration is also given to evaporation, the extent of the error becomes more evident.

In Section 8.5 it was shown that preliminary relationships between mean precipitation at rain gauging stations and their physiographic characteristics have been obtained (Tables 8-10 and 8-11), and that final relationships were derived by combining the meteorologic and hydrologic data (Tables 8-12, 8-13, and 8-14). As indicated in that section, the final relationships were obtained by combining precipitation and runoff data which also permitted obtaining generalized relationships between runoff and physiographic characteristics. The basic data and the method used to obtain these relationships are described in this section.

The basic runoff data were those obtained in 25 watersheds in the Island and 7 in Labrador (river gauging stations and flow-reporting power plants) as shown in Table 16-1. The average flow was computed for a period of 27 years (1939/40 to 1965/66 which was considered in this study to be close enough to a standard normal hydro-meteorologic period and which includes most of the usable recorded data. Missing

data which are indicated in Tables 15-1 and 15-2 were completed by correlation using monthly or annual flows. In some cases, when monthly flows were used, several seasonal or monthly correlations have been delineated (Figure 16-1). The flows used in the regional analysis have been as included in the Inland Waters Branch tape or, when not included in the tape, as published in the Water Resources Papers. A weight proportional to the years of record has been allotted to each basin. Only one of the flows was corrected, that of the Exploits River where a flow of 700 cfs was added to account for the different errors included in reporting the flows at Grand Falls plant. (Section 15.2.2)

In combining the runoff data as listed in Table 16-1 with the precipitation data, the approach consisted of the following:

- a) The correlation equations given in Tables 8-10 and 8-11, relating precipitation at gauging stations to their physiographic characteristics, were used with the file on physiographic characteristics of the grid squares to make a preliminary assessment of the precipitation distribution in the watersheds with flow data.
- b) The correlation equations given in Tables 8-4 and 8-5, relating temperature at gauging stations to their physiographic characteristics, were used with the file on physiographic characteristics of the grid squares to make an assessment of the temperature distribution in the watersheds with flow data.
- c) Turc's equation<sup>1</sup> relating actual evaporation  $E$  to mean precipitation  $P$  and mean temperature  $T$  of an area was then used with the precipitation and temperature data for each square for a preliminary assessment of actual evaporation and runoff (as difference between precipitation and evaporation) for each square of the watersheds with flow data.
- d) The preliminary runoff as established under (c) was used to compute a preliminary average runoff and flow on each of the basins with flow data, and coefficients  $K$  representing the ratio between the recorded and computed average flow were established. The values of  $K$  obtained in the first trial are shown in Table 16-1.
- e) A new precipitation distribution was computed in each square of the basins with flow data, using  $K$  as a correction factor, as follows:

Precipitation (corrected) = K Runoff + Evaporation where Runoff and Evaporation correspond to the previous estimates. The error was thus assumed to be included completely in precipitation since, for the high values of the precipitation and low values of the temperature, characteristic for the Province. Turc's formula indicates little change in the corresponding evaporation for significant changes in precipitation.

- f) With the corrected values of the precipitation estimated in the squares and the precipitation data at rain gauging stations, a new correlation between precipitation and physiographic factors was established (in which the rain gauging stations data have a weight a hundred times larger than the precipitation estimated in each square).
- g) The computation was then repeated as many times as required to obtain K as close to 1 as considered to be reasonable, taking into account that individual runoff values are probably affected by errors up to 6 percent.

For this computation, the limits set for K were between 1.1 and 0.9. However, it was found that it was impossible to reduce K to less than 1.17 for two basins - the Terra Nova basin at Eight Mile Bridge and the Mobile River at Mobile First Pond (Table 16-1). It is surmised that the flows of the Terra Nova River are overestimated because of errors in the stage-discharge relationship. It is possible that the error is also due, at least partially, to the fact that the drainage basin of this river is not very well defined. With respect to the Mobile River, it might be that the error is primarily in the computation of the average runoff from the grid because of the very small size of the river basin (43.4 square miles).

As shown in Table 16-1, most of the final values of K are higher than 1, and this indicates that, generally, the estimate of runoff by the suggested method will be on the conservative side.

The correlation between corrected precipitation in squares plus precipitation at gauging stations and physiographic factors obtained after the last runoff iteration was considered as the final correlation for precipitation (Tables 8-12, 8-13, and 8-14).

The values of the computed runoff, from the last iteration in each of the squares of the basins with flow data multiplied by the final values of K, were correlated with the corresponding physiographic characteristics. The physiographic characteristics used in the precipitation correlations, as indicated in Section 8.5, were related mostly to topographic conditions and geographic location with respect to principal humidity sources and dominant winds. In the runoff analysis a series of new characteristics which might influence the runoff (proportion of forest, lake, swamp areas, and depth of overburden) were added. Although these factors may also influence the precipitation and temperature distribution, it should be pointed out that it is hard to link such physiographic characteristics to a rain gauging station.

In the course of the iterative computations it became apparent from the examination of the relative errors that better correlations can be obtained if the Island is divided into two sub-regions corresponding roughly to two main and distinct physiographic areas; the western sub-region characterized by relatively high ridges and steep slopes, and the eastern sub-region with lower elevations and gentler slopes. This division is indicated in Figure 16-2. Accordingly, after the preliminary distribution of precipitation, the iterative computations were carried out separately for each sub-region.

The equations of the final runoff - physiographic characteristics correlation are shown in Tables 16-2, 16-3, and 16-4. The square grid distribution of the average runoff in the Province obtained as a result of the above-described computations is shown in Figures 16-2 and 16-3.

#### 16.2 Appreciation of Average Runoff Distribution Results

The coefficients of the runoff correlations are high for all three regions. However, these statistics do not help in establishing the reliability of the correlations since the data themselves have been derived by using a correlation with part of the independent variables. More significant are the checks done by using flow data at stations not included in the correlation because of brevity of the record period. At a few of these stations, some of them of particular interest from a practical viewpoint, the flows have been estimated both from the short records available (not less than a year), by correlation with neighbouring stations and from the above-mentioned correlations with physiographic factors. The results are shown in Table 16-5. As indicated by the table, the runoff computed from the results obtained using the square grid technique are always lower than those obtained from direct flow data

completed by correlation with neighbouring stations. This is a result of the fact that the precipitation data are underestimated, whereas some of the river gauging station flows are overestimated during the winter because of snow and ice effects. The runoff estimation method being based on both series of data, the results obtained are near the average and include reasonable corrections for both series of data.

Thus these preliminary results seem to indicate that the reliability of the method is satisfactory for the purpose of this study. It is felt, however, that further checks of the results are required, especially in the western region of the Island where the errors affecting the earlier flow of the Upper Humber River, and those derived by correlation with this river for basins located in the Great Northern Peninsula, may have resulted in a slightly distorted picture of the runoff distribution in this area. A very important feature of the runoff correlations described above is that generally dependent variables have the sign one would expect them to have from deterministic considerations. This is less true for the Labrador results where the correlations for precipitation and temperature were based on the indications obtained from isolines drawn by the Department of Transport, Meteorological Branch, rather than on actual data. Obviously one cannot interpret these correlations as deterministic equations because of the statistical methods which were used to establish them, and of the implications related to the complex inter-correlations between the independent variables. There are also some differences in the way in which the variables indicating the influence of the distance from the center of the square to the sea in different directions enter into the correlations. It is felt that these differences can be explained mainly by the topographic dissimilarities between the two regions and the variation in the orographic effects of the dominant winds.

Although the correlations obtained seem to be reliable, caution should be observed in using them for small basins (less than 200 square miles) since, in such cases, by computing the physiographic factors, errors may be introduced. For these basins a more refined analysis of the physiographical factors based on a grid with smaller intervals would be required. Nevertheless, a first approximation of the runoff in these basins can be obtained from these correlations as shown by the results obtained in Table 16-5.

For the purpose of this report the average flow along the main stem and major tributaries of the river basins selected for more advanced studies have been computed using the runoff-physiographic relationships, and the results of these computations are shown in Volume Four, Section 1.1.

It is interesting to mention, in concluding this section, the average data of the simplified water budget for the Province:

	<u>Island</u>	<u>Labrador</u> (South of 56°30'N Lat)
	inches/year	
Precipitation	55.9	32.1
Runoff	42.9	23.9
Evaporation	13.0	8.2

REFERENCES

- 1 Turc, L. Le bilan d'eau des sol. Relation entre les précipitation, l'évaporation et l'écoulement. Ann. Agrom. 5, 1954.



CORRELATION OF MEAN MONTHLY RUNOFF OF WHITE BEAR  
 RIVER AT WHITE BEAR LAKE, AND THE AVERAGE MEAN MONTHLY  
 RUNOFF OF THE LEWASEECHJEECH BROOK AT LITTLE GRAND LAKE  
 AND SANDY BROOK AT SANDY BROOK POWERHOUSE  
 (PRODUCED BY COMPUTER - PLOTTER)

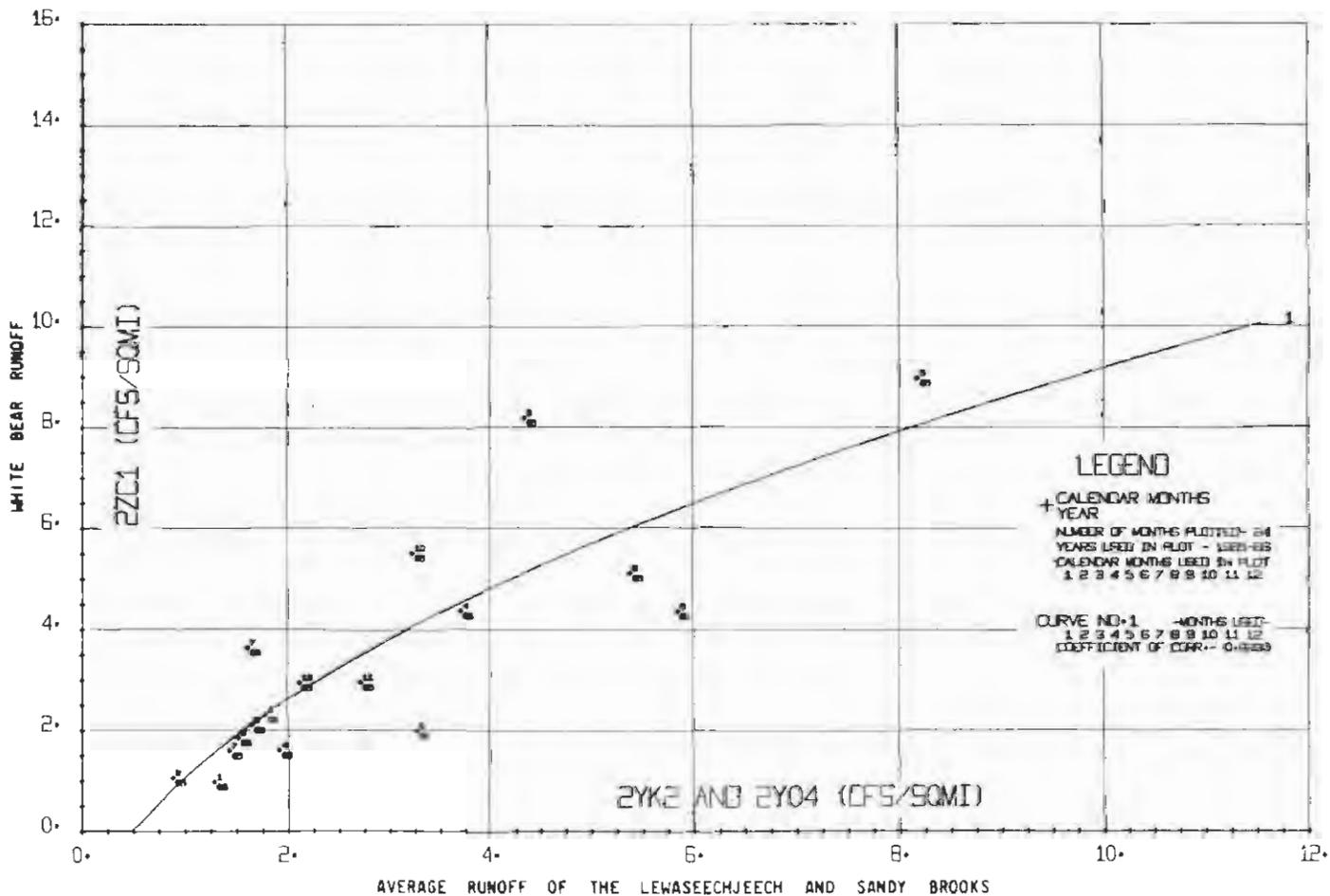


FIGURE 16-1

NEWFOUNDLAND  
 SQUARE GRID DISTRIBUTION OF  
 AVERAGE RUNOFF

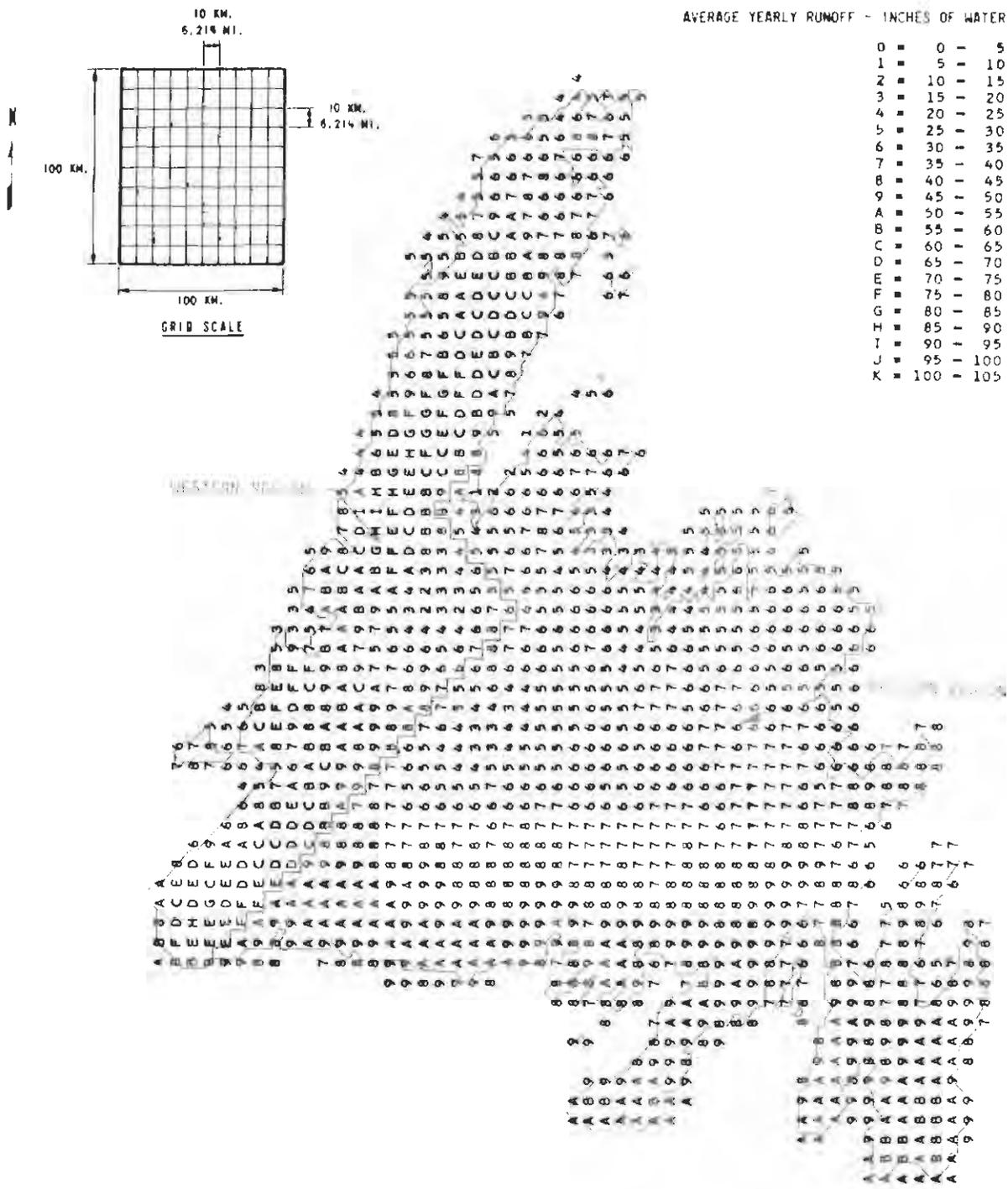
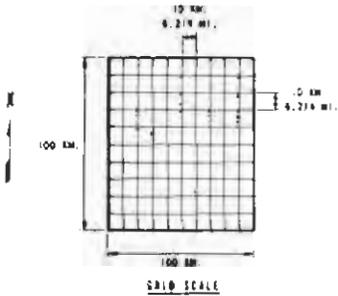


FIGURE 16-2

LABRADOR  
 SQUARE GRID DISTRIBUTION  
 OF AVERAGE ANNUAL RUNOFF



AVGE RUNOFF - INCH/YEAR\*100 -

0	=	1000	-	1099
1	=	1100	-	1199
2	=	1200	-	1299
3	=	1300	-	1399
4	=	1400	-	1499
5	=	1500	-	1599
6	=	1600	-	1699
7	=	1700	-	1799
8	=	1800	-	1899
9	=	1900	-	1999
A	=	2000	-	2099
B	=	2100	-	2199
C	=	2200	-	2299
D	=	2300	-	2399
E	=	2400	-	2499
F	=	2500	-	2599
G	=	2600	-	2699
H	=	2700	-	2799
I	=	2800	-	2899
J	=	2900	-	2999
K	=	3000	-	3099
L	=	3100	-	3199
M	=	3200	-	3299
N	=	3300	-	3399
O	=	3400	-	3499
P	=	3500	-	3599
Q	=	3600	-	3699
R	=	3700	-	3799
S	=	3800	-	3899
T	=	3900	-	3999
U	=	4000	-	4099
V	=	4100	-	4199
W	=	4200	-	4299
X	=	4300	-	4399
Y	=	4400	-	4499
Z	=	4500	-	4599





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A - NEWFOUNDLAND

B - LABRADOR

Station No.	Recorded Average Discharge C. F. S.	Initial K <sup>*</sup>	Final K <sup>*</sup>	Station No.	Recorded Average Discharge C. F. S.	Initial K <sup>*</sup>	Final K <sup>*</sup>
2YC1	915	1.3324	.9916	30A1	13900	0.8870	1.0169
2YD1	359	1.6108	1.0534	30B2	25200	0.9152	1.0094
2YK1	4790	.9388	.9700	30C1	19600	0.7239	0.9607
2YK2	591	1.0010	1.0203	30E1	30900	0.7215	0.9968
2YK3	370	1.0099	1.0482	3PB1	8970	0.8235	1.0061
2YK4	522	.8604	1.0212				
2YL1	2924	1.2796	1.0090				
2YM1	920	1.0248	1.0395				
2Y01	8205	.8821	.9676				
2Y03	372	.9509	.9881				
2YQ1	4122	1.1062	1.0085				
2YR1	243	1.0555	.9337				
2YS1	1392	1.2964	1.1557				
2ZB1	435	1.3808	1.0382				
2ZD1	990	.9202	.9472				
2ZE1	2840	1.0054	.9824				
2ZF1	1369	1.0770	1.0107				
2ZH1	849	1.0649	.9379				
2ZG1	288	1.1559	1.0109				
2ZK1	372	1.1741	1.0257				
2ZM1	197	1.0977	1.0246				
2ZM2	158	1.0612	.9513				
2ZM3	191	1.3016	1.1462				
2ZM5	116	1.1367	1.0213				
2ZM6	5	1.0819	.9637				

K<sup>\*</sup> = RATIO BETWEEN RECORDED AND ESTIMATED FLOW  
INITIAL FROM ESTIMATED PRECIPITATION AND EVAPORATION  
FINAL FROM CORRELATION BETWEEN RUNOFF AND PHYSIOGRAPHIC FACTORS

NEWFOUNDLAND AND LABRADOR  
RATIO BETWEEN RECORDED AND  
AND COMPUTED AVERAGE FLOW  
AT HYDROMETRIC STATIONS

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND - EASTERN REGION  
CORRELATION BETWEEN  
RUNOFF AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 18

F LEVEL 1.914

STANDARD ERROR OF DEP VARIABLE = 257.4292

CONSTANT 6193.8264

R 239

VARIABLE	COEFF	STANDARD ERROR/	
X - 1	-47.74218780	5.42922050	LATITUDE (1) COORDINATE OF SQUARE IN MASTER FILE SEE APPENDIX A
X - 3	-142.16403239	71.09774798	AREA OF FOREST / AREA OF LAND
X - 4	-138.40454143	100.03375262	AREA OF SWAMP / AREA OF LAND
X - 5	-2.41144228	0.39684408	OVERBORROW COEFFICIENT
X - 6	17.16999058	3.50809288	SHORTEST DISTANCE TO THE SEA (KILOMETERS)
X - 8	-3.09036493	1.81570268	DISTANCE TO THE SEA IN SOUTH EAST DIRECTION (KILOMETERS)
X - 9	0.13049015	0.02447388	SLOPE OF SQUARE (1:1) (1) X 10 <sup>10</sup>
X - 11	13.41071131	2.75752258	AVERAGE ELEVATION (FEET X 10)
X - 13	-4.17803970	1.15551018	AVERAGE BARRIER HEIGHT IN SOUTH WEST DIRECTION (FEET X 10)
X - 14	-0.29478341	0.02711428	SHORTEST DISTANCE TO THE SEA (2)
X - 15	-0.00252822	0.00073928	DISTANCE TO THE SEA IN SOUTH EAST DIRECTION (2)
X - 16	0.02557743	0.00604457	DISTANCE TO THE SEA IN SOUTH WEST DIRECTION (2)
X - 18	-0.03216024	0.01383678	AVERAGE BARRIER HEIGHT IN SOUTH EAST DIRECTION (2)
X - 19	-0.13015162	0.03520712	

$$\begin{aligned} \text{RUNOFF (INCH YEAR) } \times 10^{-2} &= -47.74218780 x_1 - 142.16403239 x_3 - 138.40454143 x_4 - 2.41144228 x_5 - x_6 (1.29478341 x_8 - 13.41071131) \\ &\quad - 0.0252822 x_7^2 - x_8 (1.0036493 - 0.2567143 x_8) + 13040015 x_9 + x_{11} (13.41071131 - 0.0226034 x_{11}) \\ &\quad - 13033162 x_{12}^2 - 4.17803970 x_{13} + 8193.8564 \end{aligned}$$

(EQ. 11-5)

NOTE: DATA COMPARING ACTUAL (ESTIMATED) TO COMPUTED RUNOFF IN THE 402 SQUARES ARE NOT SHOWN BUT ARE AVAILABLE IN THE COMPUTER FILE

NEWFOUNDLAND - WESTERN REGION  
 CORRELATION BETWEEN RUNOFF AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 17

F LEVEL 1.036

STANDARD ERROR OF DEP VARIABLE - 231.7601

CONSTANT 5708.1600

VARIABLE	COEFF	STANDARD ERROR/
X - 1	-10.50867873	2.09595585
X - 2	-260.499208-1	205.81218419
X - 7	-3.21873468	0.93146003
X - 8	-10.46189958	2.30266476
X - 9	0.11014787	0.01618738
X - 11	-0.22600014	3.26532744
X - 12	-10.19209894	1.11705184
X - 13	4.12906240	1.81647968
X - 14	-0.17947861	0.01844100
X - 15	0.00536765	0.00149327
X - 16	0.01911734	0.00667335
X - 18	0.01923955	0.01376094
X - 19	0.01940056	0.00737737

LATITUDE ( ) COORDINATE OF SQUARE IN MASTER FILE - SEE APPENDIX 4- )  
 AREA OF LAKE AREA OF LAND  
 DISTANCE TO THE SEA IN SOUTH EAST DIRECTION KILOMETERS  
 DISTANCE TO THE SEA IN SOUTH WEST DIRECTION KILOMETERS  
 SLOPE OF SQUARE - ((X1 - X2) X 10<sup>-5</sup>)  
 AVERAGE ELEVATION OF SQUARE ( FEET X 10 )  
 AVERAGE BARRIER HEIGHT IN SOUTH EAST DIRECTION ( FEET X 10 )  
 AVERAGE BARRIER HEIGHT IN SOUTH WEST DIRECTION ( FEET X 10 )  
 ( SHORTEST DISTANCE TO THE SEA )<sup>2</sup>  
 ( DISTANCE TO SEA IN SOUTH EAST DIRECTION )<sup>2</sup>  
 ( DISTANCE TO SEA IN SOUTH WEST DIRECTION )<sup>2</sup>  
 ( AVERAGE ELEVATION )<sup>2</sup>  
 ( AVERAGE BARRIER HEIGHT IN SOUTH WEST DIRECTION )<sup>2</sup>

R = .992

$$\text{RUNOFF (INCH YEAR) X } 10^{-2} = -10.50867873 X_1 - 260.49920841 X_2 - 31847851 X_6^2 - X_7 (- 00536305 X_7 + 3.21873468) \\ + 01811734 X_8^2 + 11014787 X_9 + X_{11} (- 01023555 X_{11} + 19.206000514) - 10.37209894 X_{12} \\ + X_{13} (- 01900536 X_{13} + 4.12808130) + 5708.1550 \quad (\text{EQ } 11 - 5)$$

NOTE: DATA COMPARING ACTUAL ESTIMATED TO COMPUTED RUNOFF  
 IN THE 17 SQUARES ARE NOT SHOWN, BUT ARE AVAILABLE  
 IN THE COMPUTER FILE

LABRADOR

CORRELATION BETWEEN RUNOFF AND PHYSIOGRAPHIC CHARACTERISTICS

STANDARD ERROR OF DEP VARIABLE = 101.5965

CONSTANT 1050.5732

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	30.80831913	0.15465426
X - 2	-0.14958073	0.00123187
X - 3	0.00001689	0.00000032
X - 4	0.88409674	0.00606868
X - 5	0.62730741	0.11484701
X - 6	-0.00125939	0.00034887
X - 7	5.04719926	0.05344889
X - 8	-0.00348229	0.00004096
X - 9	-5.63366605	0.03659049
X - 10	0.00102472	0.00002365
X - 11	-8.00211527	0.04227156
X - 12	0.01690395	0.00030778
X - 13	1.13924980	0.04795977
X - 14	0.00547916	0.00038429
X - 15	0.41204744	0.03866077
X - 16	0.43682444	0.02896448
X - 17	0.61583704	0.04766955

COEFFICIENT OF CORRELATION = 0.8946

- X( 1) - LATITUDE ( J NUMBER OF SQUARE IN GRID )
- X( 2) - SLOPE OF SQUARE ( FT/FT)\*100000
- X( 3) - (SLOPE)\*\*2
- X( 4) - AZIMUTH OF SLOPE MEASURED FROM NORTH (RANGE = 0 TO 180 DEGREES)
- X( 5) - AVERAGE ELEVATION OF SQUARE OR STATION (TENS OF FEET)
- X( 6) - (AVERAGE ELEVATION)\*\*2
- X( 7) - DISTANCE TO THE SEA IN EAST DIRECTION (KILOMETERS)
- X( 8) - (DISTANCE TO THE SEA IN EAST DIRECTION)\*\*2
- X( 9) - DISTANCE TO THE SEA IN SOUTH EAST DIRECTION (KILOMETERS)
- X(10) - (DISTANCE TO THE SEA IN SOUTH EAST DIRECTION)\*\*2
- X(11) - BARRIER HEIGHT IN EAST DIRECTION (TENS OF FEET)
- X(12) - (BARRIER HEIGHT IN EAST DIRECTION)\*\*2
- X(13) - BARRIER HEIGHT IN SOUTH EAST DIRECTION (TENS OF FEET)
- X(14) - (BARRIER HEIGHT IN SOUTH EAST DIRECTION)\*\*2
- X(15) - LAKE/LAND - PERCENT
- X(16) - FOREST/LAND - PERCENT
- X(17) - SWAMP/LAND - PERCENT
- X(18) - DEPENDANT VARIABLE - RUNOFF ( (INCH/YEAR)\*100)

THE EQUATION OF THE CORRELATION IS FOUND  
BY REPLACING THE REGRESSION COEFFICIENTS  
(RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{CONSTANT} + \sum_{i=1}^n RC_i X_i$$

The Shawinigan Engineering Company Limited  
 James F. MacLaren Limited

COMPARISON BETWEEN RUNOFF ESTIMATED BY CORRELATION  
 AND RUNOFF ESTIMATED USING THE SQUARE GRID TECHNIQUE

<u>River</u>	<u>Station</u>	<u>Drainage Area sq.mi.</u>	<u>Estimated Flow by Square Grid Method cfs</u>	<u>Estimated Flow by Correlation cfs</u>	<u>Percentage Difference</u>	<u>Number of Years of Records</u>
White Bear	White Bear Lake	308	998	1015	1.67	2
Sandy Brook	Sandy Brook Powerhouse	196	422	465	9.25	3
Indian Brook	Diversion Canal Inlet	92	202	212	4.72	3 $\frac{1}{2}$
Come By Chance	Near Goobies Lake	13.3	42	51	17.65	1
Heart's Content	Southern Cove Pond	35.5	114	115	1	17



17 ANNUAL, SEASONAL, AND MONTHLY FLOW VARIATION

The variation of the flow in a section of a river is a result of both the variation of the precipitation and evaporation, and of the natural regulating capacity of the basin (lakes, swamps, groundwater, and river valley storage, plus snow and ice accumulation). The flow variation is consequently related to the aggregate climatic and physiographic characteristics of the basin; therefore it would be very difficult to assess, from data on flow variation in time, the variation in time of the related areal distribution of the runoff. Such an analysis would require much more data than is presently available, and consequently the analysis of the flow variation was restricted to attempts to relate different flow statistics and characteristics to the aggregated physiographic characteristics of the basins.

17.1 Annual Flow Variation

The annual variation of the flow has been analyzed by assessing the standard deviation ( $S$ ) coefficient of variation ( $C_v$ ) and coefficient of skew ( $C_s$ ) of the annual flow at 25 stations in the Island (Table 17-1) and 6 stations in Labrador (Table 17-2). Correlations between these coefficients and the aggregate physiographic characteristics of the basins have been attempted only for the Island since the amount of data for Labrador was too small. The equations of the correlations obtained are shown in Tables 17-3 to 17-5.

The coefficients of correlation for  $S$  and  $C_v$  equations are higher than that for  $C_s$  reflecting the known fact that the coefficient of skew requires a long period of record to be well defined. Fitting of the cumulative probability curves has shown that the Pearson Type III curves fit best to the recorded annual, seasonal, and monthly flows. Therefore, the variation of these flows has been studied generally on the basis of all three statistics required to compute Pearson Type III curves (average, standard deviation, coefficient of skew).

It should be noted that in cases when records at one station are derived by a linear correlation with the records at another station, if the period synthesized by correlation is long compared to the total study period, the coefficients of variation and skew at the two stations will tend to be equal. However, most of the correlations used in this study were either curvilinear or consisted of two or several different seasonal or monthly correlations. In these cases the above situation no longer develops.

The average flows and coefficients of variation and skew, recorded and computed from the correlation with physiographic characteristics, were used to compute two series of Pearson Type III probability curves for the annual flows which are shown superimposed in Figure 17-1. The comparison of the two series of curves indicates that the curves obtained from computed statistics do not diverge significantly from those based on recorded statistics. The correlations between S,  $C_v$ , and  $C_s$ , and the file on the grid physiographic characteristics can be used to compute standard deviations, coefficients of variation and skew at any section along the main stem and major tributaries of larger river basins which may be of interest in further studies. Synthesis of such statistics was done for some of the river basin studies (see Volumes Six and Seven).

## 17.2 Seasonal Flow Variation

When considering seasonal variation, the seasons were defined conventionally as follows:

Fall	October - December
Winter	January - March
Spring	April - June
Summer	July - September

Actually, as shown in Section 8, the seasons are of different lengths, varying from one region to another. But if seasons of different length are accepted, comparisons between seasons and regions are difficult to make. Consequently, seasons of uniform length were considered for the whole Province.

The values of the seasonal flows have been computed at 25 stations on the Island and 6 stations in Labrador for the period (1939/40 to 1965/66), and on this basis the corresponding standard deviations of coefficients of variation and skew have been calculated and tabulated (Table 17-6). For the Island correlations between the seasonal flows, their standard deviations, and the aggregated physiographic characteristics have been obtained (Tables 17-7 to 17-14). This could be used with the file on grid physiographic characteristics to synthesize the seasonal flows and then the coefficients of variation of the seasonal flow for any river of the Island. Synthesis of these statistics was done for the river basins studied in more detail in Volumes Six and Seven. It should be noted that in all cases when the synthesis of seasonal flows indicates a difference from the mean annual flow, the latter must be considered as correct, and the seasonal flows should be adjusted accordingly.

Average seasonal flow correlations for the coefficient of skew have also been attempted, but these were much less successful. Nevertheless a correlation obtained for the Fall flow coefficient of skew has been used to synthesize coefficients of skew at gauging stations. Cumulative probability curves were then synthesized for the Fall, using computed average seasonal flows, standard deviations, and coefficients of skew, and these were compared to the recorded cumulative probability curves (Figure 17-2). As indicated by the results obtained, in spite of the significant errors in synthesizing the coefficients of skew, the differences between the recorded and synthesized cumulative probability curves for this season are not significant.

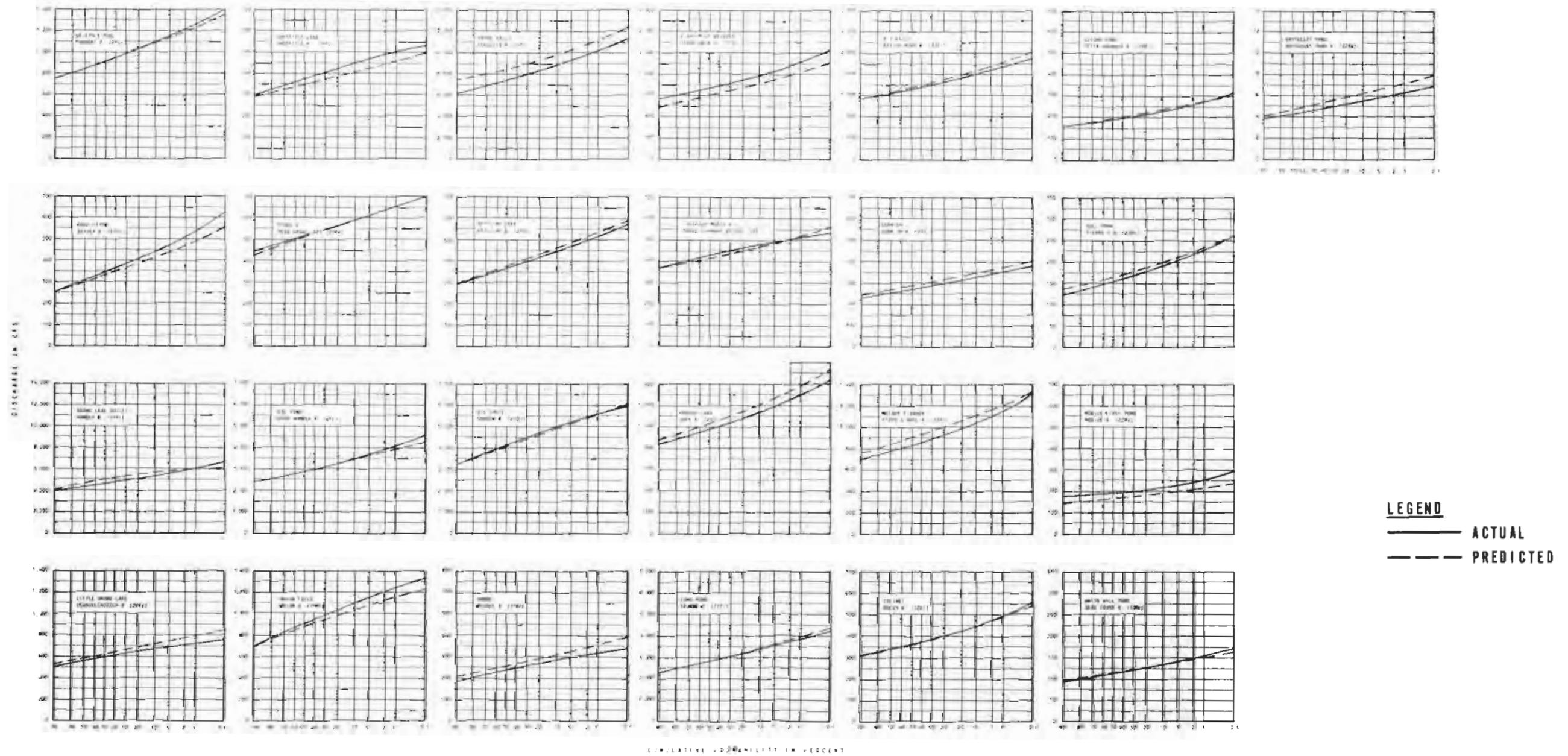
### 17.3 Monthly Flow Variation

The monthly flow variation was analyzed by establishing the same statistics in a similar way as for the seasonal flows (Table 17 - 15).

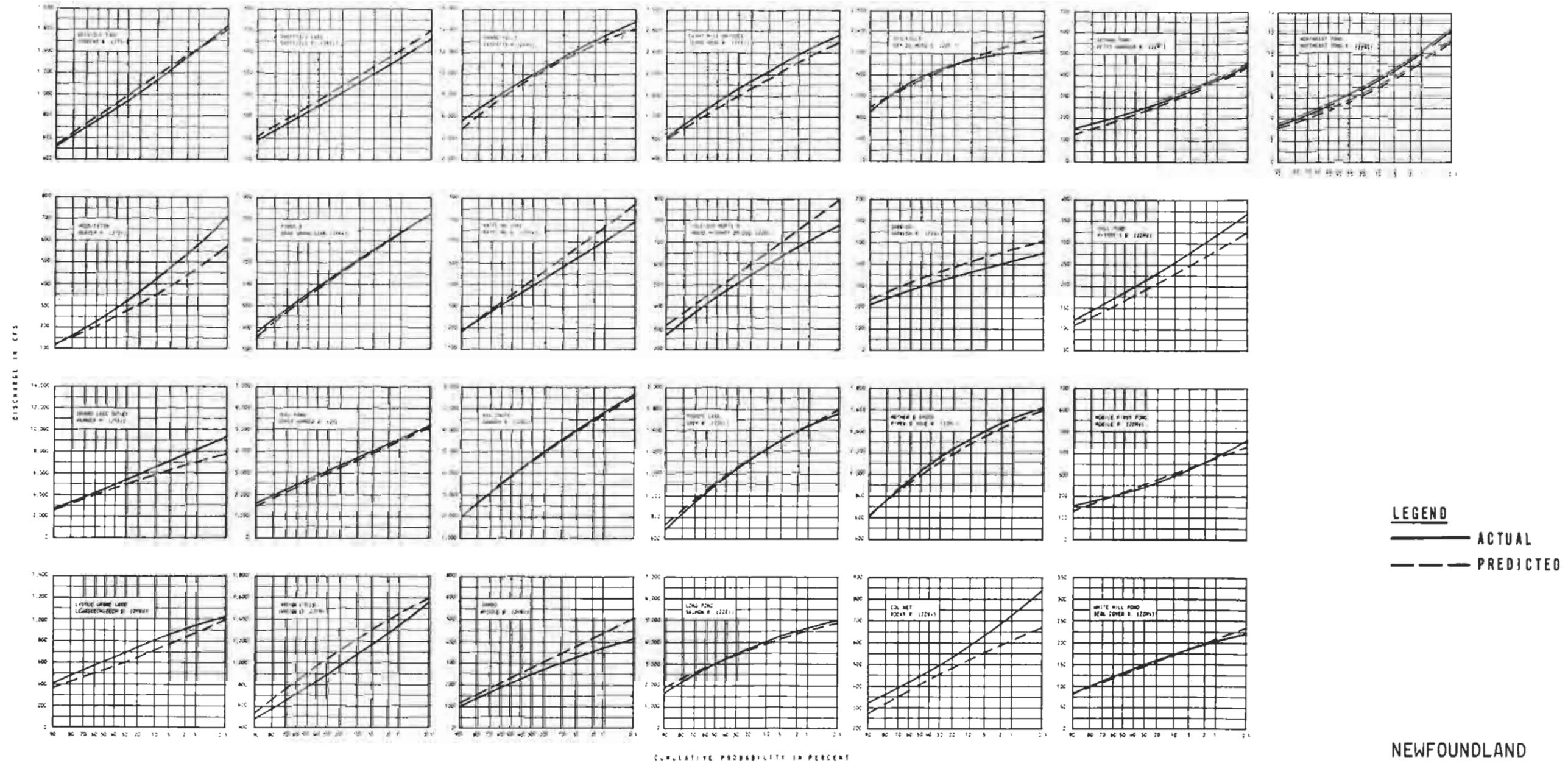
For the Island, correlations between the mean monthly flows, their standard deviations, and the aggregated physiographic characteristics of the basins have been established for each month (Tables 17-16 to 17-39). These correlations were used to synthesize mean monthly flows and their standard deviations for the rivers studied in more detail in Volumes Six and Seven. It should be noted that whenever the mean monthly synthesized flows indicate a difference from the mean annual flow, the latter should be considered as correct, and the mean monthly flows corrected accordingly. Attempts to obtain correlations for  $C_s$  have not been successful. However, if the distribution of the recorded  $C_s$  values is analyzed, estimates of  $C_s$  can be obtained in different areas and these could be used with the correlations for the mean monthly flows and their standard deviations to assess the Pearson Type III statistics for monthly flows on ungauged rivers. Such a procedure, although very crude, gives synthesized probability curves which could be successfully used in preliminary hydrologic estimations. It should be noted that mean monthly flows present much greater asymmetry than the mean annual or seasonal flows.

In addition to the statistical analysis, the values of the average monthly flows, the monthly flows of the highest and lowest flow years, and of the highest and lowest flow months during the period of record were tabulated (Tables 15-3 and 15-4). The mean monthly runoff hydrographs are shown in Figure 17-3).

The variation of the monthly flow has been further analyzed by another approach. This consisted of computing, for 22 of the stations on the Island for which monthly flows were synthesized for the whole hydrometeorological study period, the volume of storage which would be required for the complete regulation of the flow. A correlation was then developed between this hydrologic index and the aggregated physiographic characteristics of the basins. This could be used with the file on grid physical characteristics for computing this index for any river on the Island, larger than 200 square miles. Such computations were done for the river basins studied in more detail in Volumes Six and Seven.



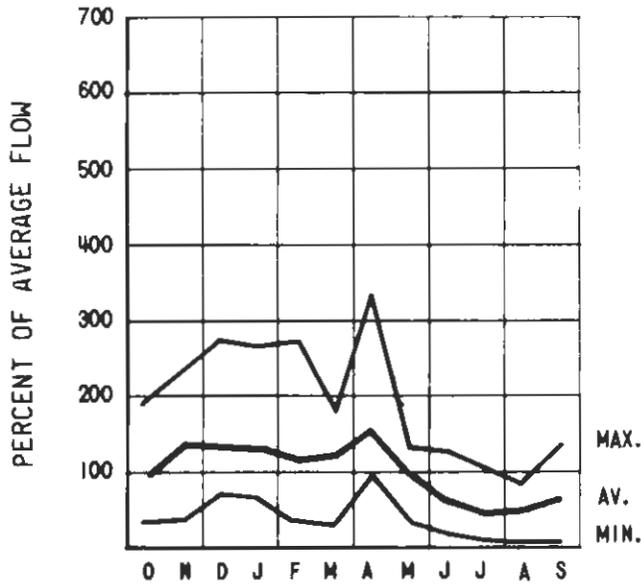
NEWFOUNDLAND  
 COMPARISON OF RECORDED AND  
 SYNTHESIZED PROBABILITY CURVES  
 OF MEAN ANNUAL FLOWS



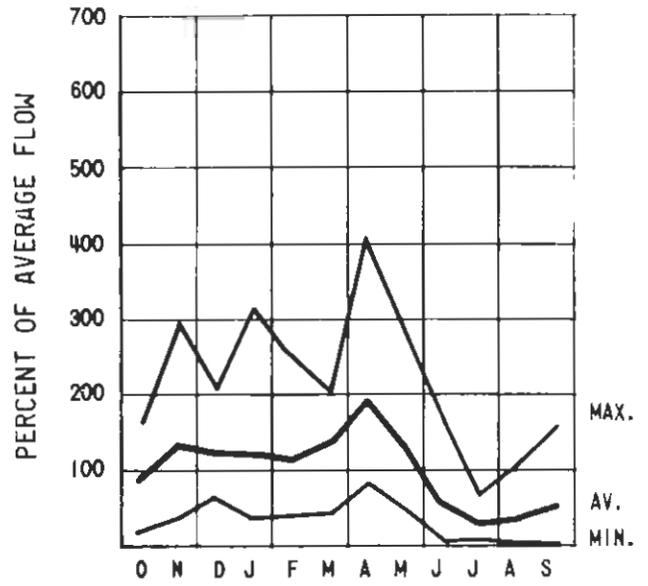
NEWFOUNDLAND  
COMPARISON OF RECORDED AND  
SYNTHESIZED PROBABILITY  
CURVES OF MEAN SEASONAL  
FLOWS (OCTOBER-DECEMBER)

NEWFOUNDLAND AND LABRADOR  
INDEX HYDROGRAPHS OF AVERAGE,  
MAXIMUM, AND MINIMUM MONTHLY FLOWS

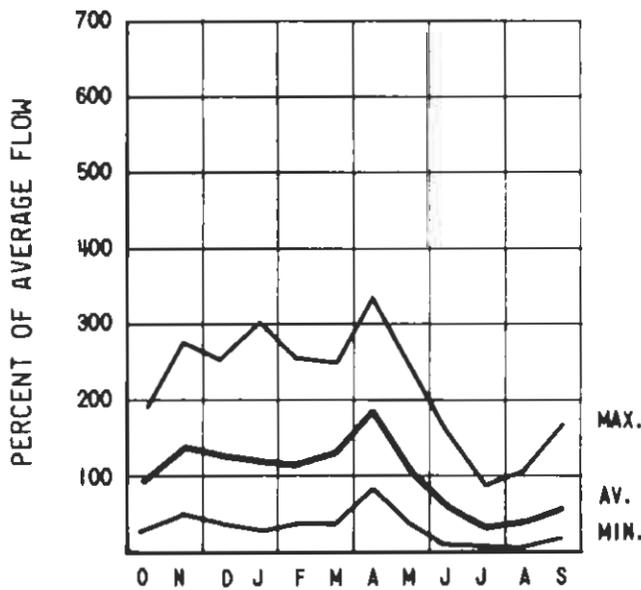
ROCKY RIVER  
NEAR COLINET



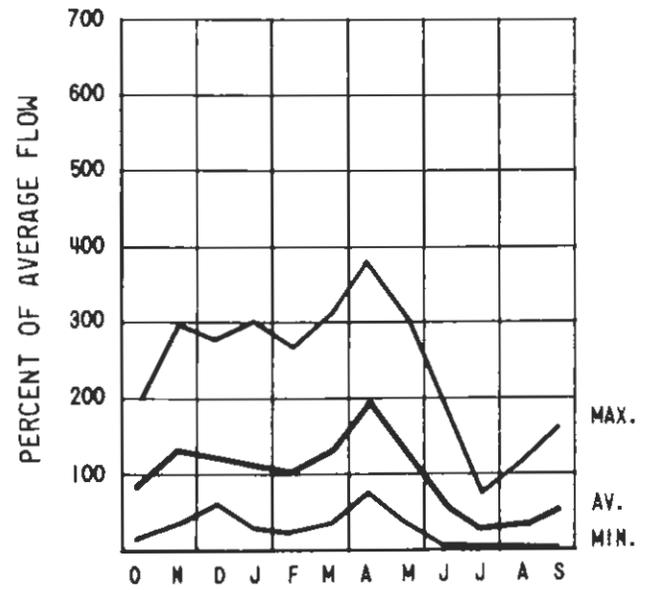
PETTY HARBOUR RIVER  
AT SECOND POND



PIERRE'S BROOK  
AT GULL POND



NORTHEAST POND RIVER  
AT NORTHEAST POND

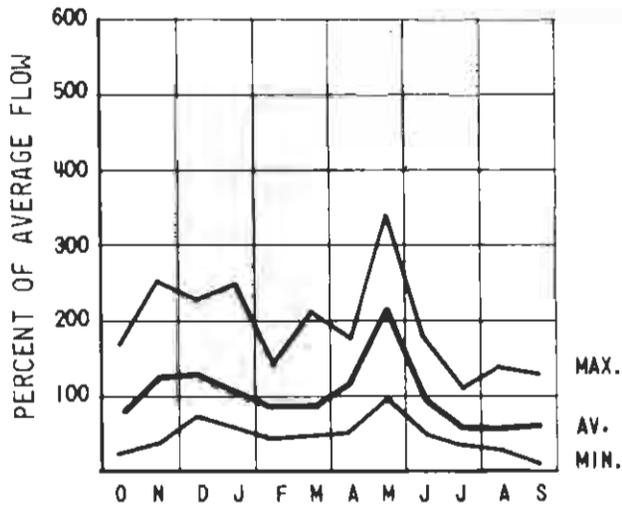


INDEX HYDROGRAPHS IN HYDROLOGIC REGION

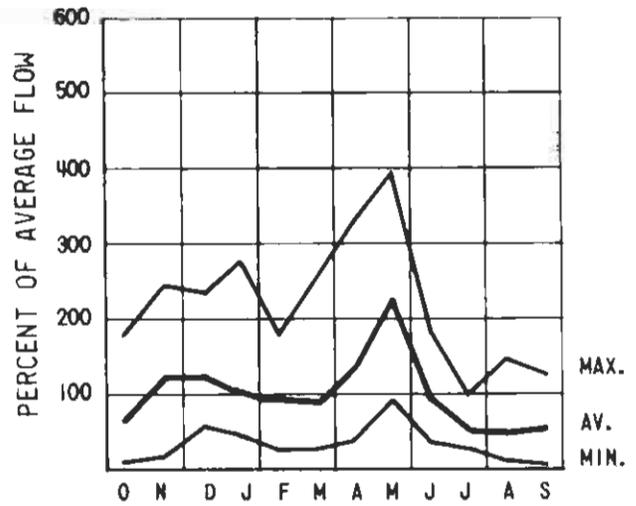
H<sub>1</sub>

NEWFOUNDLAND AND LABRADOR  
 INDEX HYDROGRAPHS OF AVERAGE,  
 MAXIMUM, AND MINIMUM MONTHLY FLOWS

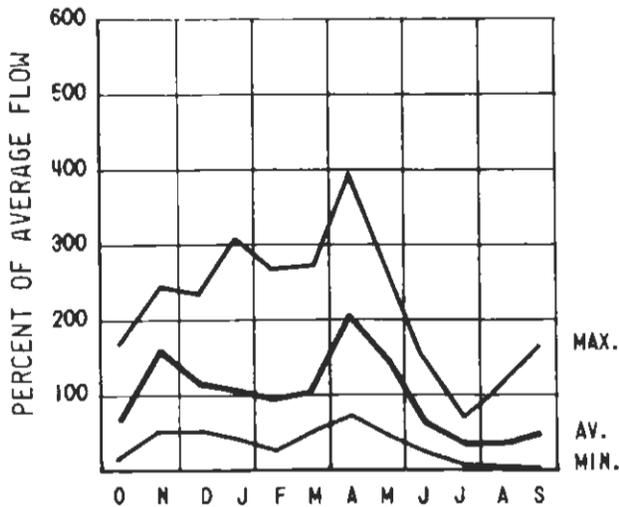
GREY RIVER  
 NEAR PUDOPS LAKE



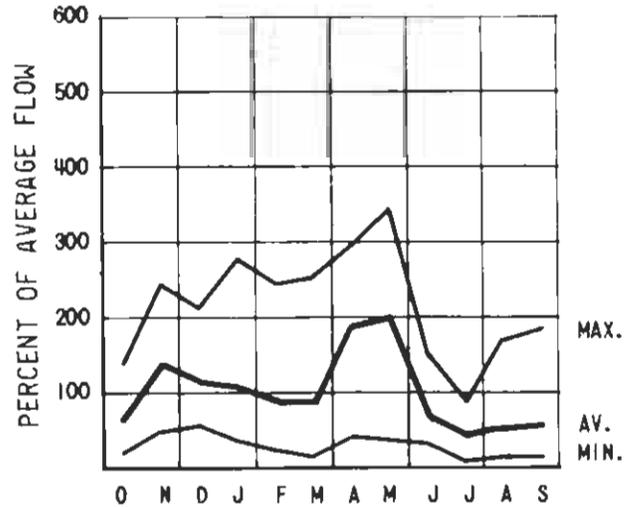
SALMON RIVER  
 AT LONG POND



PIPER'S HOLE RIVER  
 AT MOTHER'S BROOK



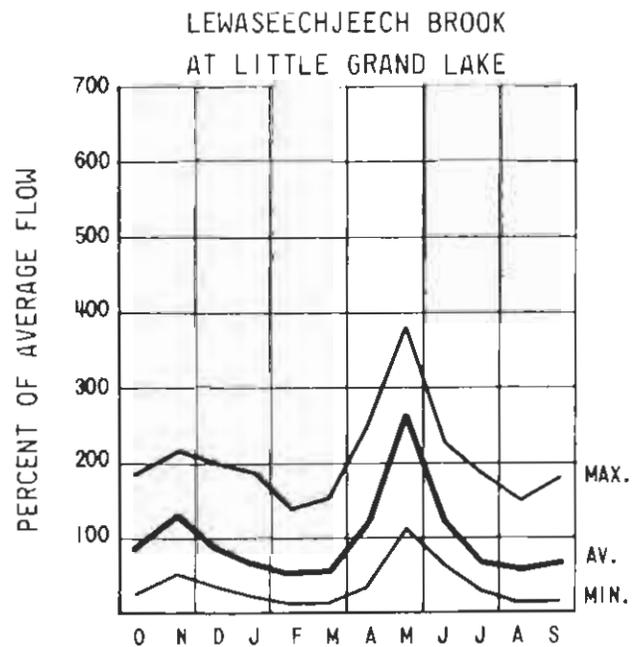
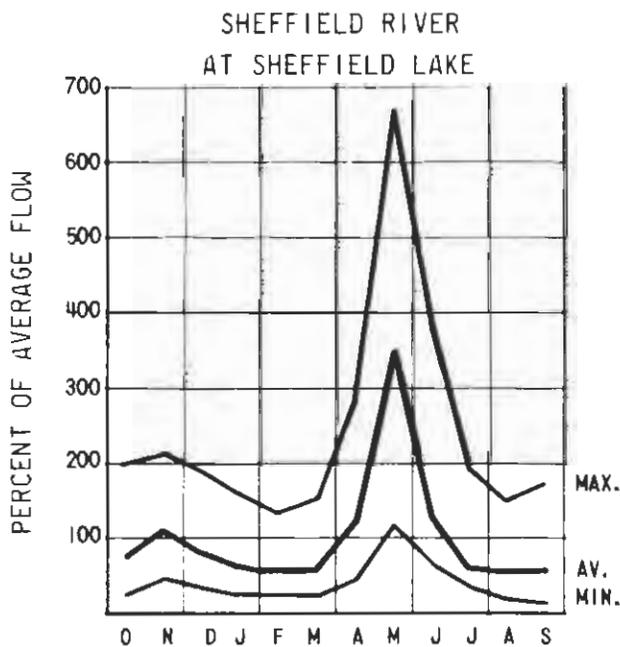
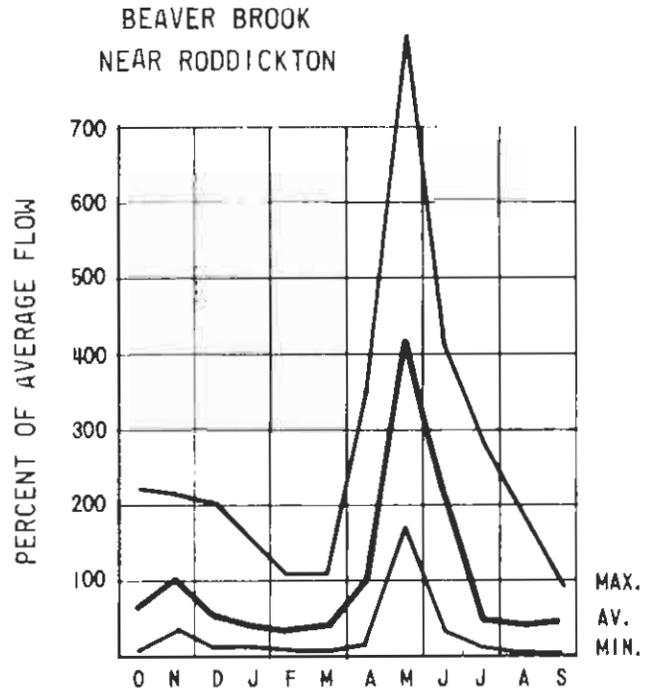
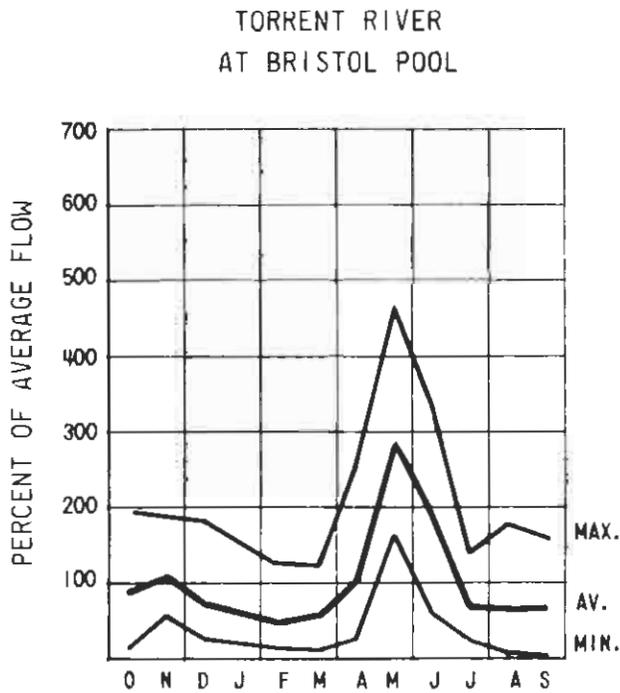
TERRA NOVA RIVER  
 AT EIGHT MILE BRIDGES



INDEX HYDROGRAPHS IN HYDROLOGIC REGION

H<sub>2</sub>

NEWFOUNDLAND AND LABRADOR  
INDEX HYDROGRAPHS OF AVERAGE,  
MAXIMUM, AND MINIMUM MONTHLY FLOWS

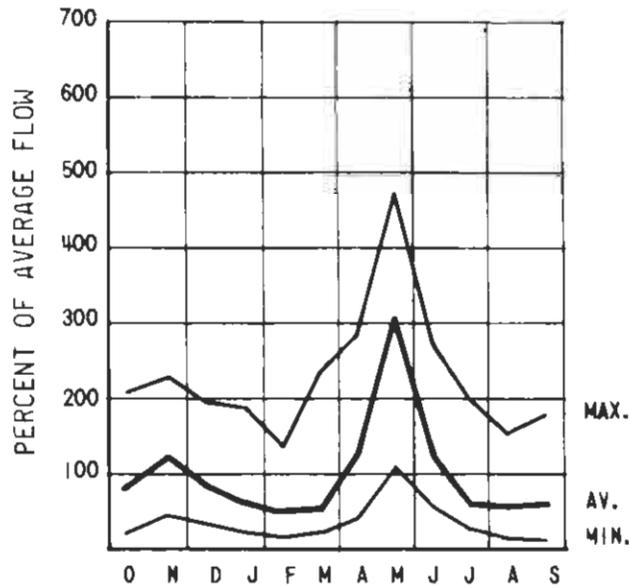


INDEX HYDROGRAPHS IN HYDROLOGIC REGION

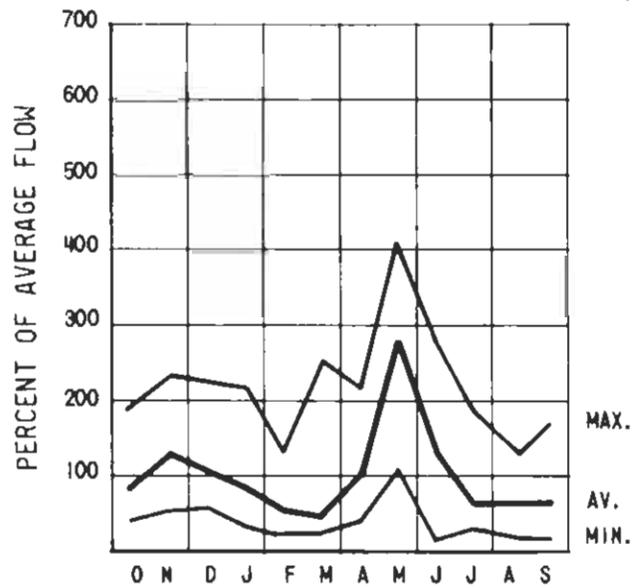
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NEWFOUNDLAND AND LABRADOR  
INDEX HYDROGRAPHS OF AVERAGE,  
MAXIMUM, AND MINIMUM MONTHLY FLOWS

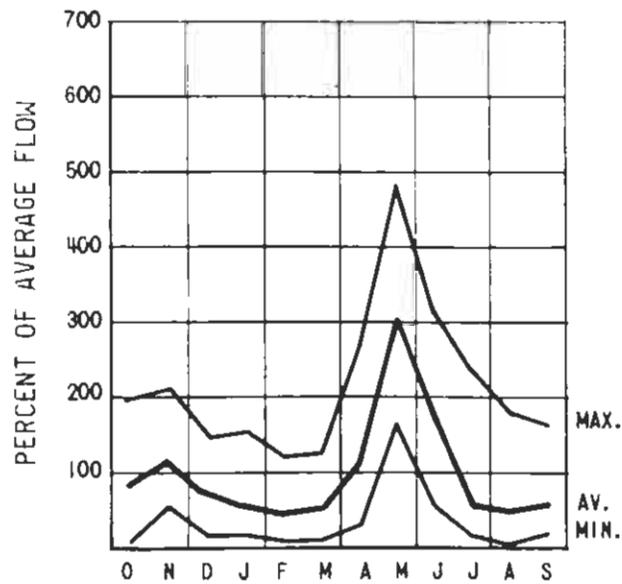
HUMBER RIVER AT  
GRAND LAKE OUTLET



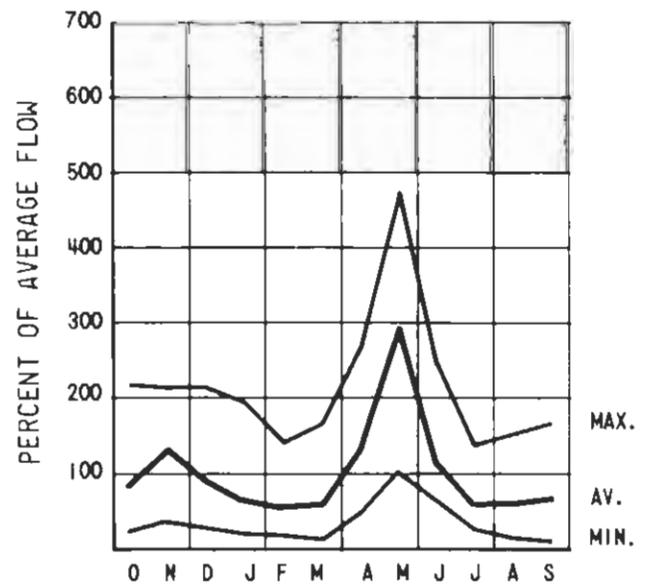
HINDS BROOK  
NEAR GRAND LAKE



UPPER HUMBER RIVER  
AT SEAL POND



ISLE-AUX-MORTS RIVER  
ABOVE HIGHWAY BRIDGE

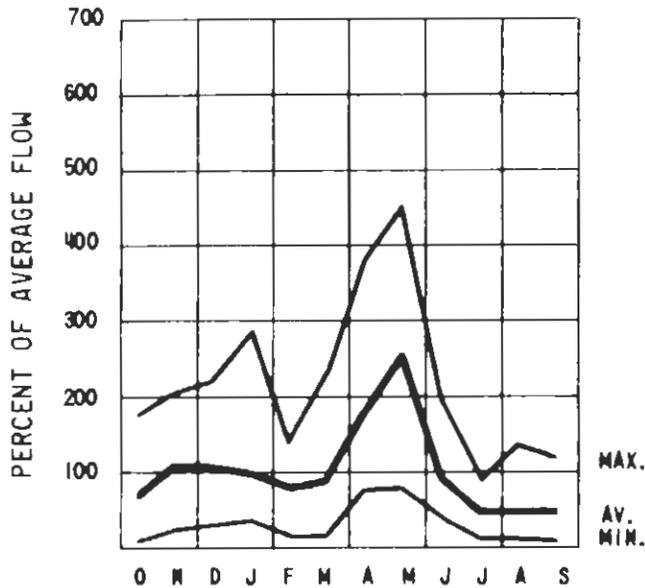


INDEX HYDROGRAPHS IN HYDROLOGIC REGION

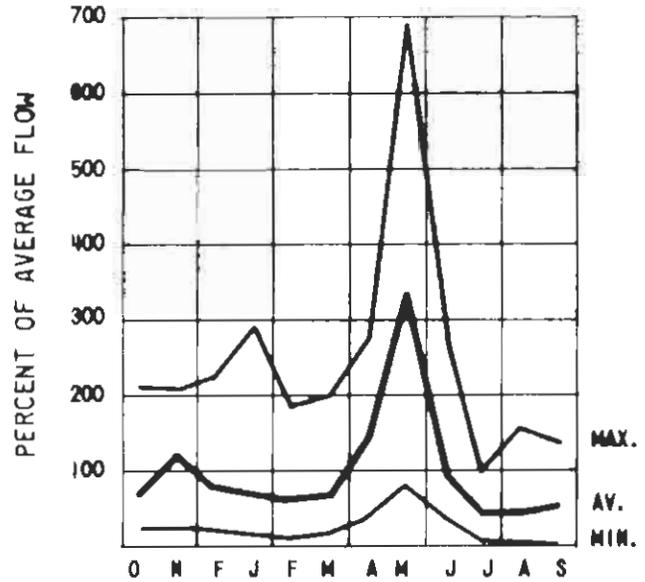
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NEWFOUNDLAND AND LABRADOR  
 INDEX HYDROGRAPHS OF AVERAGE,  
 MAXIMUM, AND MINIMUM MONTHLY FLOWS

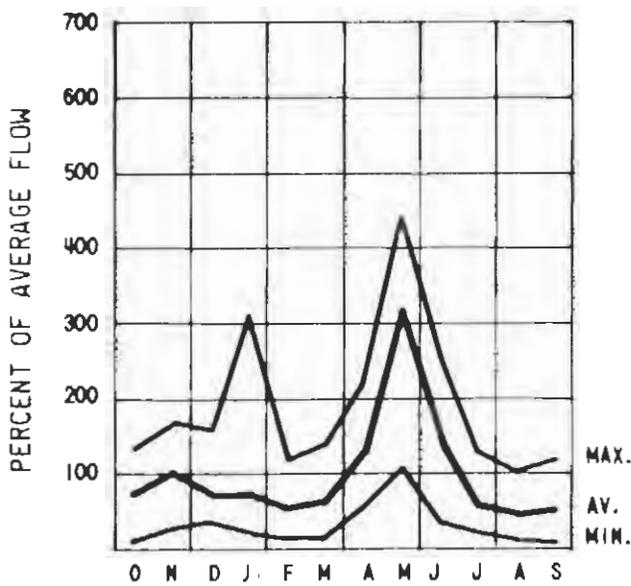
EXPLOITS RIVER AT  
 GRAND FALLS



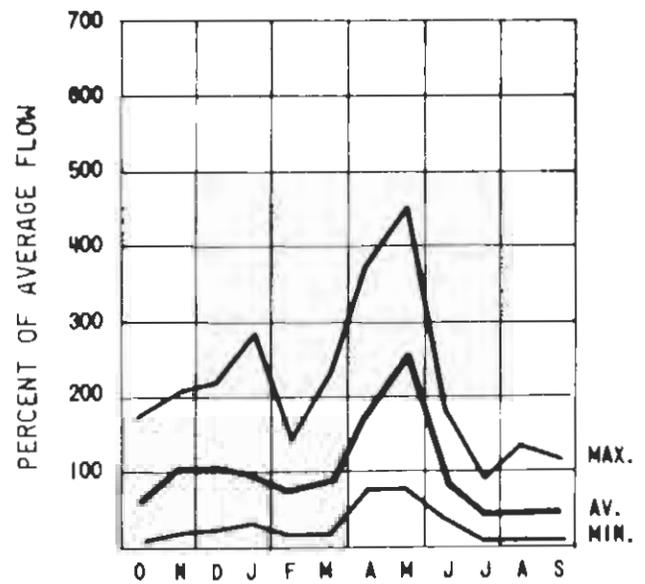
RATTLING BROOK  
 AT RATTLING BROOK



INDIAN BROOK  
 AT INDIAN FALLS



GANDER RIVER  
 AT BIG CHUTE



INDEX HYDROGRAPHS IN HYDROLOGIC REGION

H4

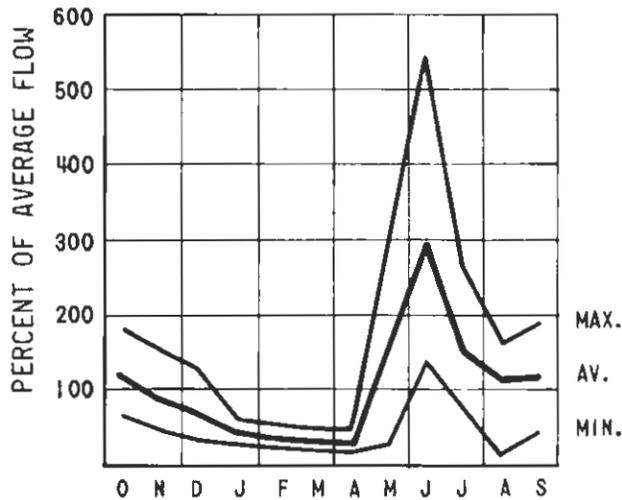
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310

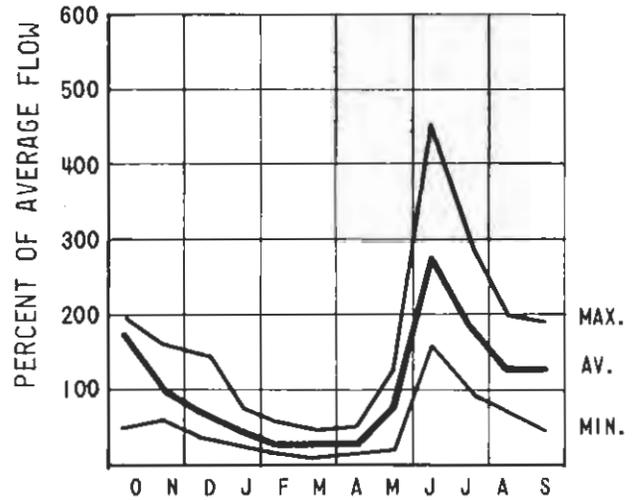
TABLER  
16-1  
16-2

NEWFOUNDLAND AND LABRADOR  
 INDEX HYDROGRAPHS OF AVERAGE,  
 MAXIMUM, AND MINIMUM MONTHLY FLOWS

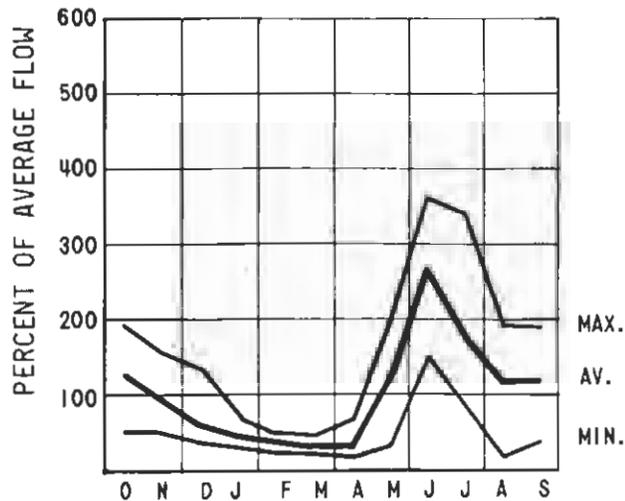
ASHUANUPI RIVER  
 AT MENIHEK RAPIDS



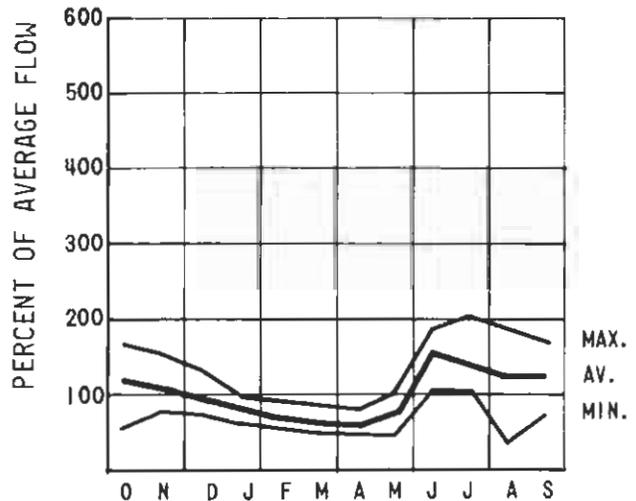
CHURCHILL RIVER  
 AT FLOUR LAKE



CHURCHILL RIVER  
 AT MUSKRAT FALLS

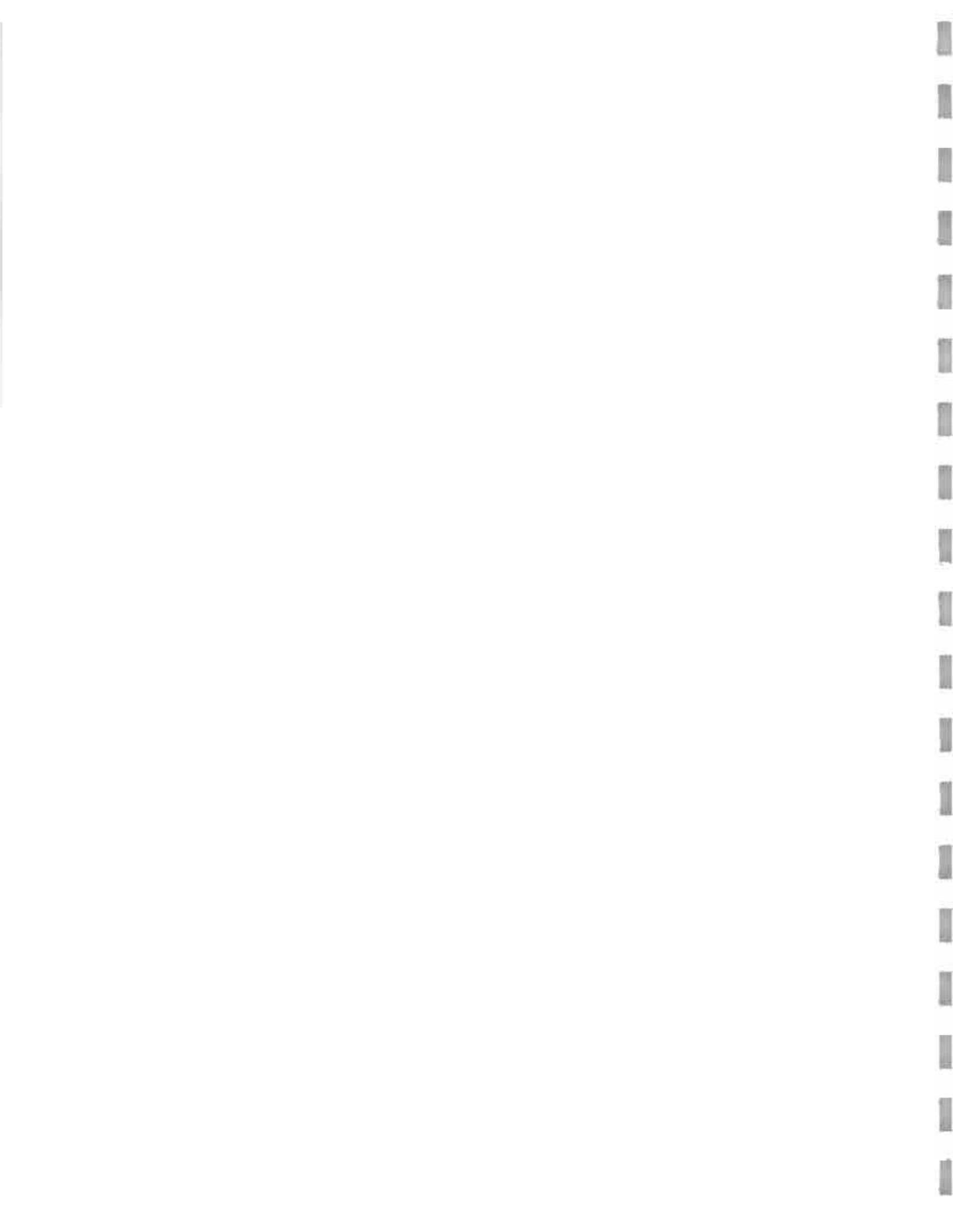


NASKAUPI RIVER  
 AT FREMONT LAKE



INDEX HYDROGRAPHS IN HYDROLOGIC REGION

H5



The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
STATISTICS OF MEAN ANNUAL FLOW

ANNUAL FLOW MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION AND COEFFICIENTS OF SKEW  
AT RIVER GAUGING STATIONS AND FLOW REPORTING HYDRO PLANTS

STATION	MEAN	S	CV	CS
2YC1	916.6	125.1	0.136	0.371
2YD1	355.4	75.9	0.213	0.393
2YK1	4789.6	571.5	0.119	0.138
2YK2	591.0	65.2	0.110	-0.204
2YK3	370.2	53.8	0.145	-0.009
2YK4	521.1	58.2	0.111	0.038
2YL1	2925.4	441.8	0.151	0.500
2YM1	912.8	152.2	0.166	-0.159
* 2Y01	7517.5	1129.1	0.150	0.147
2Y03	372.2	62.4	0.167	0.213
2YQ1	4127.5	680.8	0.164	-0.031
2YR1	242.9	39.0	0.160	-0.344
2YS1	1366.6	186.7	0.136	0.494
2ZB1	434.6	47.0	0.108	-0.077
2ZD1	990.3	119.3	0.120	0.475
2ZE1	2809.2	399.6	0.142	0.361
2ZF1	1341.0	166.0	0.123	0.126
2ZG1	273.8	33.1	0.120	0.098
2ZH1	852.1	117.9	0.138	0.636
2ZK1	373.9	45.2	0.121	0.714
2ZM1	196.8	28.4	0.144	0.651
2ZM2	158.5	27.6	0.174	0.479
2ZM3	192.1	23.1	0.120	0.674
2ZM5	115.7	15.6	0.135	0.273
2ZM6	4.7	0.6	0.136	0.290

\* THE FLOWS AT THIS STATION HAVE TO BE CORRECTED BY ADDING 1000 CFS. THIS WILL CHANGE SLIGHTLY THE CV AND CS.

LABRADOR  
STATISTICS OF MEAN ANNUAL FLOW

ANNUAL FLOW MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION  
AND COEFFICIENTS OF SKEW AT RIVER GAUGING STATIONS AND FLOW  
REPORTING HYDRO PLANTS

STATION	MEAN	S	CV	CS
30A1	13518.	2042.	0.151	-0.161
30B2	24419.	3263.	0.133	0.412
30D2	15398.	2589.	0.168	-0.594
30D3	14200.	2181.	0.153	-0.957
30E1	54657.	6884.	0.125	0.024
3PB1	7351.	712.	0.096	0.726

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
AVERAGE ANNUAL FLOW AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	28.36795	29.33462	-0.96667	PETTY HARBOUR R (22M1)
2	27.66596	23.28065	4.38531	PIERRES BROOK (22M2)
3	441.67362	439.11438	2.55924	UPPER HUMBER R (22F1)
4	398.87713	402.94287	-4.06573	SALMON RIVER (22E1)
5	117.57572	106.47610	11.09962	PIPER'S HOLE R (22H1)
6	189.91165	211.04818	-21.13653	TERRA NOVA R (22F1)
7	164.94265	181.88320	-16.94055	BAY DU NORD R (22F1)
8	45.25394	49.37615	-4.12220	ROCKY R (22X1)
9	23.03997	23.62013	-0.58016	MOBILE R (22M3)
10	15.65997	14.09114	1.56883	SEAL LOVE R (22M5)
11	570.00891	600.16736	-30.15845	HUMBER R (22X1)
12	151.55764	128.32733	23.23032	INDIAN BROOK (22M1)
13	576.98999	641.70813	-64.71814	GANDER R (22Q1)
14	1108.76684	1238.39770	-129.63086	EXPLOITS R (22Q1)
15	53.64992	49.27776	4.37216	SHEFFIELD R (22R3)
16	46.97993	44.98065	1.99927	ISLE AUX MORTS R (22R1)
17	32.87995	35.53352	-2.65356	GARNISH R (22Q1)
18	62.12390	57.45357	4.67033	PATLING BROOK (22Q3)
19	75.61485	56.62599	18.98885	BEAVER BROOK (22Q1)
20	124.71179	112.38258	12.32921	TORRENT R (22C1)
21	0.67999	0.80914	-0.12914	NORTHEAST POND (22M6)
22	38.87995	40.34896	-1.46900	MIDDLE BROOK (22R1)
23	57.83090	70.61467	-12.78376	HINDS BROOK (22R4)
24	65.00987	69.68710	-4.67723	LEMASSECH/EECH BROOK (22R2)
25	118.79977	132.30444	-13.50467	GREY R (22Q1)

X-1 - AREA OF LAKE (SQ.KM.)	(LOG VALUES)
X-2 - AREA OF FOREST (SQ.KM.)	(LOG VALUES)
X-3 - AREA OF SWAMP (SQ.KM.)	(LOG VALUES)
X-4 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-5 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-6 - DIST. TO SEA IN SEDIMENT (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X-8 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-9 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-10 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-11 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-12 - FLOW (CFS)	(LOG VALUES)

DEPENDENT VARIABLE = STANDARD DEVIATION (LOG VALUES)  
COEFFICIENT OF CORRELATION R=0.9963

STANDARD ERROR OF DEP VARIABLE =	0.1791	
CONSTANT	1.3299	
VARIABLE (X <sub>i</sub> )	COEFF (R <sub>C</sub> )	STANDARD ERROR
X = 2	0.1152668	0.03011279
X = 4	-0.1798851	0.16419076
X = 8	-0.1906013	0.07079264
X = 12	0.07726485	0.03896743

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (R<sub>C</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANT LOG CONSTANT} + \sum_{i=1}^n X_i R_{C_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN COEFFICIENT OF VARIATION  
OF ANNUAL FLOW AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	0.14400	0.16818	-0.02418	PETTY HARBOUR R (22M1)
2	0.17400	0.15096	0.02303	PIERRES BROOK (22M2)
3	0.15100	0.15490	-0.00390	UPPER HUMBER R (21F1)
4	0.14200	0.13872	0.00327	SALMON RIVER (22E1)
5	0.13800	0.13001	0.00798	PIPER'S HOLE R (22M1)
6	0.13600	0.15259	-0.01659	TERRA NOVA R (21S1)
7	0.12300	0.13360	-0.01060	BAY DU NORD R (22F1)
8	0.12100	0.13275	-0.01175	ROCKY R (22M1)
9	0.12000	0.13343	-0.01343	MOBILE R (22M5)
10	0.13500	0.12324	0.01175	SEAL LOVE R (22M5)
11	0.11900	0.12275	-0.00375	HUMBER R (21F1)
12	0.16600	0.14589	0.02010	INDIAN BROOK (21M1)
13	0.16400	0.14798	0.01601	DANDEF R (21Q1)
14	0.13000	0.12910	0.00089	ERKOLITS R (21O1)
15	0.14500	0.13818	0.00681	SHEFFIELD R (21K5)
16	0.10800	0.09807	0.00992	ISLE AUX MORTS R (22B1)
17	0.12000	0.11516	0.00483	GERBISH R (22U1)
18	0.16700	0.17364	-0.00664	RATTLING BROOK (21O3)
19	0.21300	0.18793	0.02506	BEAVER BROOK (21O1)
20	0.13600	0.13554	0.00045	TORRENT R (21C1)
21	0.13600	0.14316	-0.00716	NORTHEAST POND (22M5)
22	0.16000	0.15354	0.00645	MIDDLE BROOK (21P1)
23	0.11100	0.11918	-0.00818	HINDS BROOK (21K4)
24	0.11000	0.12199	-0.01199	LEWISSECHJECH BROOK (21K2)
25	0.12000	0.12449	-0.00449	SPRET R (21O1)

X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA OF LAKE	(LOG VALUES)
X-3 - UNIT AREA OF FOREST	(LOG VALUES)
X-4 - UNIT AREA OF SWAMP	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT. TO 1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. ABOVE SEA)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. ABOVE SEA)	(LOG VALUES)
X-13 - UNIT FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - COEFFICIENT OF VARIATION (LOG VALUES)  
COEFFICIENT OF CORRELATION R = 0.796

STANDARD ERROR OF DEP VARIABLE = 0.0993

CONSTANT -1.0045

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X - 2	0.00891677	0.002776613
X - 3	0.17311772	0.01419871
X - 6	-0.001119299	0.003183818
X - 8	0.00664743	0.007604672
X - 9	-0.21466198	0.05190788
X - 13	0.61911165	0.1964046

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTYLOG. CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

TABLE 17-4

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN THE COEFFICIENT OF SKEW  
OF AVERAGE ANNUAL FLOW AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	0.65100	0.32132	0.32967	PETTY HARBOUR R (22M1)
2	0.47900	0.37941	0.09959	PIERRE'S BROOK (2242)
3	0.00500	0.01349	-0.00849	UPPER HUMBER R (21L1)
4	0.36100	0.39970	-0.03870	SALMON RIVER (22E1)
5	0.63500	0.33321	0.30179	PIPER'S HOLE R (22H1)
6	0.49400	0.33219	0.16180	TERRA NOVA R (21S1)
7	0.12600	0.43475	-0.30875	BAY DU NORD R (22F1)
8	0.71400	0.46196	0.25203	ROCAT R (22x1)
9	0.67400	0.42329	0.25070	MOBILE R (22M3)
10	0.27300	0.33642	-0.06342	SEAL COVE R (22M5)
11	0.13800	-0.08604	0.22404	HUMBER R (21K1)
12	-0.15900	-0.09251	-0.06649	INDIAN BROOK (21M1)
13	-0.03100	0.23477	-0.26577	GANDER R (21Q1)
14	0.16100	0.22316	-0.06216	EXPLOITS R (21O1)
15	-0.00900	-0.07137	0.06237	SHEFFIELD R (21K5)
16	-0.07700	0.36841	-0.44541	ISLE AUX MOIS R (22B1)
17	0.09800	0.40330	-0.30530	GARNISH R (22G1)
18	0.21300	0.16144	0.05156	RETEILING BROOK (21D5)
19	0.39300	0.27926	0.11373	BEAVER BROOK (21D1)
20	0.37100	0.24107	0.12992	TORRENT R (21C1)
21	0.29000	0.08943	0.20056	NORTHEAST POLO (22M6)
22	-0.34400	0.14331	-0.48731	MIDDLE BROOK (21R1)
23	0.03800	0.05277	-0.01477	HINDS BROOK (21K4)
24	-0.20400	-0.05344	-0.15056	LEWALLECHJECH BROOK (21K2)
25	0.47500	0.38583	0.08916	GREY R (22D1)

- X- 1 - AREA OF WATERSHED(SQ.KM.)
- X- 2 - AREA OF LAKE(SQ.KM.)
- X- 3 - AREA OF FOREST(SQ.KM.)
- X- 4 - AREA OF SWAMP(SQ.KM.)
- X- 5 - AVGE. COEFF. OF OVERBURDEN
- X- 6 - SHORTEST DIST. TO SEA(KM.)
- X- 7 - DIST. TO SEA IN SE. DIRN(KM.)
- X- 8 - DIST. TO SEA IN S.W. DIRN(KM.)
- X- 9 - AVGE. SLOPE(FT./1000 FT.)
- X-10 - AVGE. AZ. OF SLOPE DEG. FROM N.
- X-11 - AVGE. ELEVATION(FT. X10)
- X-12 - AVGE. BARRIER HT. (FT. X10)
- X-13 - FLOW(CFS)

DEPENDENT VARIABLE - COEFFICIENT OF SKEW  
COEFFICIENT OF CORRELATION R=0.9690

STANDARD ERROR OF DEP VARIABLE = 0.2403

CONSTANT 0.6889

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X = 8	-0.00185553	0.00079428
X = 9	-0.0014763	0.0005932

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{CONSTANT} + \sum_{i=1}^n RC_i X_i$$

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND AND LABRADOR  
STATISTICS OF SEASONAL FLOWS

NEWFOUNDLAND

SEASONAL FLOW MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION AND COEFFICIENTS OF SKEW  
AT RIVER GAUGING STATIONS AND FLOW REPORTING HYDRO PLANTS

STATION	OCTOBER - DECEMBER				JANUARY - MARCH				APRIL - JUNE				JULY - SEPTEMBER			
	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS
2YC1	819.3	239.2	0.291	0.19	479.9	217.0	0.452	0.35	1756.6	304.3	0.173	0.52	610.8	214.1	0.350	1.02
2YD1	264.4	119.5	0.452	0.46	133.7	72.3	0.541	0.72	863.6	227.1	0.262	0.04	160.1	104.1	0.650	2.51
2YK1	4615.7	1464.4	0.317	0.04	2660.7	1075.5	0.404	0.35	8966.4	1493.8	0.166	0.17	2915.6	1208.8	0.414	0.96
2YK2	617.8	153.6	0.248	0.29	348.5	140.0	0.401	0.55	1012.4	142.3	0.140	0.02	385.2	149.1	0.387	0.98
2YK3	324.2	105.0	0.323	0.15	211.6	83.1	0.392	0.28	739.0	163.9	0.221	0.16	206.0	88.1	0.427	1.07
2YK4	548.7	132.9	0.242	0.17	319.2	112.7	0.353	0.41	888.8	152.2	0.171	0.06	327.9	124.5	0.379	0.68
2YL1	2678.8	833.4	0.311	0.02	1520.0	666.5	0.438	0.46	5827.9	1027.7	0.176	0.40	1674.8	732.3	0.437	1.45
2YM1	776.1	229.7	0.295	0.23	592.1	241.1	0.407	0.55	1812.8	340.6	0.187	0.71	470.4	243.9	0.518	1.52
2Y01	7644.5	2400.9	0.314	0.28	4898.7	2526.5	0.515	0.28	13344.5	3089.7	0.231	0.30	4182.4	2110.5	0.504	0.12
2Y03	338.3	117.3	0.346	0.07	253.9	120.9	0.476	0.44	718.3	205.2	0.285	0.03	178.5	106.2	0.595	0.59
2YQ1	3831.3	1425.3	0.372	0.26	3617.5	1376.1	0.380	0.03	7201.3	1562.0	0.216	0.51	1860.0	849.8	0.456	0.17
2YR1	203.6	79.5	0.390	0.33	285.1	104.1	0.365	0.01	386.8	86.0	0.222	0.52	96.0	43.0	0.448	0.34
2YS1	1458.6	476.6	0.326	0.33	1277.1	582.9	0.456	0.74	2059.6	483.5	0.234	1.31	670.9	301.9	0.450	0.52
2ZB1	439.5	129.3	0.294	0.31	248.0	114.8	0.462	0.51	780.8	150.5	0.192	0.07	270.1	104.9	0.388	0.12
2ZD1	1072.7	292.1	0.272	0.50	900.1	258.7	0.287	0.07	1409.9	270.5	0.191	0.48	578.4	202.5	0.350	0.15
2ZE1	2922.6	933.8	0.319	0.62	2630.6	862.6	0.328	0.19	4266.7	999.8	0.234	0.35	1416.8	681.7	0.481	0.14
2ZF1	1498.8	362.2	0.241	1.19	1442.8	354.9	0.245	0.64	1695.3	304.7	0.179	0.34	727.1	235.4	0.323	0.30
2ZG1	293.2	60.0	0.204	0.27	300.4	61.5	0.204	0.13	339.8	56.3	0.165	0.36	161.7	56.1	0.347	0.79
2ZM1	991.6	290.5	0.292	0.65	876.8	324.0	0.369	0.85	1188.7	239.1	0.201	0.88	351.2	184.6	0.525	0.33
2ZK1	452.9	103.8	0.229	0.44	457.7	116.5	0.254	0.86	387.5	91.0	0.234	0.02	197.4	83.6	0.423	0.19
2ZM1	225.9	59.8	0.264	0.45	238.9	71.5	0.299	0.49	247.6	69.0	0.278	0.02	74.8	47.8	0.639	0.83
2ZM2	188.0	51.8	0.275	0.24	190.1	55.9	0.294	0.26	187.0	58.8	0.314	0.33	69.1	39.4	0.571	0.45
2ZM3	222.7	55.3	0.248	0.83	223.9	54.4	0.243	0.83	216.0	53.3	0.246	0.21	105.9	34.8	0.328	0.57
2ZM5	131.1	33.8	0.257	0.23	144.8	42.8	0.295	0.75	134.0	36.5	0.272	0.09	53.1	24.9	0.469	0.39
2ZM6	5.4	1.7	0.312	0.68	5.4	1.6	0.293	0.46	6.1	1.7	0.279	0.15	1.9	1.1	0.589	0.68

\* THE FLOWS AT THIS STATION HAVE TO BE CORRECTED BY ADDING 1000 CFS. THIS WILL CHANGE SLIGHTLY THE CV AND CS.

LABRADOR

STATION	OCTOBER - DECEMBER				JANUARY - MARCH				APRIL - JUNE				JULY - SEPTEMBER			
	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS
30A1	11848.	2743.	0.231	0.32	4538.	1075.	0.236	1.40	20792.	5289.	0.254	0.27	17443.	4552.	0.260	0.13
30B2	24084.	5512.	0.228	0.06	8437.	2303.	0.272	0.32	29561.	7090.	0.239	0.13	35838.	9289.	0.259	0.38
30D2	14142.	3435.	0.242	0.03	6968.	1733.	0.248	1.88	20490.	4845.	0.236	0.06	21540.	5976.	0.277	0.44
30D3	13548.	3880.	0.286	0.00	5668.	1592.	0.280	2.20	17229.	3271.	0.189	1.03	21850.	5757.	0.263	0.38
30E1	50398.	12328.	0.244	0.33	19397.	4055.	0.209	1.19	74049.	14333.	0.193	0.96	77648.	21438.	0.276	0.32
3PB1	7952.	1095.	0.137	0.38	5165.	710.	0.137	0.69	6893.	912.	0.132	0.70	9542.	1660.	0.174	0.47

TABLE 17-6

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN SEASONAL FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
OCTOBER - DECEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	819,30639	961,95337	-142,64698	TORRENT RIVER AT BRISTOLS POOL (21c1)
2	264,49316	323,27144	-58,77828	BEAVER BROOK NEAR BORDUICKTON (21d1)
3	4615,74817	4247,60938	368,13879	HUMBER RIVER AT GRAND LAKE GUILLET (21k1)
4	617,81298	540,67873	77,13427	LOWBEECHBEECH BROOK AT LITTLE GRAND LAKE (21k2)
5	324,24590	368,72777	-44,48187	SHEFFIELD RIVER AT SHEFFIELD LAKE (21k3)
6	548,72656	555,88577	-7,15921	HINDS BROOK NEAR GRAND LAKE (21k4)
7	2676,81641	2509,26904	167,54737	UPPER HUMBER RIVER AT SEAL POND (21L1)
8	776,13293	890,73304	-114,60011	INDIAN BROOK AT INDIAN FALLS (21M1)
9	8704,48049	8275,81252	428,66797	EXPLOITS RIVER AT GRAND FALLS (21M1)
10	338,33221	354,31555	-16,98334	RATILING BROOK AT RATILING LAKE (21O3)
11	3831,87847	3798,38974	33,48873	GANDER RIVER AT BIG CHOLF (21O5)
12	203,69076	232,49986	-28,80910	MIDDLE BROOK NEAR GANDU (21O1)
13	1498,66677	1358,70708	139,95969	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	439,52960	485,19854	-45,66894	ISLE AUX MORTS RIVER ABOVE HIGHWAY BRIDGE (22B1)
15	1872,71216	2053,49097	-180,77881	GREY RIVER NEAR PUDOP'S LAKE (22D1)
16	2922,63232	2974,72754	-52,09522	SALMON RIVER AT LONG POND (22E1)
17	1498,84717	1461,95459	36,89258	BAR DE NORD RIVER AT BIG FALLS (22F1)
18	293,23388	328,61797	-35,38409	BARNISH RIVER NEAR BARNISH (22G1)
19	991,67966	987,20068	4,47897	PAPER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
20	452,77387	399,60960	53,16427	ROCKY RIVER NEAR COLINE? (22K1)
21	225,91305	207,04624	18,86681	PETTY HARBOR RIVER AT SECOND POND (22M1)
22	150,07304	165,04327	-14,97023	PIERRE'S BROOK AT BULL POND (22M2)
23	224,71359	220,27984	4,43375	MOBILE RIVER AT MOBILE FIRST POND (22M3)
24	131,13243	129,05044	2,08199	SEAL COVE RIVER AT WHITE HILL POND (22M5)
25	24,55670	30,01043	-5,45373	NORTHEAST POND RIVER AT NORTHEAST POND (22P5)

X-1 - AREA OF WATERSHED(SQ.KM.)	LOG. VALUES
X-2 - UNIT AREA OF LAKE	LOG. VALUES
X-3 - UNIT AREA OF FOREST	LOG. VALUES
X-4 - UNIT AREA OF SWAMP	LOG. VALUES
X-5 - AVGE. COEFF. OF OVERBURDEN	LOG. VALUES
X-6 - SHORTEST DIST. TO SEA (KM.)	LOG. VALUES
X-7 - DIST. TO SEA IN S.W. DIRECTION	LOG. VALUES
X-8 - DIST. TO SEA IN N.W. DIRECTION	LOG. VALUES
X-9 - AVGE. SLOPE (FT./100 FT.)	LOG. VALUES
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N)	LOG. VALUES
X-11 - AVGE. ELEVATION (FT.)	LOG. VALUES
X-12 - AVGE. BARRIER HT. (FT. X 10 <sup>3</sup> )	LOG. VALUES
X-13 - UNIT AVG. ANNUAL FLOW (CFS/SQ. KM.)	LOG. VALUES
DEPENDENT VARIABLE = SEASONAL AVE. FLOW	LOG. VALUES
COEFFICIENT OF CORRELATION = 0.9977	

STANDARD ERROR OF DEPENDENT VARIABLE = 0.03998

CONSTANT = 0.04067

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X-1	0.48675861	0.01495729
X-2	-0.09493797	0.01312428
X-3	0.06269427	0.01578080
X-4	-0.04352881	0.02785969
X-5	0.19321774	0.12451616

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$*DLP = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN SEASONAL FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
JANUARY - MARCH

	ACTUAL	PREDICTED	DEVIATION	
1	479,99878	450,24121	29,75757	TORRENT RIVER AT BRISTOLS TUNE (2761)
2	133,71572	202,07617	-68,36045	BEAVER BROOK NEAR WOODCROFTS (2761)
3	2660,74414	2787,13623	-126,39210	HUMBER RIVER AT GRAND LAKE COLLET (2761)
4	348,52984	310,50761	38,02224	LEWISERCHILLER BROOK AT LITTLE GRAND LAKE (2762)
5	211,60421	255,07525	-43,47104	SHEFFIELD RIVER AT SHORT HOLE LAKE (2763)
6	319,27059	386,65106	-67,38036	HINES BROOK NEAR GRAND LAKE (2764)
7	1520,00610	1215,26855	304,73761	UPPER HUMBER RIVER AT SEAL POND (2761)
8	592,18322	711,02649	-118,84327	INDIAN BROOK AT INDIAN FALLS (2761)
9	5805,29590	6311,44044	-506,14459	EXPLOITS RIVER AT GRAND FALLS (2761)
10	253,93765	306,00012	-52,06244	RATTLING BROOK AT RATTILING LAKE (2763)
11	3617,50440	3424,43555	193,06887	GANDER RIVER AT BIG CHUTE (2761)
12	285,12255	262,79675	22,32580	MIDDLE BROOK NEAR GANDY (2761)
13	1277,19336	1063,14697	214,04641	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2761)
14	248,09799	282,72815	-34,63013	ISLE AUX MOIS RIVER ABOVE HIGHWAY BRIDGE (2761)
15	900,13244	848,35914	51,77331	GREY RIVER NEAR PONDUS LAKE (2761)
16	2630,66895	2443,27393	187,39505	SALMON RIVER AT LONG POND (2761)
17	1442,88379	1321,73047	121,15332	BAY DU NORD RIVER AT BIG FALLS (2761)
18	300,45581	399,19226	-98,73646	GARRISH RIVER NEAR GARRISH (2761)
19	876,88986	972,76208	-95,87223	PIPER'S HOLE RIVER AT MOTHER'S BROOK (2761)
20	457,73944	419,90033	37,83911	ROCKY RIVER NEAR COLLECT (2761)
21	238,94989	199,17610	39,77379	PETTY WOOD RIVER AT SECOND POND (2761)
22	190,15985	140,82609	49,33376	PETER'S BROOK AT GULL POND (2761)
23	223,95009	200,00534	23,94473	MIDDLE RIVER AT MIDDLE FIRST POND (2763)
24	144,82681	120,27354	24,60326	SEAL LAKE RIVER AT WHITE HILL POND (2761)
25	5,49999	5,52192	-0,02193	NORTHEAST POND RIVER AT NORTHEAST POND (2761)

X - 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)	STANDARD ERROR OF DEP. VARIABLE = 0.1916		
		CONSTANT	2.0709	
X - 2 - UNIT AREA OF LAKE	(LOG VALUES)			
X - 3 - UNIT AREA OF FOREST	(LOG VALUES)	VARIABLE (X <sub>i</sub> )	COEFF. (R <sub>i</sub> )	STANDARD ERROR
X - 4 - UNIT AREA OF SWAMP	(LOG VALUES)	X - 1	0.96005751	0.02843322
X - 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)	X - 3	-0.22331100	0.05529106
X - 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)	X - 11	-0.44818100	0.0725164
X - 7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)	X - 12	-0.11077587	0.06693958
X - 8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)			
X - 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)			
X - 10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)			
X - 11 - AVGE. ELEVATION (FT. X 10)	(LOG VALUES)			
X - 12 - AVGE. BARRIER HT. (FT. X 10)	(LOG VALUES)			
X - 13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)			
DEPENDENT VARIABLE - SEASONAL AV. FLOW	(LOG VALUES)			
COEFFICIENT OF CORRELATION R = 0.9907				

THE EQUATION OF THE CORRELATION IS FOUND BY MAKING THE PROVISIONAL COEFFICIENTS (R<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG (CONSTANT)} \prod_{i=1}^n X_i^{R_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN SEASONAL FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
APRIL - JUNE

	ACTUAL	PREDICTED	DEVIATION
1	1756.62329	1363.48901	393.13428
2	863.60229	593.40771	270.19458
3	8966.46467	9098.27540	-131.81073
4	1012.49011	989.32702	23.16309
5	739.03479	589.47351	149.56128
6	888.81201	1016.71862	-127.90661
7	5827.95020	7135.59766	-1307.64746
8	1812.79590	1434.00222	378.79368
9	14507.88869	16537.30474	-2029.41605
10	718.38025	545.45263	172.92762
11	7201.32227	7412.80274	-211.48047
12	386.81335	376.88971	9.92364
13	2059.63574	2437.92529	-378.28955
14	780.88598	612.71875	168.16723
15	1409.93364	1489.05200	-79.11836
16	4266.75684	3875.45996	391.29688
17	1695.39013	1763.82495	-68.43482
18	339.82617	379.95410	-40.12793
19	1188.76074	1229.06518	-40.30444
20	387.57922	421.07167	-33.49245
21	247.62878	241.06686	6.56192
22	187.01184	261.75476	-74.74292
23	216.07342	288.06836	-71.99494
24	134.04895	136.75323	-2.70428
25	6.10122	6.54335	-0.44213

- TORRENZ RIVER AT BRISBOLS POOL (21C1)
- BEAVER BROOK NEAR HODDICKTON (21D1)
- HUMBER RIVER AT GRAND LAKE OUTLET (21E1)
- LEWISSEEMILLER BROOK AT LITTLE GRAND LAKE (21K2)
- SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
- WINDS BROOK NEAR GRAND LAKE (21K4)
- UPPER HUMBER RIVER AT SERL POND (21L1)
- INDIAN BROOK AT INDIAN FALLS (21M1)
- EXPLOITS RIVER AT GRAND FALLS (21O1)
- RATTLING BROOK AT RATTLING LAKE (21O3)
- WANDER RIVER AT BAS COME (21Q1)
- MIDDLE BROOK NEAR WAND (21R1)
- TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
- 55L BOX MOUNTS RIVER ABOVE HIGHWAY BRIDGE (22N1)
- GREY RIVER NEAR PIDDY'S LAKE (22O1)
- SALMON RIVER AT LOON POND (22E1)
- BAT DU NORD RIVER AT BIG FALLS (22F1)
- GANNISH RIVER NEAR GANNISH (22G1)
- PIPER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
- ROCKY RIVER NEAR COLINET (22K1)
- PEPIN MARGINA BLOOD AT SECOND POND (22M1)
- PIERRE'S BROOK AT GULL POND (22M2)
- MOBILE RIVER AT MOBILE FIRST POND (22M3)
- SCAL COVE RIVER AT WHIEL HILL POND (22M5)
- NORTHEAST POND RIVER AT NORTHEAST POND (22N5)

X-1 - AREA OF WATERSHED(SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA OF LAKE	(LOG VALUES)
X-3 - UNIT AREA OF FOREST	(LOG VALUES)
X-4 - UNIT AREA OF SWAMP	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - SEASONAL AV. FLOW	(LOG VALUES)
COEFFICIENT OF CORRELATION R=0.9522	

STANDARD ERROR OF DEP VARIABLE = 0.2003  
CONSTANT 4.4283

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X-1	1.04634901	0.0344031
X-4	0.07029167	0.03006240
X-5	-0.15466346	0.00912483
X-13	0.05193234	0.2182960

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN SEASONAL FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
JULY - SEPTEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	610.80953	562.82141	47.97913	TORRENT RIVER AT BRISTOLS FOLDS (21C1)
2	160.13540	162.33575	-2.20034	NEAVER BROOK NEAR PRODUCTION (21D1)
3	2915.60547	2928.93799	-13.33252	HUMBER RIVER AT GRAND LAKE OUTLET (21K1)
4	385.28253	340.60229	44.68024	LEWISSECHUEN BROOK AT LITTLE GRAND LAKE (21K2)
5	206.03640	172.95595	33.07996	SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
6	327.92504	338.92999	-11.00494	RINGS BROOK NEAR GRAND LAKE (21K4)
7	1674.88257	1765.11816	-110.23561	UPPER HUMBER RIVER AT SEAL POND (21L1)
8	470.44281	403.54856	66.89424	INDIAN BROOK AT INDIAN FALLS (21R1)
9	5099.84473	5538.22657	-438.38184	EXPLOITS RIVER AT GRAND FALLS (21U1)
10	178.50564	157.21566	21.28998	BATTLING BROOK AT BATTILING LAKE (21O3)
11	1660.08008	2076.85694	-216.77664	WINDEN RIVER AT BIG CHUTE (21Q1)
12	96.09851	117.16214	-21.06363	MIDDLE BROOK NEAR GAMBO (21R1)
13	670.92395	679.25610	-8.33215	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	270.19665	305.65147	-35.45482	ISLE AUX MOIS RIVER ABOVE HIGHWAY BRIDGE (22B1)
15	578.44262	598.54667	-20.10425	GREY RIVER NEAR FUDGYS LAKE (22D1)
16	1416.81079	1534.99414	-118.18336	SALMON RIVER AT LONG POND (22L1)
17	727.13391	686.02024	40.91367	BAY DU NORD RIVER AT BIG FALLS (22H1)
18	161.70318	147.04550	14.65768	GARNISH RIVER NEAR GARNISH (22G1)
19	351.20880	348.20257	3.00624	PIPER'S HOLE RIVER AT MOTHER'S BROOK (22M1)
20	197.44384	175.46211	21.98173	ROCKY RIVER NEAR COINLET (22K1)
21	74.80229	76.73846	-1.93617	PETTY HARBOR RIVER AT SECOND POND (22H1)
22	69.13553	81.04756	-11.91192	PIERRE'S BROOK AT GULL POND (22M2)
23	105.90089	84.71611	21.18478	MOBILE RIVER AT MOBILE FIRST POND (22M3)
24	55.17259	59.20735	-4.03465	SERRE CIVE RIVER AT WHITE HILL POND (22N5)
25	1.90740	2.13888	-0.23147	NORTHEAST POND RIVER AT NORTHEAST POND (22N5)

DEPENDENT VARIABLE - SEASONAL AV. FLOW	(LOG VALUES)	STANDARD ERROR OF DEP VARIABLE -	CONSTANT	2.9369	0.1267
		COEFF (RC <sub>i</sub> )	STANDARD ERROR		
X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)	X - 1	0.29922890	0.01688430	
X-2 - UNIT AREA OF LAKE	(LOG VALUES)	X - 5	-0.46501472	0.07052487	
X-3 - UNIT AREA OF FOREST	(LOG VALUES)	X - 8	-0.46349370	0.05416520	
X-4 - UNIT AREA OF SWAMP	(LOG VALUES)	X - 11	0.37676656	0.08863677	
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)	X - 12	0.09795163	0.03837485	
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)				
X-7 - DIST. TO SEA IN S.W. DIR. (KM.)	(LOG VALUES)				
X-8 - DIST. TO SEA IN S.W. DIR. (KM.)	(LOG VALUES)				
X-9 - AVGE. SLOPE (FT. / 1000 FT.)	(LOG VALUES)				
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)				
X-11 - AVGE. ELEVATION (FT. x 10)	(LOG VALUES)				
X-12 - AVGE. BARRIUR HT. (FT. x 10)	(LOG VALUES)				
X-13 - UNIT AVG. AN. FLOW (CFS / SQ. KM.)	(LOG VALUES)				

DEPENDENT VARIABLE - SEASONAL AV. FLOW (LOG VALUES)  
COEFFICIENT OF CORRELATION R=0.9968

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA  

$$Y_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n x_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN SEASONAL FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
OCTOBER - DECEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	239,22714	242,77310	+6,54596	TORRENT RIVER AT BPISTOLS POOL (2Yc1)
2	119,57917	126,19303	+6,61386	BEAVER BROOK NEAR RODDICKTON (2Yd1)
3	146,47027	120,719074	-25,751196	HUMBER RIVER AT GRAND LAKE DILET (2Yk1)
4	159,53916	161,13259	+1,59343	LEWISSETTSBROOK AT LITTLE GRAND LAKE (2YK2)
5	105,00129	108,36564	+3,36435	SHEFFIELD RIVER AT SHEFFIELD LAKE (2Yk3)
6	132,92895	141,90876	+8,97981	HINDS BROOK NEAR GRAND LAKE (2Yk4)
7	833,47619	832,07214	-1,40405	UPPER HUMBER RIVER AT SEAL POND (2Yl1)
8	229,73297	236,01626	+6,28329	INDIAN BROOK AT INDIAN FALLS (2Ym1)
9	236,73308	235,25291	-1,48017	EXPLOITS RIVER AT GRAND FALLS (2Yol)
10	117,35425	130,14968	+12,79543	RATTLING BROOK AT RATTLING LAKE (2Yos)
11	1429,34887	1437,16943	+7,82056	BANDER RIVER AT BIG CHUTE (2Yq1)
12	79,54122	76,12472	-3,41650	MIDDLE BROOK NEAR JAMBU (2Yr1)
13	476,68872	490,78929	+14,10057	TERNA NUVA RIVER AT EIGHT MILE BRIDGES (2Ys1)
14	129,35934	123,50337	-5,85597	ISLE AUX MORTS RIVER ABOVE JILLOWAY BRIDGE (2Zb1)
15	292,11242	272,87945	-19,23297	GREY RIVER NEAR PLOOPS LAKE (2Zd1)
16	933,84802	869,23756	-64,61046	SALMON RIVER AT LONG POND (2ZEt)
17	362,20703	393,01000	+30,80297	BAY DU NORD RIVER AT BIG FALLS (2Zf1)
18	60,04287	69,74215	+9,69928	GANNIM RIVER NEAR BARNISH (2Zg1)
19	280,53711	258,07694	-22,46017	PIPER'S HOLE RIVER AT MOTHER'S BROOK (2Zh1)
20	105,65366	107,18988	+1,53622	ROCKY RIVER NEAR COLINET (2Zk1)
21	57,85855	60,01866	+2,16011	PETTY HARBOR RIVER AT SECOND POND (2Zm1)
22	51,88633	46,19279	-5,69354	PIERRE'S BROOK AT GULL POND (2Zn2)
23	52,31983	58,90330	+6,58347	MIDDLE RIVER AT MIDDLE FIRST POND (2Zn3)
24	33,82833	31,23800	-2,59033	SEAL EDGE RIVER AT WHITE HILL ROAD (2Zn5)
25	1,70305	1,63376	-0,06929	NORTHEAST POND RIVER AT NORTHEAST POND (2Zn6)

DEPENDENT VARIABLE - STANDARD DEVIATION	(LOG VALUES)
x-1 - AREA OF WATERSHED(SQ.KM)	(LOG VALUES)
x-2 - UNIT AREA OF LAKE	(LOG VALUES)
x-3 - UNIT AREA OF FOREST	(LOG VALUES)
x-4 - UNIT AREA OF SWAMP	(LOG VALUES)
x-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
x-6 - SHORTEST DIST. TO SEA(KM)	(LOG VALUES)
x-7 - DIST. TO SEA IN SE. DIRECTION(KM)	(LOG VALUES)
x-8 - DIST. TO SEA IN SW. DIRECTION(KM)	(LOG VALUES)
x-9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
x-10 - AVGE. AZ. OF SLOPE( DEG. FROM N.)	(LOG VALUES)
x-11 - AVGE. ELEVATION(FT. X100)	(LOG VALUES)
x-12 - AVGE. BARRIER HT.(FT. X100)	(LOG VALUES)
x-13 - UNIT AVG. AN. FLOW( CFS/SQ. KM)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEVIATION	(LOG VALUES)
COEFFICIENT OF CORRELATION R=0,9983	

STANDARD ERROR OF DEP VARIABLE = 0,0854			
CONSTANT 0,0006			
VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR	
x - 1	1,03808382	0,01607459	
x - 2	-0,05554956	0,02668939	
x - 3	0,12230859	0,01243232	
x - 4	-0,23422500	0,09009295	
x - 10	-0,01177542	0,02402496	
x - 13	1,1246233	0,12342432	

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN SEASONAL FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
JANUARY - MARCH

	ACTUAL	PREDICTED	DEVIATION	
1	217.07702	211.03872	6.03830	TORRENT RIVER AT BRISTOLS POOL (2Yc1)
2	72.39735	77.07489	-4.67753	BEAVER BROOK NEAR BODDICKTON (2Yd1)
3	1075.56933	1166.67456	-91.10524	HUMBER RIVER AT GRAND LAKE OUTLET (2Yk1)
4	140.05285	131.35723	8.69561	LEMSSECHJICH BROOK AT LITTLE GRAND LAKE (2YX2)
5	83.12486	95.37959	-12.25473	SHEFFIELD RIVER AT SHEFFIELD LAKE (2YX3)
6	112.71328	138.31906	-25.60576	HINDS BROOK NEAR GRAND LAKE (2YK4)
7	666.56616	523.16089	143.40527	UPPER HUMBER RIVER AT SEAL POND (2Yl1)
8	241.12619	245.58364	-4.45745	INDIAN BROOK AT INDIAN FALLS (2YH1)
9	2559.11328	2617.29834	-58.18506	EXPLOITS RIVER AT GRAND FALLS (2Y01)
10	120.95310	119.49790	1.45520	RUTTING BROOK AT BATTLEFORD LAKE (2Y03)
11	1376.16211	1360.84819	15.31391	SANDER RIVER AT BIG CHUTE (2YQ1)
12	104.16334	99.75012	4.41322	MIDDLE BROOK NEAR DAMBO (2YH1)
13	582.94275	418.88366	164.05909	TERRA NOVA RIVER AT LIGHT MILE BRIDGES (2Y51)
14	114.61025	120.98845	-6.37820	ISLE ROY MONTS RIVER ABOVE HIGHWAY BRIDGE (2Z61)
15	258.76123	273.63702	-14.87579	BRET RIVER NEAR PUDDYS LAKE (2Z01)
16	862.46716	533.58520	328.88196	SALMON RIVER AT LONG POND (2Z11)
17	354.91113	437.14726	-82.23613	BAY DU NORD RIVER AT BIG FALLS (2Z71)
18	61.56848	94.77042	-33.20194	GARIBDI RIVER NEAR GARIBDI (2Z81)
19	324.87303	281.24705	43.62598	PEPPER'S HOLE RIVER AT MOTHER'S BROOK (2ZH1)
20	116.59398	130.62177	-14.02779	HOCKEY RIVER NEAR COLINET (2ZK1)
21	71.56625	53.21513	18.35112	PITTS HARBOUR RIVER AT SECOND POND (2ZM1)
22	55.92791	55.74579	0.18212	PIERRE'S BROOK AT BULL POND (2Z02)
23	54.48133	52.44047	2.04086	MOBILE RIVER AT BURKE FIRST POND (2ZM3)
24	42.81840	30.25843	12.55997	SEAL COZE RIVER AT WHITE HILL POND (2ZM5)
25	1.61428	1.71747	-0.10319	NORTHEAST POND RIVER AT NORTHEAST POND (2ZM5)

X- 1 - AREA OF WATERSHED (SQ KM)	LOG VALUES
X- 2 - UNIT AREA OF LAKE	LOG VALUES
X- 3 - UNIT AREA OF FOREST	LOG VALUES
X- 4 - UNIT AREA OF SWAMP	LOG VALUES
X- 5 - AVGE. COEFF. OF OVERBURDEN	LOG VALUES
X- 6 - SHORTEST DIST. TO SEA (KM)	LOG VALUES
X- 7 - DIST. TO SEA IN SEA (1/100 KM)	LOG VALUES
X- 8 - DIST. TO SEA IN SW (3/4 1/100 KM)	LOG VALUES
X- 9 - AVGE. SLOPE (FT. / 1000 FT.)	LOG VALUES
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N)	LOG VALUES
X-11 - AVGE. ELEVATION (FT. / 100)	LOG VALUES
X-12 - AVGE. BARRIER HT. (FT. / 100)	LOG VALUES
X-13 - UNIT AVG. AN. FLOW (CFS. / SQ. KM)	LOG VALUES
DEPENDENT VARIABLE - STANDARD DEVIATION	LOG VALUES
COEFFICIENT OF CORRELATION R=0.9400	

STANDARD ERROR OF DEP. VARIABLE = 0.1976

VAR. NO. (X <sub>i</sub> )	CONSTANT	24.3762	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X = 1			0.95735410	0.00818591
X = 2			0.06126955	0.00394949
X = 3			-0.34819210	0.00612548
X = 11			-0.31433546	0.00870708

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA  

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN SEASONAL FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
APRIL - JUNE

	ACTUAL	PREDICTED	DEVIATION	
1	304.30261	277.72270	26.57991	TORRENT RIVER AT BRISTOL'S POOL (21c1)
2	227.11758	126.61860	100.49898	BLAYNE BROOK NEAR MODIFICATION (21d1)
3	1493.81689	1676.49905	-182.68216	MUMBER RIVER AT GRAND LAKE OUTLET (21A1)
4	142.30123	207.86853	-65.56730	LEHRSECHALLEH BROOK AT LITTLE GRAND LAKE (21K2)
5	163.94696	130.48101	33.46595	SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
6	152.25720	221.15213	-68.89493	HINDS BROOK NEAR GRAND LAKE (21K4)
7	1027.79053	1306.54370	-278.75317	UPPER HUMBIA RIVER AT SEAL POND (21L1)
8	340.63340	303.49978	37.13362	INDIAN BROOK AT INDIAN FALLS (21M)
9	2896.05225	2947.72119	-51.66894	EXPLOITS RIVER AT GRAND FALLS (21O1)
10	205.22766	123.45285	81.77481	MATTHEW BROOK AT HOTSPRING LAKE (21O3)
11	1562.08398	1391.94413	170.13985	GANDER RIVER AT BIG CHUTE (21P1)
12	86.09574	93.16258	-7.06684	MIDDLE BROOK NEAR RAMPO (21R1)
13	483.54760	489.29050	-5.74290	SENA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	150.52871	128.29860	22.23011	LAKE AUX MONTS RIVER ABOVE HIGHWAY BRIDGE (22B1)
15	270.57208	293.01428	-22.44220	GREY RIVER NEAR BODDYS LAKE (22D1)
16	999.79750	751.04928	248.74822	SALMON RIVER AT LONG POND (22E1)
17	304.76672	353.25073	-48.48401	BAY DU BORD RIVER AT RED FALLS (22F1)
18	56.33699	85.20191	-28.86492	GARNISH RIVER NEAR GARNISH (22G1)
19	239.18151	298.33886	-59.15735	PIPER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
20	91.07566	96.09531	-5.01965	ROCKY RIVER NEAR ZAGLINE (22K1)
21	69.04470	55.57954	13.46516	PETTY HARBOUR RIVER AT SECOND POND (22M1)
22	58.84477	60.77573	-1.93096	PIERRE'S BROOK AT GULL POND (22N2)
23	53.30491	64.96746	-11.66255	MOULLE RIVER AT MOULLE FIRST POND (22M3)
24	36.56756	32.744.3	3.82313	SEAL EDGE RIVER AT WHITE HILL POND (22P5)
25	1.70681	1.93955	-0.23274	NORTHEAST POND RIVER AT NORTHEAST POND (22'5)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA OF SWAMP	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEVIATION	(LOG VALUES)
COEFFICIENT OF CORRELATION R=0.9834	

STANDARD ERROR OF DEP VARIABLE =	0.2717	
CONSTANT	3.1023	
VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.98980428	0.04676042
X - 4	0.08107968	0.04093587
X - 5	-0.71389174	0.01349069
X - 13	0.71046698	0.29610391

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN SEASONAL FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
JULY - SEPTEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	214.18737	202.36871	11.81866	TORRENT RIVER AT BRISTOLS POOL (2Y01)
2	104.18519	89.07652	15.10867	BLAVER BROOK NEAR WOODICKTON (2Y01)
3	1208.46377	1210.67749	-1.81372	HUMBER RIVER AT GRAND LAKE OUTLET (2Y01)
4	149.12672	134.85589	14.27282	LEWIS/CHELSEY BROOK AT LITTLE GRAND LAKE (2Y02)
5	88.17443	78.63142	9.54301	SHEFFIELD RIVER AT SHEFFIELD LAKE (2Y03)
6	124.51083	129.16803	-4.65718	WINDS BROOK NEAR GRAND LAKE (2Y04)
7	732.34289	955.92114	-223.07827	UPPER HUMBER RIVER AT SEAL POND (2Y01)
8	243.96664	205.56674	38.40990	INDIAN BROOK AT INDIAN FALLS (2Y01)
9	2083.66553	2110.04785	-26.38232	EXPLOITS RIVER AT GRAND FALLS (2Y01)
10	106.25495	74.02648	32.22847	RATTING BROOK AT RATTING LAKE (2Y03)
11	944.81692	999.10376	-54.28684	DANGER RIVER AT BIG CHUTE (2Y01)
12	43.05563	36.44734	6.60829	MIDDLE BROOK NEAR GAMBOL (2Y01)
13	304.92764	316.37036	-11.44272	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2Y01)
14	104.97350	89.75401	15.21949	ISLE AUX MOULTS RIVER ABOVE RAILWAY BRIDGE (2Y01)
15	202.52838	223.06723	-20.53885	GREY RIVER NEAR FODD'S LAKE (2Y01)
16	681.79174	584.39721	97.39453	SALMON RIVER AT LONG POND (2Y01)
17	235.47604	266.83465	-31.35861	BAY DU NORD RIVER AT BIG FALLS (2Y01)
18	56.17670	71.41558	-15.23888	VARREN RIVER NEAR GAMBOL (2Y01)
19	144.63403	139.92275	4.71128	PEPEN'S MILL RIVER AT MOTHER'S BROOK (2Y01)
20	33.46854	32.53783	0.93071	ROCKY RIVER NEAR COLLECT (2Y01)
21	47.80046	45.72029	2.08017	PETTIT BROOK RIVER AT SEAL POND (2Y01)
22	39.47678	36.39408	3.08270	FRENCH'S BROOK AT SEAL POND (2Y02)
23	34.80094	42.99802	-8.19708	FRANK RIVER AT MIDDLE FIRST POND (2Y03)
24	24.98126	25.14377	-0.16251	SEAL CREEK RIVER AT WHITE HILL POND (2Y05)
25	1.12494	1.42031	-0.29537	NORTHEAST POND RIVER AT NORTHEAST POND (2Y05)

	STANDARD ERROR OF DEPENDENT VARIABLE	CONSTANT	DISPERSION (S <sub>e</sub> )	COEFF (R <sub>c</sub> )	STANDARD ERROR
X-1 - AREA OF WATERSHED(SQ.KM.)	FLOOD VALUES				
X-2 - UNIT AREA OF LAKE	FLOOD VALUES				
X-3 - UNIT AREA OF FOREST	FLOOD VALUES				
X-4 - UNIT AREA OF SWAMP	FLOOD VALUES				
X-5 - AVGE. COEFF. OF OVERBURDEN	FLOOD VALUES				
X-6 - SHORTEST DIST. TO SEA(KM.)	FLOOD VALUES				
X-7 - DIST. TO SEA IN SE. DIR.(KM.)	FLOOD VALUES				
X-8 - DIST. TO SEA IN SW. DIR.(KM.)	FLOOD VALUES				
X-9 - AVGE. SLOPE (FT./1000 FT.)	FLOOD VALUES				
X-10 - AVGE. AZ OF SLOPE(DEG.) FROM N. 0	FLOOD VALUES				
X-11 - AVGE. ELEVATION(FT. x 10)	FLOOD VALUES				
X-12 - AVGE. BARRIER HT.(FT. x 100)	FLOOD VALUES				
X-13 - UNIT AVG. ANNUAL FLOW(CFS./SQ.KM.)	FLOOD VALUES				
DEPENDENT VARIABLE - STANDARD DEVIATION	FLOOD VALUES				
COEFFICIENT OF CORRELATION R=0.995					

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (R<sub>c</sub>) IN THE FORMULA

$$X_{DEP} = INT[FLOOD CONSTANT] \prod_{i=1}^n X_i^{R_c}$$

TABLE 17-14

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
STATISTICS OF MEAN MONTHLY FLOWS

MONTHLY FLOW MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION AND COEFFICIENTS OF SKEW  
AT RIVER GAUGING STATIONS AND FLOW REPORTING HYDRO PLANTS

STATION	OCTOBER				NOVEMBER				DECEMBER				JANUARY			
	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS
2YC1	799.2	367.2	0.459	0.52	991.1	336.2	0.339	0.53	667.4	365.4	0.547	1.17	513.8	290.0	0.564	1.28
2YD1	233.9	166.7	0.712	1.65	364.1	193.1	0.530	0.59	195.3	158.6	0.811	1.87	146.4	119.1	0.813	1.79
2YK1	3994.2	1974.9	0.494	1.12	5814.2	2528.6	0.434	0.60	4038.8	1925.8	0.476	1.19	2995.1	1981.7	0.661	1.65
2YK2	541.4	224.7	0.415	0.38	783.3	272.1	0.347	0.10	528.7	217.1	0.410	1.27	400.0	220.0	0.550	1.46
2YK3	272.7	150.4	0.551	1.12	402.6	186.1	0.462	0.70	297.3	126.7	0.426	1.05	229.6	127.6	0.555	1.35
2YK4	441.5	180.6	0.409	0.99	659.8	237.0	0.359	0.50	544.7	204.3	0.375	1.20	428.7	207.2	0.483	1.68
2YL1	2540.0	1234.6	0.486	0.74	3351.4	1280.6	0.382	0.58	2144.9	1216.5	0.567	1.14	1663.9	1057.5	0.635	1.21
2YM1	705.6	373.2	0.528	0.95	937.5	356.8	0.380	0.80	685.1	333.3	0.486	0.78	678.5	565.5	0.833	2.50
2Y01	6268.5	3146.3	0.501	1.16	9921.8	4285.7	0.431	0.09	6743.3	3449.8	0.511	1.31	5274.0	3608.5	0.684	1.30
2Y03	266.7	153.3	0.574	1.40	446.1	201.6	0.451	0.19	302.1	157.3	0.520	1.66	270.2	219.3	0.811	2.38
2YQ1	2721.6	1844.6	0.677	0.50	4355.1	2157.0	0.495	0.04	4417.4	1597.1	0.361	0.11	3962.2	2594.7	0.654	1.65
2YR1	136.5	91.9	0.673	0.60	237.8	125.7	0.528	0.13	236.7	84.8	0.358	0.05	307.0	182.6	0.594	1.35
2YS1	910.3	537.0	0.589	0.46	1902.8	818.4	0.430	0.00	1562.8	576.8	0.369	0.43	1455.3	960.8	0.660	1.41
2ZS1	364.4	181.8	0.499	1.03	565.0	216.3	0.382	0.17	389.0	180.3	0.463	1.13	271.5	172.0	0.633	1.68
2ZD1	739.4	347.7	0.470	0.73	1217.0	470.7	0.386	0.11	1261.6	423.5	0.335	0.58	1036.2	458.5	0.442	1.41
2ZE1	1931.0	1126.2	0.583	0.80	3377.0	1469.5	0.435	0.16	3459.8	1295.7	0.374	0.60	2888.3	1489.5	0.515	1.60
2ZF1	922.6	394.9	0.428	1.18	1829.0	585.9	0.320	0.65	1744.9	502.9	0.288	0.31	1532.9	574.5	0.374	1.29
2ZG1	242.2	101.4	0.418	1.37	319.4	94.5	0.296	0.44	318.0	82.9	0.260	0.53	301.0	122.7	0.407	1.07
2ZH1	588.5	349.9	0.594	0.99	1375.9	565.1	0.410	0.09	1010.5	339.6	0.336	0.12	902.1	523.4	0.580	1.73
2ZK1	346.2	145.4	0.419	0.63	510.2	188.8	0.370	0.64	502.4	181.8	0.361	1.00	488.8	223.9	0.458	0.83
2ZM1	173.1	81.4	0.470	0.21	259.4	115.9	0.447	0.97	245.2	90.3	0.368	0.67	234.2	144.9	0.618	1.20
2ZM2	149.6	71.5	0.477	0.64	216.7	102.0	0.470	0.94	197.8	79.8	0.403	0.35	186.0	122.3	0.658	1.10
2ZM3	184.5	64.7	0.350	0.62	249.0	102.6	0.411	1.29	234.5	73.2	0.312	0.88	226.8	108.6	0.479	1.25
2ZM5	99.7	49.9	0.500	0.31	149.0	59.5	0.399	0.60	144.5	47.6	0.329	0.40	146.7	78.6	0.535	0.94
2ZM6	4.2	2.2	0.513	0.51	6.2	2.7	0.447	1.01	5.8	2.7	0.471	1.11	5.3	3.6	0.685	1.21

\* THE FLOWS AT THIS STATION HAVE TO BE CORRECTED BY ADDING 1000 CFS. THIS WILL CHANGE SLIGHTLY THE CV AND CS.

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

MONTHLY FLOW MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION AND COEFFICIENTS OF SKEW  
AT RIVER GAUGING STATIONS AND FLOW REPORTING HYDRO PLANTS

STATION	FEBRUARY				MARCH				APRIL				MAY			
	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS
2YC1	445.9	276.5	0.620	0.91	480.1	283.0	0.589	0.77	927.5	548.2	0.591	1.02	2594.4	758.5	0.292	0.30
2YD1	119.7	94.7	0.791	1.22	134.9	102.2	0.757	1.07	352.9	303.7	0.860	1.84	1487.9	618.5	0.415	0.45
2YK1	2423.2	1457.9	0.601	1.39	2563.8	1587.6	0.619	1.82	6111.7	3229.0	0.528	0.83	14793.8	4387.4	0.296	0.42
2YK2	317.5	184.2	0.580	1.25	328.0	198.4	0.605	1.49	711.2	337.9	0.475	0.67	1567.2	409.9	0.261	0.38
2YK3	197.1	105.5	0.535	1.12	208.0	117.4	0.564	1.54	440.6	234.0	0.531	1.19	1299.7	539.2	0.414	0.43
2YK4	289.9	143.2	0.494	1.17	239.1	124.1	0.519	1.66	511.6	253.2	0.494	0.83	1453.9	403.7	0.277	0.48
2YL1	1383.5	895.6	0.647	0.97	1512.5	939.2	0.620	0.85	3331.1	1756.9	0.527	1.00	8887.2	2559.1	0.287	0.23
2YM1	507.5	243.5	0.479	0.74	590.4	317.5	0.537	0.77	1168.7	530.0	0.453	0.75	2926.6	804.3	0.274	0.53
* 2Y01	4653.6	3486.4	0.749	1.05	4768.5	3938.4	0.825	1.78	11063.7	4840.1	0.437	0.38	21325.6	7767.1	0.364	0.36
2Y03	237.2	149.9	0.631	1.09	254.2	192.7	0.757	1.58	540.4	256.9	0.475	0.78	1244.1	554.1	0.445	0.09
2YQ1	3232.7	1251.8	0.387	0.13	3657.4	2267.1	0.619	1.16	7417.3	2857.1	0.385	0.93	10551.1	4053.5	0.384	0.20
2YR1	255.3	101.7	0.398	0.28	292.9	176.2	0.601	1.18	407.2	145.6	0.357	0.40	549.8	223.4	0.406	0.02
2YS1	1190.7	848.9	0.712	2.60	1185.5	714.4	0.602	1.37	2545.0	1021.0	0.401	0.31	2703.7	1272.6	0.470	0.29
2ZB1	233.0	159.0	0.682	1.22	239.7	174.1	0.726	1.53	576.7	280.4	0.486	0.55	1270.5	412.2	0.324	0.21
2ZD1	840.8	290.8	0.345	0.17	823.2	397.3	0.482	1.39	1137.6	348.5	0.306	0.13	2127.6	709.1	0.333	0.09
2ZE1	2531.9	1054.7	0.416	0.73	2471.7	1312.5	0.531	1.56	3807.4	1689.6	0.443	1.35	6388.2	2501.0	0.391	0.06
2ZF1	1427.4	530.3	0.371	0.99	1368.2	434.8	0.317	1.22	2092.5	637.0	0.304	0.70	2007.0	595.2	0.296	0.03
2ZG1	287.2	84.1	0.292	0.15	313.0	118.3	0.378	0.46	442.8	121.1	0.273	1.01	366.1	116.0	0.316	0.20
2ZH1	825.1	478.6	0.580	1.50	903.3	472.5	0.523	1.72	1734.1	643.4	0.371	0.25	1283.4	538.1	0.419	0.07
2ZK1	430.6	185.7	0.431	1.39	453.7	177.7	0.391	0.40	576.5	203.7	0.353	1.45	363.1	125.6	0.345	0.51
2ZM1	221.6	108.5	0.489	0.62	260.8	122.1	0.468	0.90	379.0	150.6	0.397	0.72	255.1	118.5	0.464	1.09
2ZM2	179.3	93.1	0.519	0.61	205.1	91.1	0.444	0.45	295.3	123.8	0.419	1.14	170.6	79.5	0.466	0.83
2ZM3	212.3	79.8	0.376	0.51	232.6	100.6	0.432	0.75	308.2	126.0	0.408	0.76	215.0	74.7	0.347	0.64
2ZM5	137.5	58.4	0.425	0.79	150.1	62.0	0.413	0.88	203.7	67.6	0.331	0.73	129.2	51.1	0.395	0.67
2ZM6	4.9	2.7	0.551	0.79	6.1	3.2	0.521	0.84	9.2	3.7	0.405	0.41	6.1	2.9	0.481	1.07

\* THE FLOWS AT THIS STATION HAVE TO BE CORRECTED BY ADDING 1000 CFS. THIS WILL CHANGE SLIGHTLY THE CV AND CS.

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

MONTHLY FLOW MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION AND COEFFICIENTS OF SKEW  
AT RIVER GAUGING STATIONS AND FLOW REPORTING HYDRO PLANTS

STATION	JUNE				JULY				AUGUST				SEPTEMBER			
	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS
2YC1	1747.9	724.1	0.414	0.24	631.5	373.8	0.591	2.38	585.1	372.7	0.636	0.92	615.6	322.4	0.523	0.72
2YD1	749.8	423.5	0.564	0.38	174.1	194.6	1.117	3.44	148.3	142.7	0.962	2.17	157.8	130.2	0.825	1.61
2YK1	5993.9	2658.1	0.443	1.34	2964.4	1560.0	0.526	3.12	2838.5	1765.5	0.621	1.17	2943.8	1944.6	0.660	1.14
2YK2	758.9	250.5	0.330	0.55	407.4	189.4	0.464	1.81	347.2	208.4	0.600	1.22	401.1	244.6	0.609	1.01
2YK3	476.7	274.1	0.575	2.12	218.9	113.3	0.517	3.20	195.3	127.6	0.653	1.50	203.8	142.4	0.698	1.17
2YK4	700.8	370.0	0.527	1.38	341.6	157.9	0.462	2.45	315.4	172.0	0.545	1.10	326.7	193.8	0.593	0.96
2YL1	5265.5	2151.8	0.408	0.13	1747.0	1282.8	0.734	2.67	1526.6	1169.0	0.765	1.41	1751.0	1090.8	0.622	0.90
2YM1	1343.0	651.5	0.485	0.54	519.5	395.1	0.760	2.68	426.5	351.7	0.824	1.86	465.1	312.0	0.670	1.35
2Y01	7644.2	3281.3	0.429	1.31	4151.2	2001.7	0.482	0.21	4096.3	3075.6	0.750	1.24	4299.6	3309.3	0.769	0.70
2Y03	370.5	214.9	0.580	2.00	167.3	87.9	0.525	0.44	167.3	142.3	0.850	1.38	200.8	159.1	0.792	0.68
2YQ1	3635.5	1546.5	0.425	0.82	1777.5	824.3	0.463	0.51	1814.5	1394.9	0.768	1.69	1988.1	1413.5	0.710	0.69
2YR1	203.2	87.3	0.429	0.60	97.1	42.1	0.433	0.38	92.8	74.0	0.798	1.80	98.2	72.2	0.734	0.88
2YS1	930.1	453.5	0.487	0.88	579.7	270.5	0.466	0.44	698.7	494.1	0.707	1.63	734.3	525.4	0.715	1.78
2ZB1	495.3	206.1	0.416	1.14	259.4	112.0	0.431	1.15	262.5	152.6	0.581	0.63	288.6	182.3	0.631	0.64
2ZD1	964.4	311.5	0.323	0.40	577.3	211.4	0.366	0.66	563.9	295.1	0.523	1.22	594.0	326.6	0.549	0.77
2ZE1	2604.5	988.8	0.379	0.65	1428.9	690.8	0.483	0.43	1355.0	987.2	0.728	1.29	1466.5	1027.5	0.700	0.75
2ZF1	986.5	281.7	0.285	0.58	687.8	213.9	0.311	0.01	731.9	428.6	0.585	2.62	761.5	372.6	0.489	0.62
2ZG1	210.4	64.7	0.307	0.76	145.4	54.7	0.376	0.16	158.4	69.4	0.438	-0.07	181.2	87.4	0.482	0.12
2ZH1	548.6	263.0	0.479	1.04	321.5	178.0	0.553	0.25	315.6	220.6	0.698	1.18	416.3	341.6	0.820	1.30
2ZK1	223.0	113.1	0.507	0.73	174.1	102.7	0.590	0.34	181.8	95.4	0.524	0.10	236.3	143.3	0.606	0.63
2ZM1	108.7	75.8	0.697	1.24	57.7	40.7	0.705	0.90	67.5	62.1	0.919	1.01	99.1	81.9	0.826	0.99
2ZM2	95.0	58.6	0.617	0.88	51.3	37.2	0.725	0.82	64.1	49.8	0.776	0.93	91.8	78.8	0.857	1.10
2ZM3	124.8	57.4	0.459	0.86	88.9	34.3	0.386	0.63	102.9	48.8	0.474	0.07	125.8	63.9	0.508	0.66
2ZM5	69.1	37.1	0.537	0.48	44.0	18.5	0.421	-0.05	50.7	35.4	0.699	0.79	64.7	43.0	0.665	1.04
2ZM6	2.9	2.0	0.686	1.23	1.4	1.0	0.701	0.70	1.7	1.4	0.872	1.28	2.5	2.0	0.802	0.80

\* THE FLOWS AT THIS STATION HAVE TO BE CORRECTED BY ADDING 1000 CFS. THIS WILL CHANGE SLIGHTLY THE CV AND CS.

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

LABRADOR  
STATISTICS OF MEAN MONTHLY FLOWS

STATION	OCTOBER				NOVEMBER				DECEMBER				JANUARY			
	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS	MEAN	S	CV	CS
30A1	15651.	4246.	0.271	0.30	11563.	3271.	0.282	1.17	8330.	3437.	0.412	2.28	5668.	1647.	0.290	2.48
30B2	31099.	8804.	0.283	0.10	24171.	5594.	0.231	0.52	16981.	5868.	0.345	1.45	11333.	2915.	0.257	0.61
30D2	17710.	5058.	0.285	0.00	14084.	4055.	0.287	0.30	10631.	3873.	0.364	2.20	8058.	2050.	0.254	2.00
30D3	17600.	5960.	0.338	0.16	13442.	4425.	0.329	0.38	9603.	4269.	0.444	2.31	6723.	2015.	0.299	2.23
30E1	65846.	19631.	0.298	0.12	50691.	13610.	0.268	0.85	34657.	13918.	0.401	2.17	23954.	5858.	0.244	1.67
3PB1	8897.	1616.	0.181	0.67	8048.	1051.	0.130	1.67	6912.	1252.	0.181	1.77	5814.	879.	0.151	1.37
	FEBRUARY				MARCH				APRIL				MAY			
30A1	4342.	1025.	0.236	1.12	3604.	821.	0.227	1.01	3252.	1118.	0.343	1.78	20594.	9120.	0.442	0.14
30B2	7911.	2347.	0.296	0.25	6068.	2081.	0.343	0.31	5730.	2672.	0.466	1.10	18141.	5760.	0.317	0.52
30D2	6876.	1897.	0.275	1.61	5971.	1446.	0.242	1.97	5725.	1033.	0.180	0.61	15090.	5816.	0.385	0.34
30D3	5495.	1566.	0.285	2.01	4786.	1339.	0.279	1.93	4013.	1205.	0.300	1.41	9956.	3432.	0.344	0.33
30E1	18522.	3875.	0.209	0.87	15717.	3444.	0.219	0.22	15651.	6350.	0.405	1.36	63102.	21348.	0.338	0.80
3PB1	5064.	692.	0.136	0.54	4619.	649.	0.140	0.41	4249.	521.	0.122	1.13	5352.	947.	0.176	0.02
	JUNE				JULY				AUGUST				SEPTEMBER			
30A1	38530.	13277.	0.344	0.57	20671.	6691.	0.323	0.74	15440.	5315.	0.344	0.66	16053.	5607.	0.349	0.16
30B2	64810.	18560.	0.286	0.19	45064.	14323.	0.317	0.77	31094.	11102.	0.357	0.45	31010.	9718.	0.313	0.32
30D2	40655.	13435.	0.330	0.62	27382.	10081.	0.368	1.06	18771.	6898.	0.367	0.19	18217.	5685.	0.312	0.16
30D3	37716.	8776.	0.232	1.33	28316.	10432.	0.368	1.18	18747.	6553.	0.349	0.18	18307.	6328.	0.345	0.01
30E1	143393.	33505.	0.233	0.50	99871.	36158.	0.362	1.02	66017.	23417.	0.354	0.27	66130.	23184.	0.350	0.10
3PB1	11077.	1731.	0.156	1.33	10376.	1776.	0.171	0.69	9138.	2154.	0.235	0.51	9113.	1756.	0.192	0.19

TABLE 17-15B

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
OCTOBER

	ACTUAL	PREDICTED	DEVIATION	
1	799.29443	808.22815	-8.93371	TORRENT RIVER AT BRYSTERS POND (21c3)
2	233.92538	263.12329	-29.19787	BEAVER BROOK NEAR FIDDICHTON (21d1)
3	3994.21191	4178.18458	-183.97219	HUMBER RIVER AT GRAND LAKE OUTLET (21x1)
4	541.40612	518.72534	22.68078	LEWISSEVILLE BROOK AT LITTLE GRAND LAKE (21x2)
5	272.74023	281.69384	-8.95361	SHEFFIELD RIVER AT SHEFFIELD LAKE (21x3)
6	441.55462	401.57299	39.98163	WINDS BROOK NEAR GRAND LAKE (21x4)
7	2540.06736	2430.66797	109.39942	UPPER HUMBER RIVER AT SEAL POND (21x1)
8	705.66491	699.52661	6.13830	INDIAN BROOK AT INDIAN FALLS (21y1)
9	7201.41798	6338.99513	862.42297	EXPLOITS RIVER AT GRAND FALLS (21y1)
10	266.70312	262.84661	3.85650	RATTLING BROOK AT RATTILING LAKE (21y3)
11	2721.62207	2936.93213	-215.31008	GANDER RIVER AT BIG CHUTE (21y1)
12	136.51828	169.68374	-33.16547	MIDDLE BROOK NEAR DAMUD (21y1)
13	910.33130	923.90454	-13.57324	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21y1)
14	364.44366	419.13061	-54.68695	ISLE AUX PORTS RIVER ABOVE HIGHWAY BRIDGE (22a1)
15	739.47961	693.11450	46.36512	GREY RIVER NEAR FUDOPS LAKE (22a1)
16	1930.99414	1949.10351	-18.10937	SALMON RIVER AT LONG POND (22a1)
17	922.62683	965.80896	-43.18213	BAY DU NORD RIVER AT BIG FALLS (22a1)
18	242.25885	258.83644	-16.57759	GARNISH RIVER NEAR GARNISH (22a1)
19	588.55395	633.49450	-44.94055	PIPER'S MOLE RIVER AT MOTHER'S BROOK (22b1)
20	346.25842	292.89428	53.36414	ROCKY RIVER NEAR COLINE (22c1)
21	173.11084	165.49539	7.61544	PETTY HARBOUR RIVER AT SECOND POND (22b1)
22	149.66661	125.55297	24.11362	PIERCE'S BROOK AT MILL POND (22c2)
23	184.55514	165.35199	19.20315	MOBILE RIVER AT MOBILE FISH POND (22c3)
24	99.77761	106.07019	-6.29257	SEAL COVE RIVER AT WHITE HILL POND (22c3)
25	4.28885	4.22505	0.06382	NORTHEAST POND RIVER AT NORTHEAST POND (22c3)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERSHOEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - MONTHLY AV. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9974

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.1058  
CONSTANT -1.5946

VARIABLE (X <sub>i</sub> )	COEFF. (C <sub>i</sub> )	STANDARD ERROR
X - 1	1.02319550	0.02273467
X - 3	-0.06856486	0.03849197
X - 6	-0.07036133	0.04364369
X - 9	0.18066553	0.05572863
X - 13	1.00862875	0.15655615

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (C<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTI-LOG CONSTANT} \prod_{i=1}^n X_i^{C_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
NOVEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	991.18310	1086.70141	-95.51820	TORRENT RIVER AT BRISTOLS POOL (2721)
2	364.18451	374.65656	-10.47206	BEAVER BROOK NEAR REGULATION (2701)
3	5814.20509	5664.98927	149.21582	NUMBER RIVER AT GRAND CAYS DURET (2711)
4	783.33176	683.07251	100.25925	KAHSELEHALLOR BROOK AT LITTLE GRAND LAKE (2722)
5	402.66595	405.39123	-2.72528	SHEFFIELD RIVER AT SHEFFIELD LAKE (2713)
6	659.85046	710.64892	-50.79846	HINDS BROOK NEAR GRAND LAKE (2714)
7	3351.43115	3122.39990	229.03125	UPPER NUMBER RIVER AT SEAL POND (2711)
8	937.59057	980.74597	-43.15540	INDIAN BROOK AT INDIAN FALLS (2701)
9	11194.03321	11715.81642	-521.78321	EXPLOITS RIVER AT GRAND FALLS (2701)
10	446.18432	410.76005	35.42427	RATTILING BROOK AT RATTILING LAKE (2703)
11	4355.13673	4968.27051	-613.13378	GRAND RIVER AT BIG CHUTE (2701)
12	237.85128	316.19177	-78.34049	MIDDLE BROOK NEAR GRAND (2701)
13	1902.84717	1631.58545	271.26172	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2711)
14	5665.07275	6244.78888	-579.71613	ISLE AUX MARCS RIVER ABOVE REGINAUT BRIDGE (2711)
15	1216.99662	1265.40649	-48.40987	GREY RIVER NEAR PUDONS LAKE (2701)
16	8879.06592	3701.24317	5177.82275	SALMON RIVER AT LONG POND (2721)
17	1828.99585	1726.74414	102.25171	BAF DU NORD RIVER AT BIG FALLS (2711)
18	319.00680	396.09941	-77.09261	BARNISH RIVER NEAR BARNISH (2701)
19	1375.92187	926.08186	449.84001	RIPERT'S HOLE RIVER AT ROTHER'S BROOK (2701)
20	510.25824	467.40588	42.85236	ROCKY RIVER NEAR COLVART (2701)
21	259.40686	239.01074	20.39612	PETTY HARBOUR RIVER AT SECOND POND (2701)
22	216.74026	216.39700	0.34326	PIERRE'S BROOK AT BULL POND (2702)
23	249.03649	225.24850	23.78799	MOULLE RIVER AT MOULLE FIRST POND (2703)
24	149.03674	144.23648	4.80026	SEAL COVE RIVER AT WHITE KILL POND (2705)
25	6.20739	6.37267	-0.16527	NORTHEAST POND RIVER AT NORTHEAST POND (2715)

X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA * OF LAKE	(LOG VALUES)
X-3 - UNIT AREA * OF FOREST	(LOG VALUES)
X-4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - MONTHLY AV. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9951

\* TOTAL AREA OF LAKE, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP. VARIABLE \* 0.1476  
CONSTANT 3.6408

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.96966078	0.02186981
X - 5	-0.31757481	0.00180086
X - 8	-0.37939745	0.05204028
X - 11	0.35258166	0.07955029

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
DECEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	667.44262	760.55517	-93.11256	TORRENT RIVER AT BRISTOLS POND (21c1)
2	195.36996	283.33355	-87.96357	BEAVER BROOK NEAR ROSSINGTON (21d1)
3	4038.83643	3781.70959	257.12750	HUMBER RIVER AT GRAND LAKE DUTCH (21k1)
4	525.70263	475.49746	50.20512	LEWASEECHZEL BROOK AT LITTLE GRAND LAKE (21K2)
5	297.33262	344.11615	-46.78332	SHIFFIELD RIVER AT SHIFFIELD LAKE (21K3)
6	544.77636	503.32135	41.45496	MINDS BROOK NEAR GRAND LAKE (21K4)
7	2144.95703	1700.94360	364.01324	UPPER HUMBER RIVER AT SEAL POND (21L1)
8	685.14660	772.30896	-87.16236	INDIAN BROOK AT INDIAN FALLS (21M1)
9	7718.01075	8820.36721	-1102.35671	EXPLOITS RIVER AT GRAND FALLS (21d1)
10	302.11053	354.52954	-52.41901	RATTILING BROOK AT RATTILING LAKE (21O3)
11	4417.39649	4005.86572	408.53033	BANDER RIVER AT BIG CUTE (21Q1)
12	236.70312	266.05914	-29.35599	MIDDLE BROOK NEAR GAMB (21R1)
13	1562.88428	1340.70361	222.18067	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	389.07312	538.55761	-149.48446	ISLE DU NORTS RIVER ABOVE HIGHWAY BRIDGE (22b1)
15	1261.66357	1354.82890	-92.96534	GREY RIVER NEAR FROOPS LAKE (22D1)
16	3459.84229	3246.28076	213.56155	SALMON RIVER AT LONG POND (22L1)
17	1744.92541	1568.92773	175.99270	WAT OH NORD RIVER AT BIG FALLS (22F1)
18	318.03629	351.66424	-33.62799	GARVISH RIVER NEAR GARVISH (22G1)
19	1010.55310	855.89111	154.66201	PIPER'S HOLE RIVER AT MOUNTAIN'S BROOK (22H1)
20	502.40631	432.82885	69.58247	ROCKY RIVER NEAR COUNLET (22K1)
21	245.22161	242.67807	2.54354	PETTY HARBOUR RIVER AT SECOND POND (22M1)
22	197.81436	195.98998	1.82436	PIERRE'S BROOK AT GULL POND (22M2)
23	234.55511	205.10924	29.44583	MOBILE RIVER AT MOBILE FIRST POND (22M3)
24	144.59234	117.22349	27.36883	SEAL COVE RIVER AT WHITE HILL POND (22N5)
25	5.87406	5.39365	0.48041	NORTHEAST POND RIVER AT NORTHEAST POND (22P5)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA ° OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA ° OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA ° OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X101)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X101)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - MONTHLY AV. FLOW	(LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9933

\* TOTAL AREA OF LAKE, FOREST, OR BOG AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.1690  
CONSTANT 2.5078

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.95854687	0.02331753
X - 8	-0.36267463	0.06223832
X - 12	-0.08601167	0.04964099

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$Y_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
JANUARY

	ACTUAL	PREDICTED	DEVIATION	
1	513.811769	626.66894	-112.75717	TORRENT RIVER AT BRISTOLS POOL (2Y1)
2	146.44415	266.79754	-120.35339	BEAVER BROOK NEAR BODDICKTON (2Y1)
3	2995.17481	2669.54346	325.63135	HUMBER RIVER AT GRAND LAKE OUTLET (2Y1)
4	399.99902	348.98502	50.91400	LEHRSCHMULLER BROOK AT LITTLE GRAND LAKE (2Y2)
5	229.66616	209.10532	20.56084	SHEFFIELD RIVER AT SHEFFIELD LAKE (2Y3)
6	428.73986	420.85492	7.88494	HINDS BROOK NEAR GRAND LAKE (2Y4)
7	1663.95923	1382.90366	281.05557	UPPER HUMBER RIVER AT SEAL POND (2Y1)
8	678.59118	660.04174	18.54944	INDIAN BROOK AT INDIAN TALKS (2Y1)
9	6145.08985	6938.74913	-793.65928	EXPLITS RIVER AT GRAND FALLS (2Y1)
10	270.22168	374.51678	-104.29510	RATTLING BROOK AT RATTLING LAKE (2Y3)
11	3962.28223	3522.33936	439.94287	GARDER RIVER AT BIG CHUTE (2Y1)
12	307.07330	274.31921	32.75409	MIDDLE BROOK NEAR DANDY (2Y1)
13	1455.32954	1267.16479	188.16475	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2Y1)
14	271.51794	371.72142	-100.20348	ISLE AUX MOIS RIVER ABOVE HIGHWAY BRIDGE (2Y1)
15	1036.21997	1066.50850	-30.28853	GREY RIVER NEAR PODDYS LAKE (2Y1)
16	2888.32617	2963.77149	-75.44532	SALMON RIVER AT LONG POND (2Y1)
17	1532.95923	1510.93701	22.02222	BAY DU MOUD RIVER AT BIG FALLS (2Y1)
18	300.99926	301.21264	-0.21338	GARNISH RIVER NEAR GARNISH (2Y1)
19	902.14599	871.96262	30.18337	PIPER'S HOLE RIVER AS MOTHER'S BROOK (2Y1)
20	488.85058	463.17021	24.68037	ROCKY RIVER NEAR COLINEE (2Y1)
21	234.29577	181.73773	52.55804	PETEY HARBOR RIVER AT SECOND POND (2Y1)
22	185.99963	167.12490	18.87473	PEERRE'S BROOK AT GOEL POND (2Y2)
23	226.88859	178.91856	47.97003	MOBILE RIVER AT MOBILE FIRST POND (2Y3)
24	146.74041	113.32420	33.41621	SEAL COVE RIVER AT WHITE HILL POND (2Y5)
25	5.34813	5.46584	-0.11771	NORTHEAST POND RIVER AT NORTHEAST POND (2Y6)

X-1 - AREA OF WATERSHED(SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA * OF LAKE	(LOG VALUES)
X-3 - UNIT AREA * OF FOREST	(LOG VALUES)
X-4 - UNIT AREA * OF SWAMP AND BGS	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIR (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIR (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT. / 1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS / SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - MONTHLY AV. FLOW	(LOG VALUES)

COEFFICIENT OF CORRELATION  $R=0.9886$

\* TOTAL AREA OF LAKES, FOREST, OR BGS AND SWAMPS DIVIDED BY WATERSHED AREA.

STANDARD ERROR OF DEP. VARIABLE = 0.2154			
CONSTANT = 4.1615			
VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR	
X - 1	0.09739358	0.0018083	
X - 2	-0.33246237	0.05998218	
X - 9	-0.28756015	0.09339454	

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTELOG CONSTANT} + \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
FEBRUARY

	ACTUAL	PREDICTED	DEVIATION
1	449,95179	935,94995	-485,99816
2	219,74055	239,74816	-19,99761
3	2423,21533	2471,11426	-47,99893
4	317,59194	278,00177	39,59017
5	157,14767	211,79559	-54,64792
6	289,92541	321,45697	-31,53156
7	1343,51333	1176,51929	206,99404
8	507,51721	564,77795	-57,26074
9	5533,09274	5404,70899	128,38375
10	217,29574	303,75085	-86,45511
11	3222,76753	3050,23828	172,52925
12	255,33273	234,13339	21,19934
13	1190,73730	1035,79614	154,94116
14	232,99950	303,06452	-70,06502
15	140,88656	126,14160	14,74496
16	2531,92944	2768,99854	-237,06910
17	1427,44116	1386,11181	41,32935
18	267,29577	308,79504	-41,49927
19	825,18286	699,92566	125,25720
20	430,66552	438,29937	-7,63385
21	221,66649	185,50306	36,16343
22	179,36949	131,69616	47,67333
23	212,33274	151,47137	60,86137
24	127,59229	114,98253	12,60976
25	4,96665	5,20283	-0,23617

TORRENT RIVER AT BRAYLES FORD (21x1)
WALTON BROOK NEAR REDDYKING (21x1)
WOMER RIVER AT GRAND LAKE (21x1)
LEWISLUNDY BROOK AT LITTLE GRAND LAKE (21x2)
SHEFFIELD RIVER AT SHEFFIELD LAKE (21x3)
WINDS BROOK NEAR GRAND LAKE (21x4)
UPPER NORTH RIVER AT SEAL POND (21x5)
INDIAN BROOK AT INDIAN FALLS (21x1)
EXPLOITS RIVER AT GRAND FALLS (21x1)
BATTILING BROOK AT BATTILING LAKE (21x5)
GARDEN RIVER AT WIG LIGHT (21x1)
MIDDOLL BROOK NEAR DUNDY (21x1)
TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21x5)
ISLE DU MONT RIVER ABOVE HIGHWAY BRIDGE (22x1)
GREY RIVER NEAR FUDGE LAKE (22x1)
SALMON RIVER AT LONG POND (22x1)
BOY IN MOON RIVER AT BIG TILLS (22x1)
GARRETT RIVER NEAR LARVISH (22x1)
PIPER'S HOLE RIVER AT MOTHER'S BROOK (22x1)
ROCKY RIVER NEAR COLINET (22x1)
PETTY HARBOUR RIVER AT SECOND POND (22x1)
PIPER'S BROOK AT GILL POND (22x1)
MOBILE RIVER AT MOBILE FIRST POND (22x5)
SEAL CREEK RIVER AT WHITE HILL POND (22x5)
NORTHEAST POND RIVER AT NORTHEAST POND (22x5)

X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA * OF LAKE	(LOG VALUES)
X-3 - UNIT AREA * OF FOREST	(LOG VALUES)
X-4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 10)	(LOG VALUES)
X-13 - UNIT AVG. ANNUAL FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - MONTHLY AVG. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R = 0.906

\* TOTAL AREA OF LAKES, FOREST, OR Bogs AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP. VARIABLE = 0.2302

CONSTANT = 4.1329

VARIABLE (X <sub>i</sub> )	COEFF. (R <sub>C</sub> )	STANDARD ERROR
X-1	0.92547763	0.03801669
X-4	-0.5767305	0.07104198
X-8	-0.3081429	0.06731373
X-9	-0.3312751	0.10059340

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (R<sub>C</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{R_{C_i}}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
MARCH

	ACTUAL	PREDICTED	DEVIATION
1	480.14709	574.36987	-94.22278
2	134.96267	236.88696	-101.92429
3	2563.84473	2535.71582	28.12891
4	327.99945	271.24231	56.75714
5	207.99960	217.61242	-9.61282
6	239.14755	324.20562	-85.05807
7	1512.55176	1249.96509	262.58667
8	590.44299	640.59521	-50.15222
9	5737.75977	5934.84181	-197.08204
10	254.29583	407.93268	-153.63685
11	3657.46631	3109.81572	547.65059
12	292.96246	225.05076	67.91170
13	1185.51489	925.75573	259.75916
14	239.77737	269.94860	-30.17123
15	823.29394	824.58654	-1.29260
16	24714.7002	2871.21531	21843.48489
17	1468.25537	1276.37993	191.87544
18	313.07330	409.59355	-96.52025
19	903.33154	901.72363	1.60791
20	453.70282	445.18555	8.51727
21	260.88824	202.78879	58.09945
22	205.11085	143.85100	61.25985
23	232.62905	186.42761	46.20144
24	150.14791	140.75061	9.39730
25	6.18517	5.90272	0.28245

- TORRENT RIVER AT BRISTOLS POOL (21E1)
- BEAVER BROOK NEAR RODDICKTON (21F1)
- HUMBER RIVER AT GRAND LAKE OUTLET (21K1)
- LEWISSECHASLEY BROOK AT LITTLE GRAND LAKE (21K2)
- SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
- MINDS BROOK NEAR GRAND LAKE (21K4)
- UPPER HUMBER RIVER AT SEAR POND (21L1)
- INDIAN BROOK AT INDIAN FALLS (21M1)
- EXPLOITS RIVER AT GRAND FALLS (21R1)
- BATTILING BROOK AT BATTILING LAKE (21S1)
- GARDNER RIVER AT BIG CHUTE (21U1)
- MIDDLE BROOK NEAR GARD (21Y1)
- TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
- ISLE AUX MORTS RIVER ABOVE HIGHWAY BRIDGE (22B1)
- GREY RIVER NEAR PUDOPS LAKE (22D1)
- SALMON RIVER AT LONE POND (22I1)
- BAY DU NORD RIVER AT BIG FALLS (22F1)
- GARNSH RIVER NEAR GARNSH (22G1)
- PETER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
- ROCKY RIVER NEAR COLLECT (22F1)
- PETER HARBOR RIVER AT SECOND POND (22M1)
- PIERRE'S BROOK AT GULL POND (22M2)
- MOBILE RIVER AT MOBILE FIRST POND (22M3)
- SEAR LAKE RIVER AT WHITE HILL POND (22M5)
- NORTHEAST POND RIVER AT NORTHEAST POND (22N5)

- X-1 - AREA OF WATERSHED (SQ. KM.) (LOG VALUES)
- X-2 - UNIT AREA \* OF LAKE (LOG VALUES)
- X-3 - UNIT AREA \* OF FOREST (LOG VALUES)
- X-4 - UNIT AREA \* OF SWAMP AND BOG (LOG VALUES)
- X-5 - AVGE. COEFF. OF OVERBURDEN (LOG VALUES)
- X-6 - SHORTEST DIST. TO SEA (KM.) (LOG VALUES)
- X-7 - DIST. TO SEA IN SE. DIR. (KM.) (LOG VALUES)
- X-8 - DIST. TO SEA IN SW. DIR. (KM.) (LOG VALUES)
- X-9 - AVGE. SLOPE (FT./1000 FT.) (LOG VALUES)
- X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.) (LOG VALUES)
- X-11 - AVGE. ELEVATION (FT. X10) (LOG VALUES)
- X-12 - AVGE. BARREN HT. (FT. X10) (LOG VALUES)
- X-13 - UNIT AVG. AN. FLOWS (SQ. KM.) (LOG VALUES)

STANDARD ERROR OF DEP VARIABLE = 0.2479  
CONSTANT = 2.9402

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.98701534	0.04961388
X - 3	-0.13118399	0.07188700
X - 6	-0.30495959	0.06877294
X - 9	-0.25783658	0.11255008

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$Y_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

DEPENDENT VARIABLE - MONTHLY AV. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9...

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
APRIL

	ACTUAL	PREDICTED	DEVIATION	
1	927.51611	965.33923	-37.82312	TORRENT RIVER AT BRISTOLS POOL (2Y01)
2	352.96221	401.43470	-48.47249	NEVER BROOK NEAR RODDICKTON (2Y01)
3	6111.68262	5520.95095	590.73167	HUMBER RIVER AT GRAND LAKE OUTLET (2YK1)
4	711.25781	606.44616	104.81165	LEHASELCHUECHY BROOK AT LITTLE GRAND LAKE (2YK2)
5	440.66577	447.69445	-7.02868	SHEPHERD RIVER AT SHEPHERD LAKE (2YK3)
6	511.62841	653.04858	-141.42017	HINDS BROOK NEAR GRAND LAKE (2YK4)
7	3331.13965	2509.42871	821.71100	UPPER HUMBER RIVER AT SEAL POND (2Y11)
8	1168.70141	1237.25488	-68.55347	INDIAN BROOK AT INDIAN FALLS (2Y11)
9	12237.88055	13151.68551	-913.80496	EXPLOITS RIVER AT GRAND FALLS (2Y01)
10	540.44299	550.22900	-9.78601	BATTLING BROOK AT BATTLING LAKE (2Y03)
11	7417.34278	6747.07911	670.26367	GANDER RIVER AT BIG CHUTE (2Y11)
12	407.29547	462.24377	-54.94830	MIDDLE BROOK NEAR GAMO (2Y11)
13	2544.99463	2014.80278	530.19185	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2Y51)
14	576.73950	601.03283	-24.29333	ISLE AUX MOUS RIVER ABOVE HIGHWAY BRIDGE (2Z61)
15	1147.66357	1205.35628	-57.69271	GREY RIVER NEAR PUDOPS LAKE (2Z01)
16	3807.46729	4711.29044	-903.82315	SALMON RIVER AT LONG POND (2Z61)
17	2092.58691	2277.71826	-185.13135	BAY DU NORD RIVER AT BIG FALLS (2Z51)
18	442.88775	563.94702	-121.05927	GANNISH RIVER NEAR GANNISH (2Z01)
19	1734.18042	1309.14917	425.03125	PAPER'S HOLE RIVER AT MOTHER'S BROOK (2Z11)
20	576.59106	703.20793	-126.61687	ROCKY RIVER NEAR COLINET (2ZK1)
21	379.03625	390.17773	-11.14148	PETTY HARBOUR RIVER AT SECOND POND (2ZM1)
22	295.33258	274.19445	21.13813	PIERRE'S BROOK AT GULL POND (2ZM2)
23	308.25866	280.75354	27.50512	MOBILE RIVER AT MOBILE FIRST POND (2ZM3)
24	203.77743	207.18231	-3.40488	SEAL COVE RIVER AT WHITE HILL POND (2ZM5)
25	9.21479	8.89883	0.31596	NORTHEAST POND RIVER AT NORTHEAST POND (2ZM6)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 101)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 101)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

STANDARD ERROR OF DEP VARIABLE = 0.1693

CONSTANT

3.3969

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.9874854	0.0249693
X - 8	-0.27058291	0.0084441
X - 11	-0.26721841	0.0373483
X - 12	-0.10018076	0.0109894

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{(P)} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

DEPENDENT VARIABLE - MONTHLY AV. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION = 0.9931

\* TOTAL AREA OF LAKES, FOREST, OR BODS AND SWAMPS DIVIDED BY WATERSHED AREA

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
MAY

	ACTUAL	PREDICTED	DEVIATION	
1	2594.42750	1845.47929	698.95821	TRINITY RIVER AT BRISTOL'S FALL (21K1)
2	1487.95898	786.36242	701.59656	NEVER BROOK NEAR BODDICKSON (21U1)
3	14791.80471	18646.39067	-1852.58596	MURDER RIVER AT GRAND LAKE OUTLET (21K1)
4	1567.25439	1608.13696	-40.88257	LEWISLORCHIE BROOK AT LITTLE GRAND LAKE (21K2)
5	1299.73706	927.05102	372.68597	SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
6	1453.95890	2116.79151	-662.83259	HINDS BROOK NEAR GRAND LAKE (21K4)
7	8687.18947	12931.35158	-4044.16260	UPPER HUNTER RIVER AT SEAL POND (21L1)
8	2426.62061	2264.66846	661.95227	INDIAN BROOK AT INDIAN FALLS (21M1)
9	22539.95708	24549.66410	-6909.70702	ELPHINSTON RIVER AT GRAND FALLS (21D1)
10	1244.18164	689.51452	558.66711	RATTLING BROOK AT RATTILING LAKE (21O3)
11	10551.10108	9909.82033	641.28137	SENDER RIVER AT BIG CHUTE (21O1)
12	549.88745	491.23870	58.64865	MIDDLE BROOK NEAR DAMMO (21O1)
13	2703.77149	3010.46387	-326.69238	TERRA NIVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	1270.58939	840.43335	630.15600	ISLE AUX MOUTS RIVER ABOVE HIGHWAY BRIDGE (22H1)
15	2127.66211	2398.92285	-271.26080	BREY RIVER NEAR PUDOP'S LAKE (22D1)
16	5388.27344	5887.19727	501.92383	SALMON RIVER AT LONG POND (22E1)
17	2007.03174	2184.90635	-177.87459	MAT DE BORD RIVER AT BIG FALLS (22F1)
18	100.18420	438.07908	-71.89487	ABBINISH RIVER NEAR ABBINISH (22G1)
19	1283.44116	1267.98398	15.45717	FISHER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
20	363.14752	355.46569	7.68188	NOELY RIVER NEAR COLINET (22K1)
21	250.14749	299.66058	-49.51306	ZELLY WARRIOR RIVER AT SECOND POND (22M1)
22	170.66641	277.10424	-106.43782	FISHER'S BROOK AT SOLE POND (22M2)
23	210.07386	264.17651	-54.10282	NEWELL RIVER AT MOBILE FIRST POND (22N3)
24	129.25887	179.73849	-50.47953	DEACON RIVER AT WHITE HILL POND (22N5)
25	6.17605	7.82706	-1.65100	NORTHEAST POND RIVER AT NORTHEAST POND (22N5)

- X- 1 - AREA OF WATERSHED (SQ. KM.) (LOG VALUES)
- X- 2 - UNIT AREA \* OF LAKE (LOG VALUES)
- X- 3 - UNIT AREA \* OF FOREST (LOG VALUES)
- X- 4 - UNIT AREA \* OF SWAMP AND BOG (LOG VALUES)
- X- 5 - AVGE. COEFF. OF OVERBURDEN (LOG VALUES)
- X- 6 - SHORTEST DIST. TO SEA (KM.) (LOG VALUES)
- X- 7 - DIST. TO SEA IN SW. DIRECTION (KM.) (LOG VALUES)
- X- 8 - DIST. TO SEA IN NW. DIRECTION (KM.) (LOG VALUES)
- X- 9 - AVGE. SLOPE (FT. / 100 FT.) (LOG VALUES)
- X- 10 - AVGE. AZ. OF SLOPE (DEG. FROM N.) (LOG VALUES)
- X- 11 - AVGE. ELEVATION (FT. X 10) (LOG VALUES)
- X- 12 - AVGE. BARRIER HT. (FT. X 10) (LOG VALUES)
- X- 13 - UNIT AVERAGE FLOWS (CFS / SQ. KM.) (LOG VALUES)

DEPENDENT VARIABLE - MONTHLY AVERAGE FLOW (LOG VALUES)  
COEFFICIENT OF CORRELATION 0.909809

\* TOTAL AREA OF LAKE, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF THE VARIABLE = 0.3421  
CONSTANT = 4.6749

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X - 4	1.04740524	0.05050692
X - 5	-1.20495510	0.16621717
X - 11	0.50267653	0.17876541

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
JUNE

	ACTUAL	PREDICTED	DEVIATION	
1	1747.92187	1349.52140	398.40047	TORRENT RIVER AT BRISTOLS FORD (21c1)
2	749.88720	379.40228	370.48492	BEVER BROOK NEAR BUDOCKTON (21d1)
3	593.94141	6235.08888	-5641.14747	NUMBER RIVER AT GRAND LAKE OUTLET (21k1)
4	758.96118	523.07053	235.89065	LEWISSECHUECH BROOK AT LITTLE GRAND LAKE (21K2)
5	478.70282	365.25264	113.45018	SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
6	700.85009	777.78266	-76.93257	WINDS BROOK NEAR GRAND LAKE (21K4)
7	5265.53614	7970.04200	-2704.50586	UPPER NUMBER RIVER AT SIAK POND (21L1)
8	1343.07104	424.57617	918.49487	INDIAN BROOK AT INDIAN FALLS (21M1)
9	6649.89848	4022.01369	2627.88479	EXPLOITS RIVER AT GRAND FALLS (21O1)
10	370.51763	296.55630	73.96133	RAITLING BROOK AT RAITLING LAKE (21O3)
11	3635.54395	3818.82031	-183.27636	GANDER RIVER AT BIG CHUTE (21Q1)
12	203.25881	204.86625	-1.60744	MIDDLE BROOK NEAR GAMMA (21R1)
13	980.14611	1443.99049	-463.84438	TERRA NOVA RIVER AT EXCH MILE BRIDGES (21S1)
14	495.33239	397.66465	97.66774	ISLE AND MOUNTS RIVER ABOVE HINCHY BRIDGE (22a1)
15	964.47888	1035.06836	-70.58948	GRET RIVER NEAR PUDOP LAKE (22D1)
16	2604.54736	2348.87451	255.67285	SALMON RIVER AT LONG POND (22E1)
17	986.55359	1074.54220	-87.98861	BAY DU WORD RIVER AT BIG FALLS (22F1)
18	210.40889	194.45126	15.95763	GANNISH RIVER NEAR GANNISH (22G1)
19	548.66540	593.94433	-45.27893	FIPER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
20	222.99954	208.33969	14.65985	ROCK RIVER NEAR COLIMER (22K1)
21	108.70349	119.71441	-11.01092	PITTY MOUNTAIN RIVER AT SECOND POND (22M1)
22	99.03689	108.79298	-9.75609	PIERRE'S BROOK AT BULL POND (22M2)
23	124.88865	154.35566	-29.46701	MOULLE RIVER AT MOULLE FIRST POND (22M3)
24	69.11097	86.81895	-17.70798	SERL LIXE RIVER AT WHITE BULL POND (22M5)
25	2.92221	35.03346	-32.11125	NORTHEAST POND RIVER AT NORTHEAST POND (22N1)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT. / 100 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X101)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X101)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS / SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE = MONTHLY AV. FLOW \* (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9870

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.2749

CONSTANT 8.7883

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	1.00890422	0.00134624
X - 2	-1.15870905	0.24050724
X - 7	0.21226786	0.00938135
X - 11	0.29902297	0.10021881
X - 13	1.80634951	0.40098869

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

$$\prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
JULY

	ACTUAL	PREDICTED	DEVIATION	
1	631,5913.	639,60044	8,009.1	TORRENT RIVER AT BRISTOLS FORD (27x1)
2	174,18493	139,93396	34,25097	BEVER BROOK NEAR WOODSTOCK (27x1)
3	296,44726	276,11320	20,33406	NUMBER RIVER AT GRAND LAKE LITTLE (27x1)
4	427,44348	351,16131	76,28217	WINDS BROOK NEAR GRAND LAKE (27x2)
5	216,42547	177,41000	39,01547	SHEFFIELD RIVER AT SHEFFIELD LAKE (27x3)
6	341,62896	393,55169	-51,92273	WINDS BROOK NEAR GRAND LAKE (27x4)
7	1746,49952	1872,71216	-126,21264	UPPER NUMBER RIVER AT SEAL POND (27x1)
8	519,459131	421,19731	98,26182	INDIAN BROOK AT INDIAN FALLS (27x1)
9	5019,76368	5345,17090	-325,40722	EXPLOITS RIVER AT GRAND FALLS (27x1)
10	167,33303	163,63082	3,70221	WATLING BROOK AT WATLING LAKE (27x1)
11	1777,58740	1956,83276	-179,24536	WANDER RIVER AT MAD HUNT (27x1)
12	97,18502	111,51618	-14,33116	WINDY BROOK NEAR GRAND (27x1)
13	579,70239	706,60632	-126,90393	TERRA NOVA RIVER AT EIGHT HILL BRIDGES (27x1)
14	259,40686	273,49039	-14,08353	1561 BAY MOUNTS RIVER ABOVE HIGHWAY BRIDGE (27x1)
15	577,76902	580,44112	-2,67210	GREY RIVER NEAR FIDORS LAKE (27x1)
16	1476,492283	1502,14111	-25,64883	SALMON RIVER AT LONG POND (27x1)
17	687,45566	720,56347	-33,10781	WATLING BROOK RIVER AT WATLING FALLS (27x1)
18	145,44410	112,53200	32,91210	WINDY RIVER NEAR WINDY (27x1)
19	32,45414	34,10338	-1,64924	PIPER'S HOLE RIVER AT MOON'S BROOK (27x1)
20	174,11068	143,28348	30,82720	WINDY RIVER NEAR COLLIER (27x1)
21	579,77784	639,9691	-60,19127	WINDY BROOK RIVER AT SECOND POND (27x1)
22	51,33328	66,38134	-15,04806	PIPER'S HOLE RIVER AT COLLIER POND (27x1)
23	88,92378	74,19561	14,72817	MOBILE RIVER AT MOBILE FIRST POND (27x1)
24	444,03698	461,19153	-17,15455	SEAL EDGE RIVER AT BRILLIANT POND (27x1)
25	1442,682	1408,190	34,492	NORTHEAST POND RIVER AT NORTHEAST POND (27x1)

X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)	STANDARD ERROR OF DEP VARIABLE *	0.1675
X-2 - LAKE AREA % OF LAKE	(LOG VALUES)	CONSTANT	2.7641
X-3 - UNIT AREA % OF FOREST	(LOG VALUES)	VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )
X-4 - UNIT AREA % OF SWAMP AND BOG	(LOG VALUES)	x = 1	0.95800199
X-5 - AVERAGE COEFF. OF OVERBURDEN	(LOG VALUES)	x = 5	-0.28907696
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)	x = 7	0.11045453
X-7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)	x = 8	-0.4494222
X-8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)	x = 13	0.01001568
X-9 - AVERAGE SLOPE (FT./1066 FT.)	(LOG VALUES)		
X-10 - AVERAGE AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)		
X-11 - AVERAGE ELEVATION (FT. X 10)	(LOG VALUES)		
X-12 - AVERAGE BARRIER HT. (FT. X 10)	(LOG VALUES)		
X-13 - UNIT AVERAGE FLOW (CMS/SQ. KM.)	(LOG VALUES)		

DEPENDENT VARIABLE - MONTHLY AVERAGE FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION: 0.9049999

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA.

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

TABLE 17-25

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
AUGUST

	ACTUAL	PREDICTED	DEVIATION	
1	589,18420	537,87207	-51,31214	TORRENT RIVER AT BRISTOLS POND (2701)
2	148,33300	191,83221	+43,50920	BLAVER BROOK NEAR ROBUCKTON (2701)
3	2438,54745	2819,16992	+380,62247	HUMBER RIVER AT GRAND JOUR GUILLET (2701)
4	347,29553	321,03479	-26,26074	LESLIECHOUQUEN BROOK AT LITTLE GRAND LAKE (2702)
5	195,36996	161,60327	-33,76670	SHEFFIELD RIVER AT SHEFFIELD LAKE (2703)
6	319,40661	317,99713	-1,40948	WINDS BROOK NEAR GRAND LAKE (2703)
7	1526,82822	1096,35986	-430,46836	UPPER HUMBER RIVER AT SEAL POND (2703)
8	526,59273	480,58075	-46,01198	INDIAN BROOK AT INDIAN FALLS (2704)
9	5065,49708	5422,21963	+356,72155	EXPLOITS RIVER AT GRAND FALLS (2704)
10	167,33303	147,88753	-19,44550	BATCHELOR BROOK AT BATCHELOR LAKE (2705)
11	1814,51343	2012,12378	+197,61035	GARDNER RIVER AT BIG WHITE (2705)
12	92,81468	109,40652	+16,59184	MIDDLE BROOK NEAR GARBO (2705)
13	698,70190	621,22632	-77,47558	TERRENOVA RIVER AT LIGHT MILL BRIDGES (2705)
14	262,55505	297,13968	+34,58463	ISLE AND POINTS RIVER ABOVE HIGHWAY BRIDGE (2706)
15	563,96154	581,38427	+17,42273	GREY RIVER NEAR FUDOPS LAKE (2707)
16	1354,49731	1499,35327	+144,85596	SALMON RIVER AT LOUPE POND (2707)
17	731,96099	866,88526	+134,92427	BAY DU NORD RIVER AT BIG FALLS (2707)
18	158,44414	139,10154	-19,34260	GARNISH RIVER NEAR GARNISH (2708)
19	315,66501	333,87493	+18,20992	RIPPLE HILL RIVER AT MOTHER'S BROOK (2708)
20	181,48858	167,32219	-14,16639	ROCKY RIVER NEAR COCINET (2708)
21	67,51836	72,43680	+4,91844	PETTY HARBOUR RIVER AT SECOND POND (2709)
22	64,18505	76,41927	+12,23422	PIERRE'S BROOK AT GULL POND (2709)
23	102,92378	80,02911	-22,89467	MOBILE RIVER AT MOBILE FIRST POND (2709)
24	50,70362	55,28948	+4,58586	SEAL COVE RIVER AT WHITE HILL POND (2709)
25	1,70740	1,89920	+0,19180	NORTHEAST POND RIVER AT NORTHEAST POND (2709)

X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA * OF LAKE	(LOG VALUES)
X-3 - UNIT AREA * OF FOREST	(LOG VALUES)
X-4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIRN. (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIRN. (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT. / 100 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS / SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - MONTHLY AVG. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION = 0.9957

\* TOTAL AREA OF LAKES, FOREST, OR Bogs AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.1283

CONSTANT 2.7986

VARIABLE (X <sub>i</sub> )	COEFF. (B <sub>i</sub> )	STANDARD ERROR
X - 1	1.00392127	0.01912930
X - 2	-0.04319936	0.07111743
X - 3	-0.04189675	0.05807349
X - 4	0.37554575	0.04950592
X - 5	0.04888459	0.03888092

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (B<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} + \sum_{i=1}^n X_i \cdot RC_i$$

NEWFOUNDLAND  
CORRELATION BETWEEN MEAN MONTHLY FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS  
SEPTEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	615.62805	579.04260	36.58545	TORRENT RIVER AT BRISTOLS POOL (2Y01)
2	157.86864	177.63040	-19.76176	BEAVER BROOK NEAR BODDICATION (2Y01)
3	2943.80518	2324.18948	119.61570	HUMBER RIVER AT GRAND LAKE OUTLET (2Y11)
4	401.11023	352.92114	48.18909	LEWISLEIGH BROOK AT LITTLE GRAND LAKE (2YK2)
5	203.81436	187.78737	16.02699	SHEFFIELD RIVER AT SHEFFIELD LAKE (2YK3)
6	326.74005	352.10858	-25.36853	HINDS BROOK NEAR GRAND LAKE (2YK4)
7	1751.03174	1678.23535	72.79639	UPPER HUMBER RIVER AT SEAL POND (2Y11)
8	465.14691	431.44897	33.69794	INDIAN BROOK AT INDIAN FALLS (2YR1)
9	5214.27540	3450.83595	1765.43945	EXPLOITS RIVER AT GRAND FALLS (2Y01)
10	200.85153	177.39645	23.45508	BATTLE BROOK AT BATTLE LAKE (2Y03)
11	1986.14331	2154.69775	-168.55444	BANDER RIVER AT BIG WHITE (2Y01)
12	96.29811	133.68423	-37.38612	MIDDLE BROOK NEAR GANDI (2YR1)
13	734.36828	730.57666	3.79162	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2Y51)
14	288.62909	343.07531	-54.44622	ISLE AUX PORTS RIVER ABOVE HIGHWAY BRIDGE (2Z61)
15	593.99878	603.63611	-9.63733	GREY RIVER NEAR CUDDO'S LAKE (2Z01)
16	1466.51465	1641.43506	-174.92041	SALMON RIVER AT LONG POND (2Z61)
17	761.59094	760.87365	0.71729	HAY DU NORD RIVER AT BIG FALLS (2Z11)
18	161.22180	171.82724	-10.60544	GARNISH RIVER NEAR GARNISH (2Z01)
19	416.36932	393.39593	22.97339	PIPER'S HOLE RIVER AT MOTHER'S BROOK (2Z11)
20	236.33276	205.33067	31.00209	ROCKY RIVER NEAR COLINET (2Z11)
21	94.11091	96.38398	-2.27307	PETTY HARBOUR RIVER AT SECOND POND (2Z11)
22	91.88868	95.89967	-4.01099	PIERRE'S BROOK AT GULL POND (2Z12)
23	125.85160	100.39067	25.46093	MIDDLE RIVER AT MONKIE FIRST POND (2Z15)
24	64.77766	68.34933	-3.57167	SEAL COVE RIVER AT WHITE HILL POND (2Z15)
25	2.58516	2.75734	-0.17218	NORTHEAST POND RIVER AT NORTHEAST POND (2Z15)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA ° OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA ° OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA ° OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./10E6 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - MONTHLY AV. FLOW	(LOG VALUES)
COEFFICIENT OF CORRELATION R=0.9965	

STANDARD ERROR OF DEP VARIABLE = 0.1267  
CONSTANT 3.0212

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
x - 1	0.496215927	0.00889181
x - 2	0.446755573	0.07055291
x - 3	0.049808779	0.03440682
x - 11	0.10572727	0.00886403
x - 12	0.05286768	0.03819611

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
OCTOBER

	ACTUAL	PREDICTED	DEVIATION	
1	367.20398	359.06256	8.14142	TURBENT RIVER AT BRISTOLS FORD (2101)
2	166.71054	166.61550	0.09504	BEAVER BROOK NEAR HUGGERTON (2103)
3	1974.95679	2076.94434	-101.98755	MUMBY RIVER AT GRAND LAKE UNSETT (2101)
4	224.75305	238.10028	-13.34723	LEWISLACHE BROOK AT LITTLE GRAND LAKE (2102)
5	150.45410	153.40734	-2.95324	SHEFFIELD RIVER AT SHEFFIELD LAKE (2103)
6	180.60156	174.93020	5.67136	WINDS BROOK NEAR GRAND LAKE (2104)
7	1234.59717	1210.06787	24.52930	UPPER HUMBER RIVER AT SEAL POND (2101)
8	373.19934	369.32566	3.87368	INDIAN BROOK AT INDIAN FALLS (2101)
9	3178.54688	3436.83496	-258.28808	EXPLOITS RIVER AT GRAND FALLS (2101)
10	153.31359	151.38949	1.92410	RATTILING BROOK AT RATTILING LAKE (2103)
11	1844.64575	1728.39990	116.24585	GANDER RIVER AT WILD WHITE (2101)
12	91.91717	88.75946	3.15771	MIDDLE BROOK NEAR GAMBO (2101)
13	537.06994	520.66967	16.40027	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2101)
14	181.86691	172.69201	9.17490	ISLE DU MORTS RIVER ABOVE HIGHWAY BRIDGE (2201)
15	347.77679	349.04907	-1.27227	GREY RIVER NEAR FLOODS LAKE (2201)
16	1126.24243	1046.08056	80.16187	SALMON RIVER AT LONG POND (2201)
17	394.90063	470.67974	-75.77912	BAY DU MOUD RIVER AT BIG FALLS (2201)
18	101.42334	101.39199	0.03134	DARNISH RIVER NEAR DARNISH (2201)
19	349.90094	317.59741	32.30353	PIPER'S HOLE RIVER AT MOTHER'S BROOK (2201)
20	145.41418	151.60766	-6.19348	ROCKY RIVER NEAR COLINET (2201)
21	81.43286	83.99530	-2.56243	PETTY MANOR RIVER AT ACCOON POND (2201)
22	71.53375	65.68479	5.85095	FLENNY'S CREEK AT HILL POND (2202)
23	64.72135	71.39352	-6.67216	MOBILE RIVER AT MOBILE FIRST POND (2205)
24	49.93784	46.93061	3.00723	SEAL COVE RIVER AT WHITE HILL POND (2205)
25	2.20337	2.30196	-0.09859	NORTHEAST POND RIVER AT NORTHEAST POND (2205)

X-1 - AREA OF WATER (SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA * OF LAKE	(LOG VALUES)
X-3 - UNIT AREA * OF FOREST	(LOG VALUES)
X-4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEVIATION (LOG VALUES)  
COEFFICIENT OF CORRELATION R=0.9986

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATER-SHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.0817			
CONSTANT -0.0429			
VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR	
X = 1	1.02178979	0.01742343	
X = 3	0.08167224	0.02718667	
X = 7	-0.07594247	0.03133024	
X = 12	0.06995633	0.03095459	
X = 13	1.14417955	0.12213774	

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
NOVEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	336.27508	336.01959	0.25549	TORRENT RIVER AT BRISTOL POND (2111)
2	193.17138	165.40545	27.76593	NEVER BROOK NEAR QUODDYTON (2101)
3	2528.60889	2315.94043	212.66846	MUNEE RIVER AT GRAND LAKE OUTLET (2141)
4	272.16186	259.68525	12.47661	LEWISERCHIEP WINDA AT LITTLE GRAND LAKE (2142)
5	186.12394	184.84033	1.28360	SHEFFIELD RIVER AT SHEFFIELD LAKE (2163)
6	237.08923	299.83154	-62.74228	HINDS BROOK NEAR GRAND LAKE (2164)
7	1280.63281	1135.09717	145.53567	UPPER HUNTER RIVER AT SEAL POND (2111)
8	356.87758	414.28668	-57.40900	INDIAN BROOK AT TORBIA FALLS (2111)
9	4237.86622	5004.52540	-766.65930	EXPLOITS RIVER AT GRAND FALLS (2101)
10	201.61756	191.48196	10.13560	BATTLING BROOK AT BATTLING LAKE (2103)
11	2157.02100	2204.10205	-47.08106	GANDER RIVER AT BIG CHUTE (2101)
12	125.79867	145.60553	-19.80684	MIDDLE BROOK NEAR GANDER (2101)
13	816.44030	718.28833	108.15199	TERRA NOVA RIVER AT EIGHT NICE BRIDGES (2151)
14	216.38790	228.53680	-12.14890	ISLE AUX MOUS RIVER ABOVE HIGHWAY BRIDGE (2101)
15	470.76727	481.87146	-11.10418	GREY RIVER NEAR MOOSE LAKE (2201)
16	1469.56655	1312.42700	157.13967	SALMON RIVER AT LONG POND (2211)
17	585.94470	621.83191	-35.88721	BAT DU ROND RIVER AT BIG FALLS (2211)
18	94.55966	147.32272	-52.76305	GARISH RIVER NEAR GARISH (2201)
19	565.17297	438.78704	126.38597	PIPER'S HOLE RIVER AT MOTHER'S BROOK (2211)
20	188.81396	176.85202	11.96194	ROCKY RIVER NEAR COLLETT (2211)
21	115.96988	94.77517	21.19470	PETTY HARBOUR RIVER AT SECOND POND (2211)
22	102.05294	112.86634	-10.81340	PIERRE'S BROOK AT GULL POND (2202)
23	102.59999	100.87100	1.72899	MOBILE RIVER AT MOBILE FIRST POND (2213)
24	59.58528	50.61386	8.97142	SEAL COVE RIVER AT WILLY HILL POND (2205)
25	29.77889	2.81669	26.96220	NORTHEAST POND RIVER AT NORTHEAST POND (2215)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEVIATION (LOG VALUES)  
COEFFICIENT OF CORRELATION R=0.9933

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.1714  
CONSTANT 3.2724

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
x - 1	0.97332561	0.03597525
x - 4	0.08305768	0.02794165
x - 5	-0.32520753	0.07643985
x - 7	-0.11242988	0.05723351
x - 8	-0.22594392	0.07506157

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
DECEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	365.44879	357.63916	7.80963	TORRENT RIVER AT BRISTOLS POOL (21c1)
2	158.61532	162.61077	-3.99545	BEAVER BROOK NEAR ROEDICKTON (21x1)
3	1925.87766	1677.08008	248.79766	JAMBER RIVER AT GRAND LAKE OUTLET (21x1)
4	217.11161	208.03710	9.07470	LEWISSECHIECH BROOK AT LITTLE GRAND LAKE (21x2)
5	126.70930	130.02847	-3.31917	SHEFFIELD RIVER AT SHEFFIELD LAKE (21x3)
6	204.38720	192.77776	11.60946	HINDS BROOK NEAR GRAND LAKE (21x4)
7	1216.51758	1233.66262	-17.16504	UPPER JAMBER RIVER AT SEAL POND (21x1)
8	333.39642	329.40100	3.99542	INDIAN BROOK AT INDIAN FALLS (21x1)
9	3462.59522	3451.05664	11.53857	EXPLOITS RIVER AT GRAND FALLS (21x1)
10	157.38189	148.63842	8.74347	BOTTLING BROOK AT BOTTLING CASC (21x3)
11	1597.14648	1747.17358	-150.02710	GANDER RIVER AT BIG CHUTE (21x1)
12	84.83811	111.01599	-26.17787	MIDDLE BROOK NEAR GANDER (21x1)
13	576.81262	590.50317	-13.69055	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21x1)
14	180.31948	182.98556	-2.66607	ISLE AUX MOUTS RIVER ABOVE HIGHWAY BRIDGE (21x1)
15	425.53930	439.93719	-14.39789	GREY RIVER NEAR PUDOP'S LAKE (22x1)
16	1295.73218	1155.96264	139.76956	SALMON RIVER AT LONG POND (22x1)
17	502.98400	536.81799	-33.83399	BAY DU NORD RIVER AT BIG FALLS (22x1)
18	82.97549	119.31559	-36.34011	GARNISH RIVER NEAR GARNISH (22x1)
19	339.60748	285.03936	54.56812	PIPER'S HILL RIVER AT MOTHER'S BROOK (22x1)
20	161.82821	157.84152	3.98669	ROCKY RIVER NEAR COLANET (22x1)
21	90.38121	93.449171	-3.11050	PETTY HARBOUR RIVER AT SECOND POND (22x1)
22	79.82612	75.80285	4.02327	PIERRE'S BROOK AT GULL POND (22x2)
23	73.24203	75.55359	-2.31156	MUSKIE RIVER AT MUSKIE FIRST POND (22x3)
24	47.60024	44.23423	3.36601	SEAL COVE RIVER AT WHITE HILL POND (22x5)
25	2.77247	2.55036	0.22211	NORTHEAST POND RIVER AT NORTHEAST POND (22x6)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEVIATION	(LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9997

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP. VARIABLE \* 0.1360  
CONSTANT 3.1749

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
x - 1	0.98229083	0.02159045
x - 3	0.12606648	0.05469894
x - 5	-0.35663200	0.08578802
x - 8	-0.19792899	0.09128896
x - 9	-0.12671035	0.07650491
x - 13	0.78893300	0.21517741

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
JANUARY

	ACTUAL	PREDICTED	DEVIATION	
1	290.02166	301.19024	-11.16858	TORRENT RIVER AT HYSTOLES POND (2Y01)
2	119.19812	158.55545	-39.35732	BEAVER BROOK NEAR ROQUICTON (2Y01)
3	1981.71850	1602.87720	170.84133	HUMBER RIVER AT GRAND LAKE OUTLET (2Y01)
4	220.07238	205.67282	14.39956	LEWASELCHUECH BROOK AT LITTLE GRAND LAKE (2Y02)
5	127.69226	168.95822	-41.26595	SHEFFIELD RIVER AT SHEFFIELD LAKE (2Y03)
6	207.25647	215.85305	-8.59659	HINDS BROOK NEAR GRAND LAKE (2Y04)
7	1057.53979	951.09485	106.44493	UPPER HUMBER RIVER AT SEAL POND (2Y11)
8	565.56811	465.34259	100.22547	INDIAN BROOK AT INDIAN FALLS (2Y01)
9	3674.20508	4029.46436	-355.25933	EXPLOITS RIVER AT GRAND FALLS (2Y01)
10	219.35870	219.27252	0.08618	RATLINE BROOK AT RATLINE LAKE (2Y03)
11	2594.74219	2458.91651	135.82571	GANDER RIVER AT RIG CHUTE (2Y01)
12	182.69088	182.64645	0.04443	MIDDLE BROOK NEAR GANDY (2Y01)
13	960.82592	768.63440	192.19155	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2Y51)
14	172.02447	170.20318	1.82129	ISLE AUX MOIS RIVER ABOVE HIGHWAY BRIDGE (2Z01)
15	458.52282	474.15374	-15.63092	GREY RIVER NEAR POCOPS LAKE (2Z01)
16	1489.52490	1366.68652	122.83839	SALMON RIVER AT LONG POND (2Z01)
17	574.52172	723.61206	-149.09036	BAY DU NORD RIVER AT BIG FALLS (2Z11)
18	122.78721	180.40756	-57.62033	DANISH RIVER NEAR GARDISH (2Z01)
19	523.41882	523.39489	0.02392	PIPER'S HOPE RIVER AT MOTHER'S BROOK (2Z01)
20	223.90457	243.19311	-19.28854	ROCKY RIVER NEAR DOUGLASS (2Z01)
21	144.96460	131.83175	13.13284	PETE MARQUIS RIVER AT SECOND POND (2Z01)
22	122.39637	105.25990	17.13647	PIERRE'S BROOK AT BULL POND (2Z02)
23	108.68679	110.54606	-1.85926	MULLIE RIVER AT MULLIE FIRST POND (2Z05)
24	78.60136	52.45427	26.14708	SEAL RIVE RIVER AT GARRETT HILLS POND (2Z05)
25	3.66389	3.67552	-0.01162	NORTHEAST POND RIVER AT NORTHEAST POND (2Z05)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./10E6 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEVIATION	(LOG VALUES)
COEFFICIENT OF CORRELATION	R=0.9908

STANDARD ERROR OF DEP VARIABLE = 0.1918  
CONSTANT 2.4670

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
x - 1	0.98250794	0.03467508
x - 4	0.05782438	0.03300148
x - 11	-0.57346260	0.10207256
x - 12	-0.12600597	0.05135088
x - 13	0.62530636	0.25996077

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
FEBRUARY

	ACTUAL	PREDICTED	DEVIATION	
1	276.54669	289.02215	-12.47546	TORRENT RIVER AT BRISTOLS POOL (2YC1)
2	94.78891	120.13873	-25.34982	BEAVER BROOK NEAR RODDICKTON (2YD1)
3	1457.95093	1304.48559	153.46536	HUMBER RIVER AT GRAND LAKE OUTLET (2YK1)
4	184.29959	167.26776	17.03183	LEWASEECHJEECH BROOK AT LITTLE GRAND LAKE (2YK2)
5	105.56662	120.17768	-14.61107	SHEFFIELD RIVER AT SHEFFIELD LAKE (2YK3)
6	143.25711	193.11575	-49.85865	HINDS BROOK NEAR GRAND LAKE (2YK4)
7	895.61645	716.57788	179.03860	UPPER HUMBER RIVER AT SEAL POND (2YL1)
8	243.53799	295.72686	-52.18887	INDIAN BROOK AT INDIAN FALLS (2YM1)
9	3520.51904	3105.20606	415.31305	EXPLOITS RIVER AT GRAND FALLS (2Y01)
10	149.95629	152.12368	-2.16738	RATTLING BROOK AT RATTLING LAKE (2Y03)
11	1251.83691	1539.74023	-287.90338	GANDER RIVER AT BIG CHUTE (2YQ1)
12	101.75972	118.39024	-16.63052	MIDDLE BROOK NEAR GAMBO (2YR1)
13	848.96325	538.13794	310.82537	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2YS1)
14	159.07312	172.38198	-13.30887	ISLE AUX MORTS RIVER ABOVE HIGHWAY BRIDGE (2ZB1)
15	290.89086	290.04791	0.84295	GREY RIVER NEAR PUDOPS LAKE (2ZD1)
16	1054.76977	1206.99170	-152.22193	SALMON RIVER AT LONG POND (2ZE1)
17	530.35388	606.68615	-76.33229	BAY DU MORD RIVER AT BIG FALLS (2ZF1)
18	84.13247	136.70849	-52.57601	GARNISH RIVER NEAR GARNISH (2ZG1)
19	478.63842	344.36749	134.27096	PIPER'S HOLE RIVER AT MOTHER'S BROOK (2ZH1)
20	185.76315	187.54568	-1.78253	ROCKY RIVER NEAR COLINET (2ZK1)
21	108.54541	81.36764	27.17776	PETTY HARBOUR RIVER AT SECOND POND (2ZM1)
22	93.11149	73.31561	19.79588	PIERRE'S BROOK AT GULL POND (2ZM2)
23	79.86222	77.63652	2.22570	MOBILE RIVER AT MOBILE FIRST POND (2ZM3)
24	58.49267	50.02619	8.46648	SEAL COVE RIVER AT WHITE HILL POND (2ZM5)
25	2.73706	2.56613	0.17093	NORTHEAST POND RIVER AT NORTHEAST POND (2ZM6)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA(KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN(KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN(KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE(FT./100 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE(DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION(FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW(CFS/SQ.KM.)	(LOG VALUES)

STANDARD ERROR OF DEP VARIABLE = 0.2365  
CONSTANT 3.7050

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.91162097	0.03360780
X - 5	-0.17520344	0.10561473
X - 8	-0.33180135	0.08837661
X - 9	-0.19125719	0.10367925

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

DEPENDENT VARIABLE - STANDARD DEVIATION (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9860

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
MARCH

	ACTUAL	PREDICTED	DEVIATION	
1	283.05218	313.33463	-30.28247	FORBES RIVER AT BRISBOLS POND (2Y1)
2	102.28239	119.23774	-16.95535	BEAVER RIVER NEAR RUDDLETON (2Y1)
3	1587.63843	1672.87915	-85.24072	HUMBER RIVER AT GRAND LAKE OUTLET (2Y1)
4	198.49694	185.01703	13.47991	LEWISSECHUJELIC BROOK AT LITTLE GRAND LAKE (2Y2)
5	117.45155	134.55978	-17.10823	SHEFFIELD RIVER AT SHEFFIELD LAKE (2Y3)
6	124.17974	184.05035	-59.87061	HINDS BROOK NEAR GRAND LAKE (2Y4)
7	939.29370	775.52404	163.76966	UPPER THUNDER RIVER AT SEAL POND (2Y1)
8	317.51715	372.95886	-55.44171	INDIAN BROOK AT INDIAN FALLS (2Y1)
9	3936.91016	3570.64990	366.26026	EXPLOITS RIVER AT SHONO FALLS (2Y1)
10	192.72775	167.52413	25.20362	BARTLING BROOK AT BARTLING LAKE (2Y3)
11	2267.15137	1963.19385	303.95752	BANDER RIVER AT BIG CHUTE (2Y1)
12	176.25784	151.37850	24.87934	MIDDLE BROOK NEAR GARDO (2Y1)
13	714.47680	569.16906	145.30774	TERRE NOVA RIVER AT EIGHT MILE BRIDGES (2Y1)
14	174.16583	164.37686	9.78897	ISLE AUX MOIS RIVER ABOVE HIGHWAY BRIDGE (2Y1)
15	397.35199	400.47613	-3.12414	BRET RIVER NEAR PUDS LAKE (2Y1)
16	1312.54956	1264.41601	48.13355	SALMON RIVER AT LONG POND (2Y1)
17	434.81555	649.18504	-214.36947	BAY DU NORD RIVER AT BIG FALLS (2Y1)
18	110.34373	172.24960	-61.90587	GARNISH RIVER NEAR GARNISH (2Y1)
19	472.58184	376.44647	96.13537	PIPER'S HOLE RIVER AT MOTHER'S BROOK (2Y1)
20	177.76816	244.47229	-66.70413	ROCKY RIVER NEAR SULLINE (2Y1)
21	122.17189	96.33379	25.83810	PETTY HARBOR RIVER AT SECOND POND (2Y1)
22	91.15873	76.78810	14.37063	PIERRE'S BROOK AT GULL POND (2Y1)
23	100.65353	77.30282	23.35071	MOBILE RIVER AT TONNIE FIRST POND (2Y1)
24	62.03569	55.89538	6.14031	SEAL COVE RIVER AT WHITE HILL POND (2Y1)
25	3.22451	3.27307	-0.04856	NORTHEAST POND RIVER AT NORTHEAST POND (2Y1)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1066 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEVIATION (LOG VALUES)  
COEFFICIENT OF CORRELATION R=0.9878

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP. VARIABLE = 0.2207

CONSTANT 2.4234

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.9588569	0.03238542
X - 2	-0.25174611	0.006824463
X - 13	-0.33774661	0.009481315

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
APRIL

	ACTUAL	PREDICTED	DEVIATION	
1	546.23437	441.26418	56.95014	TORRENT RIVER AT BRISTOLS POOL (21C1)
2	303.72888	338.72967	-15.00080	BEAVER BROOK NEAR RODDICKTON (21B1)
3	3228.96975	2648.17529	580.81457	HUMBER RIVER AT GRAND LAKE OUTLET (21E1)
4	337.90661	340.07971	-2.17309	LEWASTEECHIECH BROOK AT LITTLE GRAND LAKE (21K2)
5	274.04431	215.64566	16.39865	SHEFFIELD RIVER AT SHEFFIELD LAKE (21A3)
6	253.20562	306.99072	-53.78507	MIMUS BROOK NEAR GRAND LAKE (21A4)
7	1756.98511	2144.17139	-387.18629	UPPER HUMBER RIVER AT SEAL POND (21L1)
8	530.07080	438.57202	91.49873	INDIAN BROOK AT INDIAN FALLS (21M1)
9	4776.34473	4912.74024	-136.39553	EXPLOITS RIVER AT GRAND FALLS (21O1)
10	256.94030	256.16914	0.75115	RATTLING BROOK AT RATTILING LAKE (21Q3)
11	2857.11133	3000.52100	-143.40969	GRAND RIVER AT BIG CHUTE (21Q1)
12	145.68206	177.47412	-31.79205	MIDDLE BROOK NEAR GAMBO (21R1)
13	1021.06884	979.69433	41.37451	LEARE NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	280.42309	236.92208	41.50098	(SEE BOX MURTS RIVER ABOVE WINDHAT BRIDGE (22H1))
15	348.53814	373.01120	-24.47296	GREY RIVER NEAR PUDDERS LAKE (22D1)
16	1689.59717	1617.10937	72.48780	SALMON RIVER AT LUNG POND (22E1)
17	637.04712	736.03003	-98.98292	BAT DU MOND RIVER AT BIG FALLS (22F1)
18	121.12568	154.99230	-33.86661	GARNISH RIVER NEAR GARNISH (22G1)
19	643.40735	463.01721	180.39010	PIPER'S HOLE RIVER AT MOTHER'S BRIDGE (22H1)
20	203.76559	201.93649	1.82910	ROCKY RIVER NEAR COLLING (22K1)
21	150.63354	138.60388	12.02966	PETTIT HARBOR RIVER AT SECOND POND (22M1)
22	123.88426	109.90945	13.97480	PIERRE'S BROOK AT BULL POND (22M2)
23	126.04907	147.76525	-21.71617	MOBILE RIVER AT MOBILE FIRST POND (22N3)
24	67.62626	69.14433	-1.51806	SEAL COVE RIVER AT WHITE HALL POND (22N5)
25	3.73638	3.54185	0.19452	NORTHEAST POND RIVER AT NORTHEAST POND (22N6)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERWASHEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1066 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEVIATION (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9936

\* TOTAL AREA OF LAKES, FOREST, OR SWAMP AND BOG'S DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.1663

CONSTANT	VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
	X - 1	0.99290776	0.02509520
	X - 3	0.15877628	0.06255482
	X - 5	-0.57210266	0.06334829
	X - 9	-0.33603284	0.08197247
	X - 10	-0.11253951	0.04397790
	X - 13	1.44738245	0.25060880

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
MAY

	ACTUAL	PREDICTED	DEVIATION	
1	758.59793	636.36157	122.23636	TORRONE RIVER AT WATSON'S POND (2701)
2	618.59240	274.43988	344.15252	BEAVER BROOK NEAR WOODINGTON (2701)
3	4367.47852	5155.38575	-767.90723	NUMBER RIVER AT GRAND LAKE INLET (2701)
4	409.94262	523.52417	-113.58149	LEWISLEIGH BROOK AT LITTLE CREEK LAKE (2703)
5	539.28613	323.76104	215.52509	SHEFFIELD RIVER AT SHEFFIELD LAKE (2703)
6	403.79667	665.63037	-261.83349	HINDS BROOK NEAR GRAND LAKE (2704)
7	2559.19092	3769.14307	-1209.95239	UPPER NUMBER RIVER AT SEAL POND (2711)
8	804.29980	802.41894	1.88085	INDIAN BROOK AT INDIAN FALLS (2701)
9	7458.32716	9181.21682	-1722.88891	EXPLOITS RIVER AT GRAND FALLS (2701)
10	554.12641	260.28283	293.84358	BATTILING BROOK AT BATTILING LAKE (2703)
11	4053.54590	3450.90527	602.64074	LANDER RIVER AT BIG TAUFF (2701)
12	223.46853	197.69876	25.76977	MIDDLE BROOK NEAR DAMO (2701)
13	1272.65944	1055.43091	217.22854	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (2701)
14	412.24035	220.56069	191.67965	ISLE ROX MOUNTS RIVER ABOVE HIGHWAY BRIDGE (2701)
15	709.11828	602.67920	93.56092	GREY BAY RIVER NEAR PUDOPS LAKE (2701)
16	2500.99512	2027.32568	478.66925	SALMON RIVER AT LONG POND (2701)
17	595.24804	801.34301	-206.09500	BAT-DE-NORD RIVER AT BIG FALLS (2701)
18	116.04129	176.02719	-59.98592	GARNISH RIVER NEAR GARNISH (2701)
19	536.16919	479.43779	56.73140	PYPER'S HOLE RIVER AT MOTHER'S BROOK (2701)
20	125.61047	154.37625	-28.76576	ROCKY RIVER NEAR COLINET (2701)
21	115.59500	118.27220	-2.67720	PETTY HARBOUR RIVER AT SECOND POND (2701)
22	79.56262	105.46931	-25.90669	PIERRE'S BROOK AT GULL POND (2702)
23	74.76719	107.09732	-32.33013	MOBILE RIVER AT MOBILE FIRST POND (2705)
24	51.17933	70.80781	-19.62848	SEAL COVE RIVER AT WHITE HILL POND (2705)
25	2.95622	5.52642	-2.57020	NORTHEAST POND RIVER AT NORTHEAST POND (2706)

X- 1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. * OF OVERBORDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./10E6 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/50. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEVIATION (LOG VALUES)  
COEFFICIENT OF CORRELATION R=0.9743

\* TOTAL AREA OF LAKE, FOREST, SW BODS AND SWAMPS DIVIDED BY WATERSHED AREA.

STANDARD ERROR OF DEP VARIABLE = 0.3928  
CONSTANT 3.5857

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X - 1	1.01316285	0.05799162
X - 5	-1.03157997	0.19084915
X - 11	0.40588885	0.20525693

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANT/LOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
JUNE

	ACTUAL	PREDICTED	DEVIATION	
1	724.10632	402.39300	321.71331	TOMBENT RIVER AT BRISTOL'S POOL (21x1)
2	423.54095	166.87387	236.67507	BEAVER BROOK NEAR BODDICKTON (2101)
3	2658.12451	2767.51221	-109.38771	HUMBER RIVER AT GRAND LAKE OUTLET (21x1)
4	250.56210	362.98059	-112.41849	LEWASEEQUAICH BROOK AT LITTLE GRAND LAKE (21K2)
5	274.17565	207.87051	66.30514	SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
6	370.01306	477.60382	-107.59077	HINDS BROOK NEAR GRAND LAKE (21K4)
7	2151.67598	2496.50293	-344.82695	UPPER HUMBER RIVER AT SEAL POND (21L1)
8	651.16372	436.26263	214.90109	INDIAN BROOK AT INDIAN FALLS (21M1)
9	3279.08203	4445.14454	-1166.06251	EXPLOITS RIVER AT GRAND FALLS (21O1)
10	214.99737	145.43347	69.56391	RAITLING BROOK AT RAITLING LAKE (21O3)
11	1546.56714	1557.47851	-10.91137	GANDER RIVER AT BIG CHUTE (21O1)
12	87.30639	105.28710	-17.98071	MIDDLE BROOK NEAR DAMMO (21H1)
13	453.58642	573.47339	-119.88697	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	206.19128	156.82275	49.36853	ISLE AUX MORTS RIVER ABOVE HANNAH BRIDGE (22H1)
15	311.56738	335.16149	-23.59412	GREY RIVER NEAR PUDS LAKE (22O2)
16	988.80200	1062.40783	-173.60583	SALMON RIVER AT LONG POND (22E1)
17	281.79113	402.69360	-120.90247	BAY DU NORD RIVER AT BIG FALLS (22F1)
18	64.78787	97.69677	-32.90891	GARNISH RIVER NEAR GARNISH (22G1)
19	263.06781	244.17520	18.89261	PIPER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
20	113.17460	72.22413	40.95047	ROCKY RIVER NEAR CAINET (22K1)
21	75.04219	70.94690	4.09529	PETTY HARBOR RIVER AT SECOND POND (22M1)
22	55.88125	69.49417	-13.61292	PJERRE'S BROOK AT BULL POND (22M2)
23	57.44308	71.94400	-14.49892	MOBILE RIVER AT MOBILE FIRST POND (22M3)
24	37.12690	46.37759	-9.25069	SEAL FORD RIVER AT WHITE HILL POND (22M5)
25	2.00982	2.72854	-0.72272	NORTHEAST POND RIVER AT NORTHEAST POND (22M8)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT. / 100 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEVIATION	(LOG VALUES)
COEFFICIENT OF CORRELATION	R=0.9751

STANDARD ERROR OF DEP VARIABLE = 0.3538			
CONSTANT			
	3.8331		
VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR	
X - 1	0.92442204	0.05222970	
X - 5	-1.29843902	0.17188680	
X - 12	0.68921154	0.15486306	

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

\* TOTAL AREA OF LAKE, FOREST, OR SWAMP AND SHAMPS DIVIDED BY WATERSHED AREA

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
JULY

	ACTUAL	PREDICTED	DEVIATION	
1	373.87085	328.35406	45.51679	TORRENT RIVER AT BRISTOLS FORD (21C1)
2	144.53372	97.43867	47.09505	HEAVER BROOK NEAR RUDDINGTON (21D7)
3	1560.04297	1395.66748	164.37549	HUMBER RIVER AT GRAND LAKE OUTLET (21K1)
4	149.41598	184.15076	5.26519	EMASSICHELLIN BROOK AT LITTLE GRAND LAKE (21K2)
5	113.32775	86.62713	26.70062	SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
6	157.92254	156.90173	1.02081	HINDS BROOK NEAR GRAND LAKE (21K4)
7	1282.83789	1667.39038	-384.55250	UPPER HUMBER RIVER AT SEAL POND (21L1)
8	395.11499	222.67630	162.43869	INDIAN BROOK AT INDIAN FALLS (21M1)
9	1995.14062	2116.14746	-121.00684	EXPLOITS RIVER AT GRAND FALES (21O1)
10	87.96597	79.96479	7.99917	BATTILING BROOK AT BATTILING LAKE (21O3)
11	824.32629	1044.63901	-220.30272	GANDER RIVER AT BIG CHUTE (21P1)
12	42.12981	59.74710	-17.61729	MIDDLE BROOK NEAR GANDER (21P1)
13	270.56848	378.07238	-107.50390	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21S1)
14	112.05928	108.21373	3.84555	ISLE AUX MOUS RIVER ABOVE RAILWAY BRIDGE (21S1)
15	211.40472	223.92758	-12.52286	GREY RIVER NEAR PHOENIX LAKE (22D1)
16	695.81079	616.57165	79.23914	SALMON RIVER AT LONG POND (22I1)
17	213.96810	303.90240	-89.93430	BAY OF NORD RIVER AT WILD FALLS (22H1)
18	54.77027	64.07300	-9.28336	BARNISH RIVER NEAR BARNISH (22G1)
19	178.00451	170.48373	7.52078	PIPER'S HOLE RIVER AT MOTHER'S BROOK (22H1)
20	102.75950	75.14076	27.61874	ROCKY RIVER NEAR COLINET (22H2)
21	40.78205	38.01488	2.76716	PETTY HARBOR RIVER AT SECOND POND (22H1)
22	37.23826	31.65101	5.58724	PERRER'S BROOK AT HILL POND (22H2)
23	34.35683	45.60595	-11.24912	MOBILE RIVER AT MOBILE FIRST POND (22M5)
24	18.54613	25.93998	-7.39384	SEAL COVE RIVER AT WHITE HILL POND (22M5)
25	1.00338	1.17124	-0.16786	NORTHEAST POND RIVER AT NORTHEAST POND (21H5)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./10E6 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEVIATION,	(LOG VALUES)
COEFFICIENT OF CORRELATION R=0.9835	

STANDARD ERROR OF DEP. VARIABLE = 0.2430			
CONSTANT = 2.3814			
VARIABLE (X <sub>i</sub> )	COEFF. (R <sub>ci</sub> )	STANDARD ERROR	
X - 1	1.01692422	0.05603936	
X - 2	-0.00771483	0.05432942	
X - 7	0.18783444	0.01844046	
X - 13	1.48657258	0.24483705	

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (R<sub>ci</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{R_{ci}}$$

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS  
AUGUST

	ACTUAL	PREDICTED	DEVIATION	
1	374.74064	293.36200	79.37864	TORRENT RIVER AT BRATFOLD POOL (21C1)
2	142.71453	129.94909	12.76544	BEAVER BROOK NEAR RODDINGTON (21D1)
3	1765.97324	1809.12402	-43.15078	HUMBER RIVER AT GRAND LAKE OUTLET (21K1)
4	206.44421	193.53262	12.91159	LESLIE/SCHELDEN BROOK AT LITTLE GRAND LAKE (21K2)
5	127.65232	111.35239	16.29993	SHEFFIELD RIVER AT SHEFFIELD LAKE (21K3)
6	172.07632	186.05402	-13.97770	HINDS BROOK NEAR GRAND LAKE (21K4)
7	1104.12002	1028.44911	75.67091	UPPER HUMBER RIVER AT SEAL POND (21L1)
8	101.78112	300.43534	-198.65422	INDIAN BROOK AT INDIAN FALLS (21M1)
9	3062.94444	3320.19281	-257.24837	EXPLIETS RIVER AT GRAND FALLS (21O1)
10	142.31250	104.66291	37.64959	RATTLING BROOK AT RATTLING LAKE (21U3)
11	1394.94770	1534.38119	-139.43349	GANDY RIVER AT M/L LAKE (21V1)
12	74.38036	52.26171	22.11865	MIDDLE BROOK NEAR GANDY (21V1)
13	494.19174	467.19228	27.00046	TERRA NOVA RIVER AT EIGHT MILE BRIDGES (21Y1)
14	102.67773	126.04594	-23.36821	ISLE AUX MORTS RIVER ABOVE WINDMILL BRIDGE (22A1)
15	299.16810	320.78899	-21.62089	GREY RIVER NEAR WINDMILL LAKE (22B1)
16	987.28447	880.24487	107.03960	SALMON RIVER AT LONG POND (22L1)
17	424.63031	391.39743	33.23288	BAY DU NORD RIVER AT BIG FALLS (22F1)
18	64.45283	100.08426	-35.63143	GANNON RIVER NEAR GANNON (22G1)
19	220.60211	230.95739	-10.35528	PAPER'S HOLD RIVER AT MOTHER'S BROOK (22H1)
20	95.97888	102.01896	-6.04008	HOCKY RIVER NEAR COLINET (22K1)
21	62.11045	68.36659	-6.25614	PETTY HARBOUR RIVER AT SECOND POND (22M1)
22	49.63814	30.08440	19.55374	PIERRE'S BROOK AT GULL POND (22M2)
23	48.87332	39.47361	9.39971	MOBILE RIVER AT MOBILE FIRST POND (22N3)
24	35.45824	35.58890	-0.13066	SEAL COVE RIVER AT WHITE HILL POND (22N5)
25	14.68743	14.60474	0.08269	NORTHEAST POND RIVER AT NORTHEAST POND (22P5)

X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA * OF LAKE	(LOG VALUES)
X-3 - UNIT AREA * OF FOREST	(LOG VALUES)
X-4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X-5 - AVG. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X-9 - AVG. SLOPE (FT./10E6 FT.)	(LOG VALUES)
X-10 - AVG. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVG. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVG. BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CMS./SQ. KM.)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEVIATION	(LOG VALUES)
COEFFICIENT OF CORRELATION	R=0.9946

STANDARD ERROR OF DEPENDENT VARIABLE = 0.1620  
CONSTANT \* 2.3045

VARIABLE (X <sub>i</sub> )	COEFF. (B <sub>i</sub> )	STANDARD ERROR
X = 1	0.00321931	0.02429487
X = 5	-0.7301281	0.04286012
X = 13	0.6260811	0.17330110

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (B<sub>i</sub>) IN THE FORMULA

$$Y_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{B_i}$$

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

NEWFOUNDLAND

CORRELATION BETWEEN STANDARD DEVIATION OF MEAN MONTHLY FLOW AND PHYSIOGRAPHIC CHARACTERISTICS SEPTEMBER

	ACTUAL	PREDICTED	DEVIATION	
1	322,47884	325,30578	-2,82696	TORRENT RIVER AT BRISTOLS POOL (27c1)
2	130,27710	131,37854	-1,10144	BEAVER BROOK NEAR WOODICKTON (27d1)
3	1944,67724	1706,19751	238,47976	HUMBER RIVER AT GRAND LAKE OUTLET (27h1)
4	244,66122	218,53704	26,12417	LEHMSRECHICH BROOK AT LITTLE GRAND LAKE (27k2)
5	142,40591	131,39859	11,00732	SHEFFIELD RIVER AT SHEFFIELD LAKE (27k3)
6	193,48491	214,85400	-21,36909	HINDS BROOK NEAR GRAND LAKE (27k4)
7	1090,81201	1158,78271	-67,97071	UPPER HUMBER RIVER AT SEAL POND (27L1)
8	312,04553	304,24504	7,80049	INDIAN BROOK AT INDIAN FALLS (27M1)
9	329,45564	340,83843	-11,38279	EXPLOITS RIVER AT BRANTY FALLS (2101)
10	154,17919	132,42945	21,74974	RATTLING BROOK AT RATTLING LAKE (2103)
11	1413,50708	1508,69553	-95,18846	GARDNER RIVER AT BIG CHUTE (2107)
12	72,24348	98,98480	-26,74132	MIDDLE BROOK NEAR GAMBH (2108)
13	525,47143	534,02136	-8,54993	TERRE NOVA RIVER AT EIGHT MILE BRIDGES (27s1)
14	182,34066	186,23373	-3,89307	ISLE AUX MOUTES RIVER ABOVE HIGHWAY BRIDGE (27t1)
15	326,87089	339,44140	-12,57051	GREY RIVER NEAR PUDDY LAKE (22D1)
16	1027,52589	934,39941	93,12648	SALMON RIVER AT LONG POND (22E1)
17	372,83067	463,35382	-90,52315	BAF DU NORD RIVER AT RIE FALLS (22H1)
18	47,49552	106,82435	-59,32883	GRANTON RIVER NEAR GRANTON (22I1)
19	341,82355	294,30198	47,52157	PETER'S MILL RIVER AT MOTHER'S BROOK (22M1)
20	143,30493	130,11245	13,19248	ROCKY RIVER NEAR COLIN (22N1)
21	81,99117	68,63832	13,35285	PETTY HARBOUR RIVER AT SECOND POND (22P1)
22	74,42746	71,44556	2,98190	PILLET'S BROOK AT GULL POND (22Q1)
23	63,95104	76,74073	-12,78969	MOBILE RIVER AT MOBILE FIRST POND (22R1)
24	43,09874	39,61641	3,48233	SEAL COVE RIVER AT WHITE HILL POND (22S1)
25	2,07377	2,08055	-0,00678	NORTHEAST POND RIVER AT NORTHEAST POND (2271)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA * OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA * OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA * OF SWAMP AND BOG	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X101)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X101)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEVIATION (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9956

\* TOTAL AREA OF LAKES, FOREST, OR BOGS AND SWAMPS DIVIDED BY WATERSHED AREA

STANDARD ERROR OF DEP VARIABLE = 0.1472

CONSTANT 2.4322

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.96630704	0.02586745
X - 2	0.05525670	0.02241855
X - 3	-0.47844549	0.07922840
X - 4	-0.19085803	0.06487722
X - 13	0.57192561	0.19947889

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

18      MAXIMUM FLOWS

The maximum flows have been studied only on the basis of the stream gauging records since, as discussed in Section 15.2.2, the daily flows at flow-reporting hydro plants are not reliable enough for such analysis. The number of stations studied was thus limited to 17.

18.1      Causes of Flood

An analysis of the frequency of occurrence of maximum annual flows by months shows that most of the peaks occur in April, May, or June, depending on latitude and size of the basin. A secondary peak, which occasionally is the main one, occurs in November, December, or January. It is clear that in almost all cases both snowmelt and rain contribute to the flood. Theoretically the relative importance of snowmelt decreases with the size of the basin since the snowmelt occurs relatively uniformly over large areas, and storm rainfall intensity decreases with the size of the area considered. Nevertheless, the actual importance of snowmelt in flood generation is emphasized by the fact that only two maximum flows were recorded in August for the whole period of record at all river gauging stations.

18.2      Statistical Processing of Maximum Flows

A statistical analysis of the maximum daily flows was carried out using the data at 17 stream gauging stations. The missing data were synthesized by correlation for the period 1950 to 1966. The correlations used were based on the maximum daily flows in each month since the number of data available for maximum daily flows in each year is generally too small to allow any statistical inference. The annual maximum flows at the two correlated stations were, however, plotted on the same graphs as the monthly flow to check the compatibility of the monthly and annual maximum flows correlation. Two series of maximum flows were considered for each station:

- a)      Generated mainly by rain - so called summer maximum flows - occurring during the period July to November, and in higher areas July to October.
- b)      Generated mainly by snowmelt - so called winter maximum flows - occurring during the period December to June, and in higher areas November to June.

Using the series of data recorded or completed by correlation as indicated above for a period of 16 years, the average maximum flows and the corresponding coefficients of variation were computed for

both the summer and the winter maximums (Table 18-1). No attempt was made to compute the coefficient of skew since it was considered that the period of record, even expanded by correlation, is too short to warrant such computations.

Statistical processing of the data on maximum flows was not attempted for Labrador because of the short period of record available, and since all stations but one are affected by changes in storage due to the operation of hydro-electric plants.

For the Island, the average maximum flows and the standard deviations were correlated with the physiographic characteristics of the basins and the results are shown in Tables 18-2 to 18-5. The correlation coefficients are significant at the 1 percent level, and the coefficients of the variables in the correlation equations have the sign corresponding to their probable influence on the maximum flows and their standard deviations. The results of the correlations are interesting since they indicate a reduction of maximum flows with areas of lakes, and for the summer maximums, with the areas of forests. These correlations can be used with the file on grid physiographic characteristics to compute these two hydrologic parameters for any drainage basin on the Island. The correlations obtained have been used to synthesize average maximum flows and their coefficients of variation for river basins studied in more detail for which there were no recorded data available. Using these synthesized statistics and Gumbel probability distribution curves, the maximum flows with different probabilities have been computed as shown in the corresponding tables included in Volumes Six and Seven. These were compared with maximum flows obtained using the unit hydrograph technique described in Section 18.3, where the results of this comparison are also shown.

These types of correlations were not developed for Labrador because of the small amount of data available.

### 18.3 Unit Hydrograph Techniques

The data on the maximum flow developed by the statistical approach described above are not sufficient for estimation of the river flood volumes required, especially when storage developments are considered. Consequently, in parallel with the statistical processing, unit hydrographs have been developed for stations with automatic level recorders or where sufficient level readings were available to trace the shape of the hydrographs (Table 18-6). Note that all 17 river gauging stations selected are on the Island. This is because all the hydrometric stations but one in

Labrador have their flows affected by changes in storage due to the operation of hydro-electric plants. An attempt to isolate hydrographs which could be used for unit hydrograph computations on the Naskaupi River, the only station in Labrador where natural river flows are recorded, was unsuccessful because of the particular conditions in this basin which has 30 percent of its area covered by lakes.

Since most of the floods analyzed include a part of the runoff resulting from snowmelt, and since it was not possible to establish from the few scattered meteorologic data the duration and intensity of the precipitation, a special technique was used to estimate the duration and intensity of the net precipitation plus melted snow generating the flood wave analyzed. This method is based on a very simple model which considers the basin as consisting of two elements:

- a) An ideal basin with no natural or artificial storage, with a drainage basin, average channel slope, and length of river valley (up to the divide) equal to that of the actual river basin.
- b) An aggregate storage which incorporates the lake, marsh, and valley storage in such a way that, if the ideal runoff from the ideal basin is routed through it, the resulting outflow is equal to the actual flow.

It is known that, if a uniformly distributed precipitation falls over an ideal basin (without storage), the flow hydrograph increases during the concentration time and stays constant for the remaining duration of the precipitation. After the end of the storm, the flow decreased over a period equal to the concentration time. The shape of the increasing and decreasing portions of this ideal hydrograph is a function of the basin geometry. However, for small and medium basins, these portions can be approximated by straight lines (which actually means that the ideal basin has a different shape from the actual basin) without much loss of accuracy. In this case the flow hydrograph of the ideal basin can be approximated by an isosceles trapezoid. The dimensions of this trapezoid are as follows: the increasing and decreasing portions have a duration equal to the concentration time; the increasing and the constant proportion have a duration equal to the net precipitation duration; and the volume of the hydrograph is equal to the volume of the net precipitation.

The actual hydrograph will differ from the ideal, according to the hypothesis accepted, due to its routing through the aggregate storage. As can be demonstrated, an outflow (actual) hydrograph will intersect the inflow (ideal) hydrograph at a point where the outflow is maximum.

This results in a procedure of estimating the duration of the generating storm if the concentration time is known. For this purpose, on the graph of the actual hydrograph a trapezoid must be constructed by trial and error in such a way that its area equals that of the actual hydrograph, its increasing and decreasing portions have a duration equal to the concentration time, and its decreasing portion intersects the actual hydrograph at its peak (Figure 18-1). The increasing plus the constant portion of the trapezoid will indicate the duration of the precipitation.

The time of concentration for the ideal basin has been estimated using indications given by Ogievski<sup>1</sup>. Once the precipitation duration has been determined in this way, the computation of the unit hydrograph follows the known standard procedures.

The method, already used on several other occasions<sup>2, 3</sup>, proved also to be applicable to this case since, at each of the 17 river gauging stations, the six-hour unit hydrographs determined from between 3 and 5 different floods were remarkably similar (Figures 18-2 to 18-18); and for the few cases for which data on the flood-generating precipitation were available, an acceptable agreement was found between these values and the estimated durations of the corresponding net precipitation, as shown in the following table:

Comparison Between Duration of Recorded and Computed  
 Duration of Generating Precipitation

<u>Station</u>	<u>Date of Flood</u>	<u>Duration of Precipitation in Hours</u>	
		<u>Recorded</u>	<u>Computed</u>
2YM <sub>1</sub> (Indian Brook)	October 5, 1961	23 (at Buchans A)	18
	June 6, 1965	9 (at Buchans A)	24
2ZB <sub>1</sub> (Isle aux Morts)	September 30, 1963	3 (at St. Andrew's)	3
	June 25, 1964	3 (at St. Andrew's)	3

The main unit hydrograph characteristics (peak and duration) shown in Table 18-6 have been correlated to the physiographic characteristics of the corresponding basins, and the results of these computations are shown in Table 18-7 and 18-8. These correlations, of course, apply only for the Island. The derivation of similar relationships for Labrador was not possible because of lack of data.

The developed correlation for the peak is not entirely satisfactory because it does not indicate the influence of the lake and swamp area on the peak. This indicates rather the lack of sufficient data than the lack of significance of lakes, and the extension of the number of gauging stations to obtain more reasonable correlations of this type is therefore recommended. The lack of information on the flood characteristics in natural conditions in Labrador should also be considered as one of the main reasons to expand the hydrometric network in this area.

Using the results of these correlations with the physiographic data included in the grid file and the graphs included in Figure 18-19, which includes graphical relationships for the unit hydrograph shape, it is possible to estimate the unit hydrograph main characteristics for any basin on the Island. It is further possible to apply to these unit hydrographs the results of the investigations on maximized storm and seasonal snowfall conditions to compute the "maximum possible floods" for any river basin on the Island. This was done for a series of rivers studied in more detail in Volumes Six and Seven.

The use of maximized snow and precipitation data with unit hydrographs in the Island has shown that:

- a) In all cases except the largest river basin (Exploits River), floods from snowmelt and an average precipitation do not result in a very large peak, although the volume of the flood is much larger (2 to 3 times) than that resulting from the maximized precipitation. The ratio between the peaks of floods resulting from maximized precipitation only and maximized snowmelt only varies between 4.3 for small basins such as the Pipers Hole (300 square miles) to 0.89 for the Exploits River at the Bay of Exploits (4950 square miles).
- b) The maximum flow, which can be synthesized from maximized snow and precipitation data, is obviously obtained on the assumption that a maximized precipitation falls over an existing snow pack. Maximum flows can be obtained without necessarily considering that the snow pack is that corresponding to the maximized value, a snow pack of 10 to 20 inches of water equivalent generally being sufficient to create conditions corresponding to the maximum possible flow. These results confirm the findings of an earlier flood study for the Bay D'Espoir development by Montreal Engineering Company Limited<sup>4</sup>. Obviously, the ratio between the "maximum possible" flow obtained in this way and the maximum flow with the 1/10,000 probability is much larger (2 to 3 times) than the ratio between

the "maximum possible" precipitation and the maximum precipitation with the 1/10,000 year probability. This indicates that the use of the unit hydrograph and "maximum possible" precipitation falling on a snow pack is a very unlikely possibility, and that such flood computations are extremely conservative. The comparative figures of maximum flows having a probability of 1/10,000 years and flood peaks from "maximum possible" precipitation shown in the hydrologic data tables for river basins and study areas are included in Volumes Six and Seven. These should serve as an indication of the degree of conservatism included in the computations mentioned above, which assume the coincidence of a large pack of snow on the ground, critical sequence of temperatures, saturated or frozen ground, "maximum possible" precipitation, and minimum losses by infiltration or evaporation.

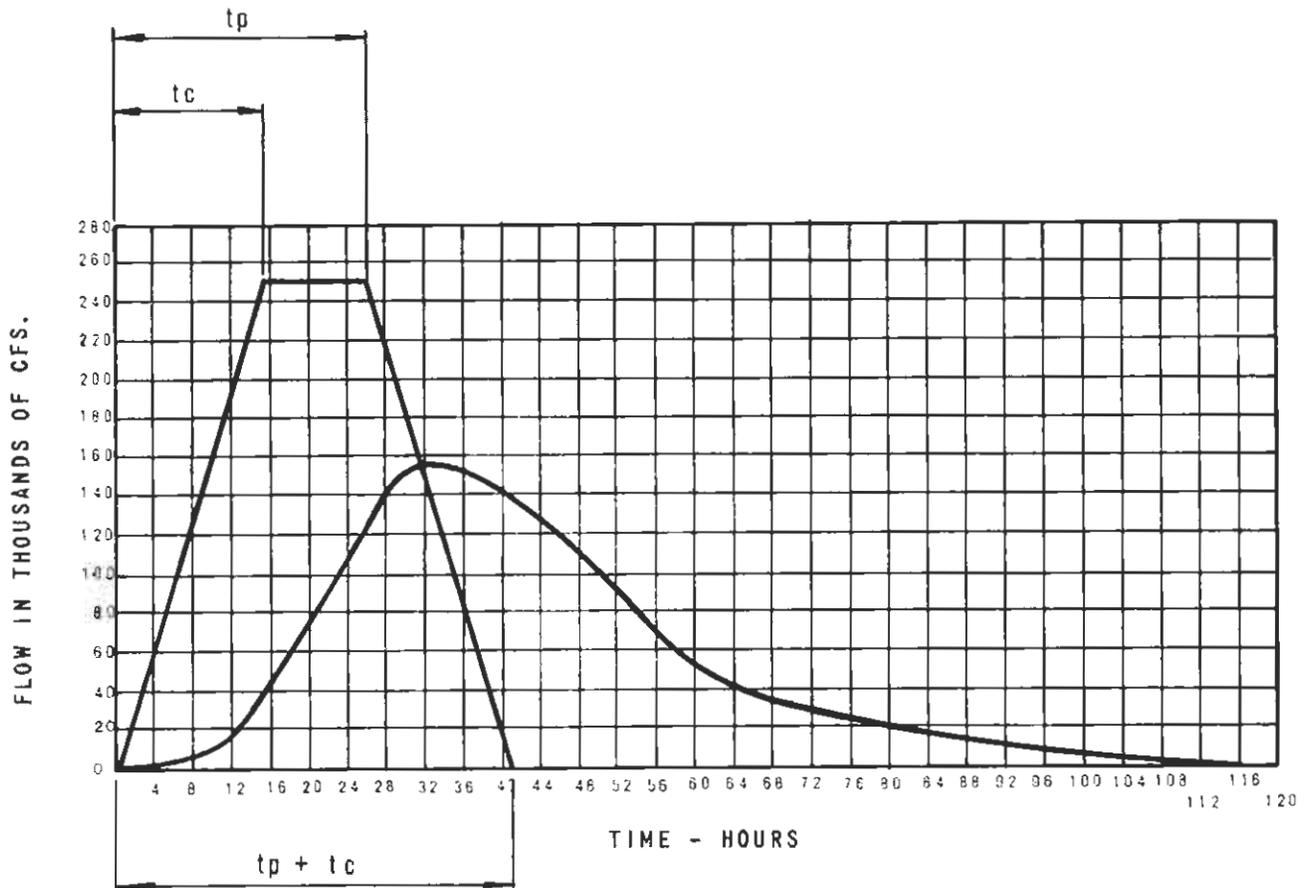
In making the comparison, however, it should be noted that the flows computed on the probability basis are average daily flows and that no corrections for sampling errors were added. The ratio between the average daily flow and the maximum instantaneous flow decreases generally with the size of the river basin and other physiographic characteristics. It is suggested that a correlation for this ratio of the same type as used in the other maximum flow characteristics should be attempted, when more data on instantaneous peaks become available. Corrections for the sampling error can be done using the standard deviation as computed by the correlation indicated in Tables 18-4 and 18-5 (or recorded values) and the known method indicated in literature, for example, in a paper by Coulson<sup>5</sup>.

REFERENCES

- 1 Ogievski, A. V. Land Hydrology. (Russian) Moscow, 1952
- 2 The Shawinigan Engineering Company Limited. Feasibility Study, Upper Parak Hydro-Electric Development. Volume III, Hydrology. Montreal, 1966.
- 3 The Shawinigan Engineering Company Limited. Power Development Survey, Guyana. Montreal, 1968.
- 4 Montreal Engineering Company Limited. Bay D'Espoir Development, Probable Maximum Floods, Preliminary Report. Montreal, 1965.
- 5 Coulson, A. Table for Computing and Plotting Frequency Curves Technical Bulletin No. 3. Ottawa, Canada. Department of Energy, Mines and Resources. Water Resources Branch, 1966.



APPROACH FOR COMPUTING THE DURATION  
OF FLOOD - GENERATING NET PRECIPITATION



$t_p$  = DURATION OF FLOOD-GENERATING NET PRECIPITATION

$t_c$  = TIME OF CONCENTRATION

TORRENT RIVER AT BRISTOLS POOL (2YC1)  
6-HR. UNITGRAPHS

ORDINATES OF AVERAGE 6-HR.  
UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	78	1,440	156	300
6	20	84	1,290	162	260
12	60	90	1,150	168	230
18	140	96	1,030	174	190
24	300	102	910	180	160
30	750	108	810	186	130
36	1,560	114	720	192	100
42	1,860	120	640	198	80
48	1,990	126	570	204	60
54	2,000	132	510	210	40
60	1,920	138	450	216	20
66	1,780	144	390	222	0
72	1,610	150	350		

TOTAL 154,920 CFS - HRS

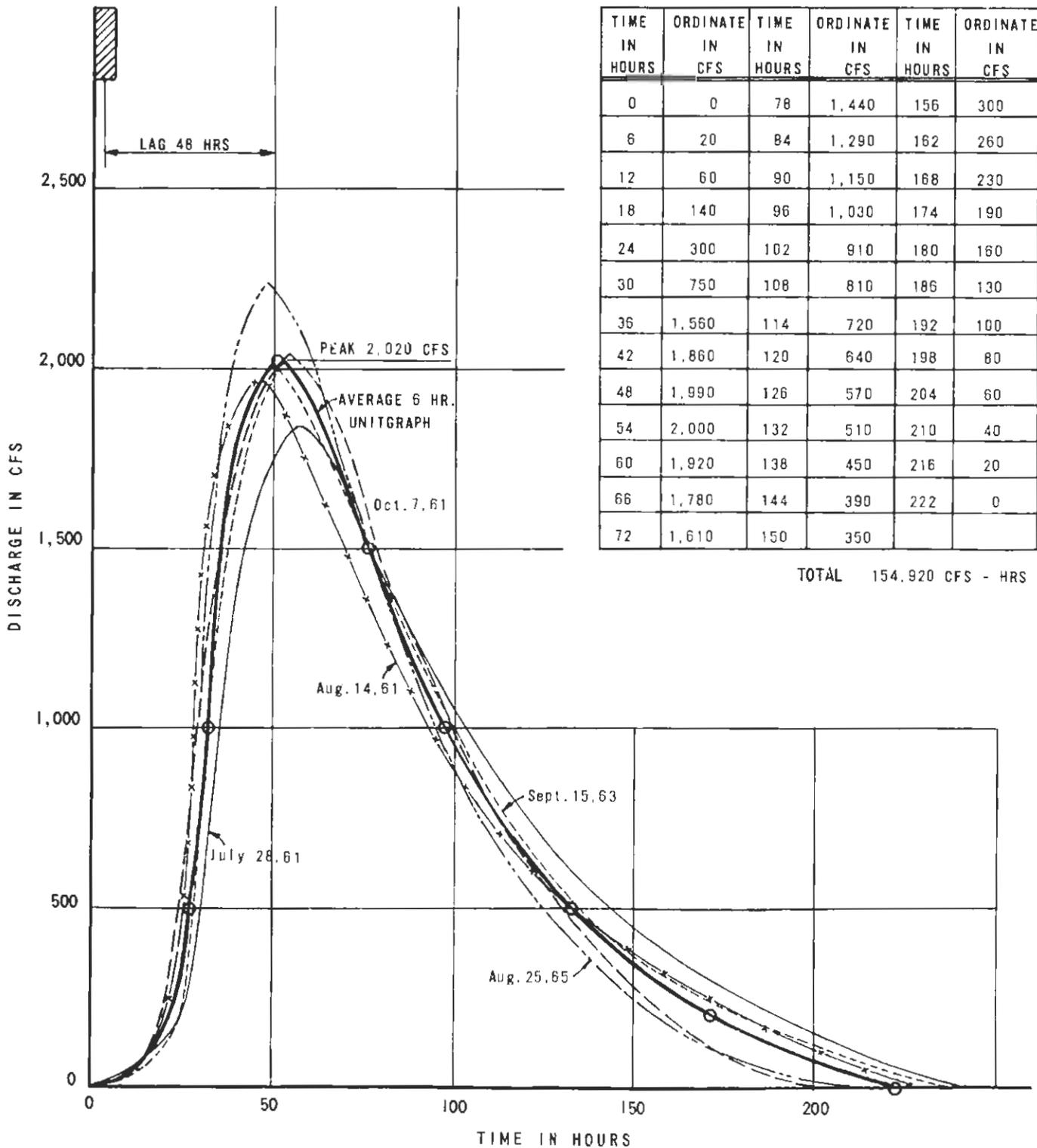
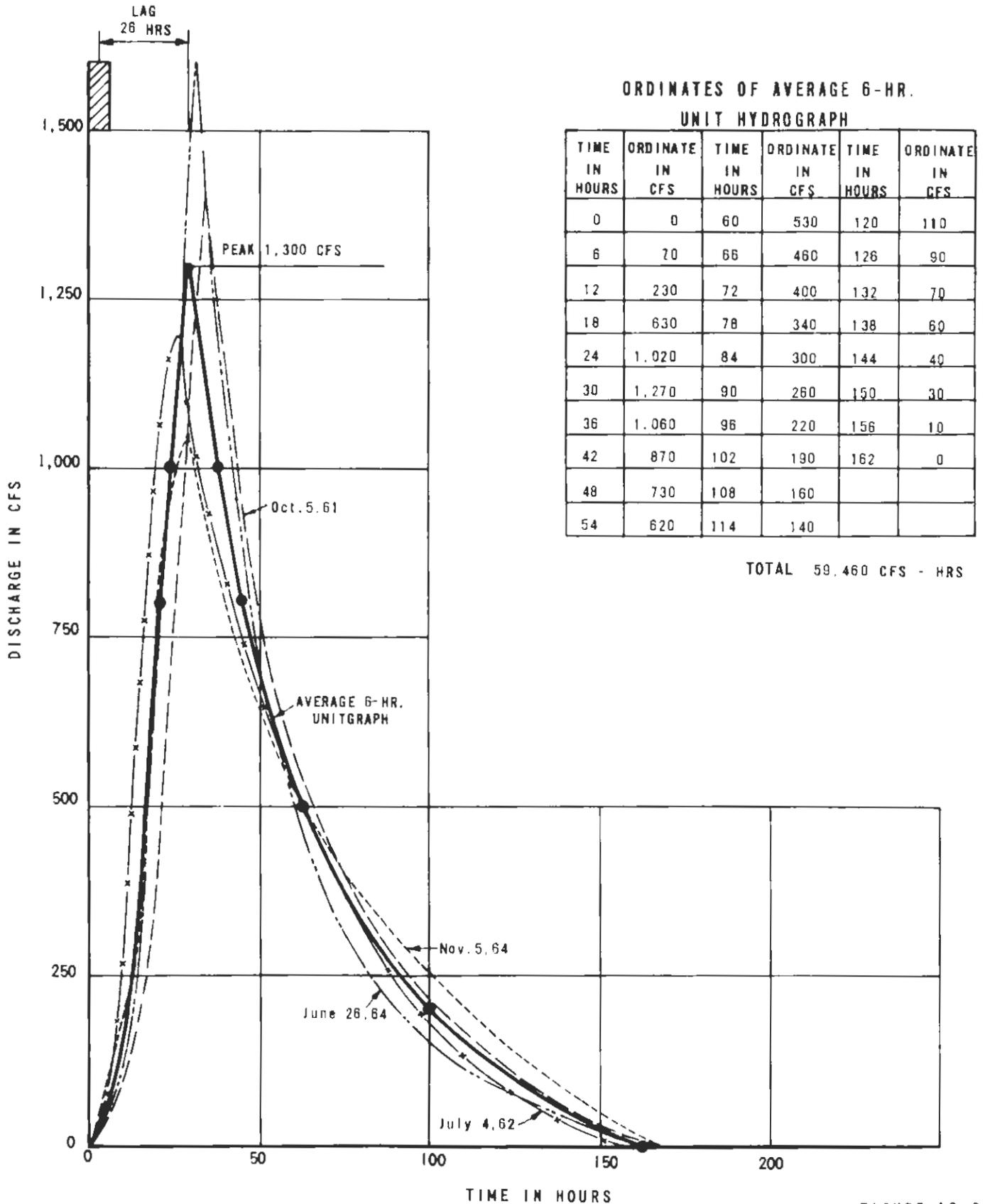
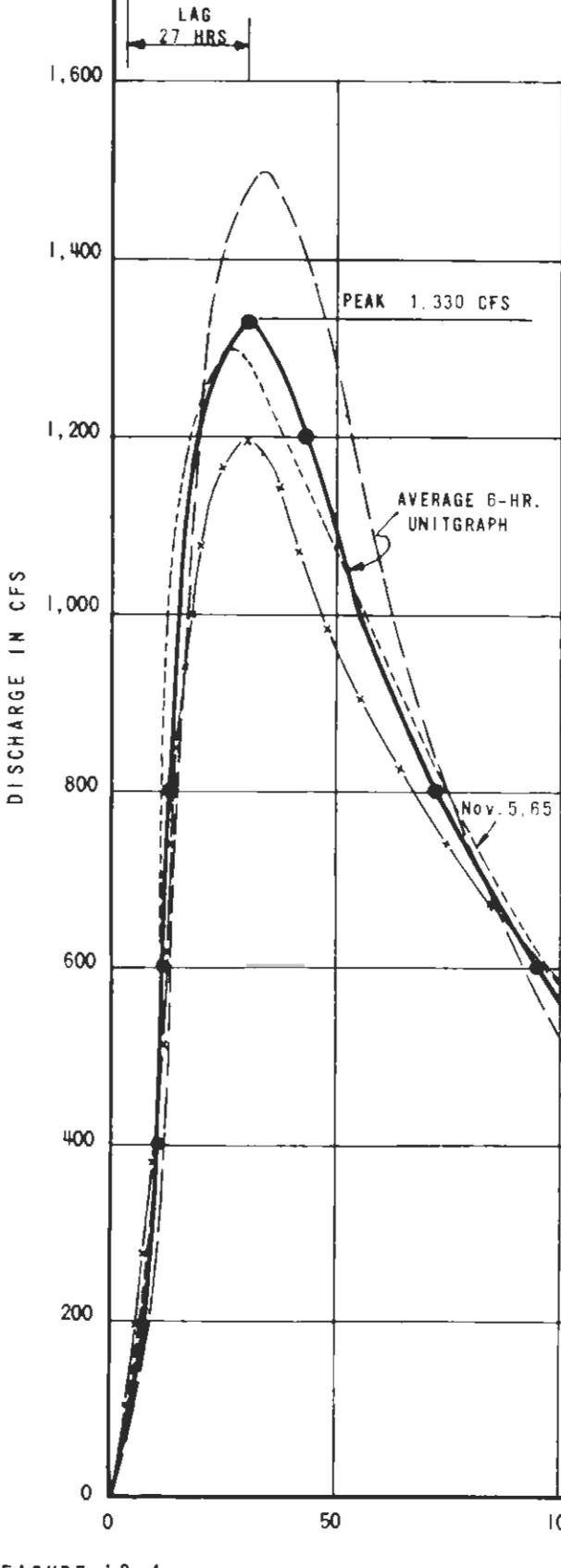


FIGURE 18-2

BEAVER BROOK NEAR RODDICKTON (2YD1)  
6-HR. UNITGRAPHS



LEWASEECHJEECH BROOK AT LITTLE GRAND LAKE (2YK2)  
6-HR. UNITGRAPHS



ORDINATES OF AVERAGE 6-HR. UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	78	750	156	230
6	140	84	690	162	200
12	720	90	640	168	170
18	1,170	96	590	174	150
24	1,290	102	550	180	130
30	1,330	108	510	186	100
36	1,290	114	470	192	80
42	1,220	120	420	198	60
48	1,130	126	390	204	40
54	1,020	132	360	210	20
60	940	138	320	216	0
66	870	144	290		
72	810	150	260		

TOTAL 116,100 CFS - HRS

FIGURE 18-4

TIME IN HOURS

SHEFFIELD RIVER AT SHEFFIELD LAKE (2YK3)  
 6-HR. UNITGRAPHS

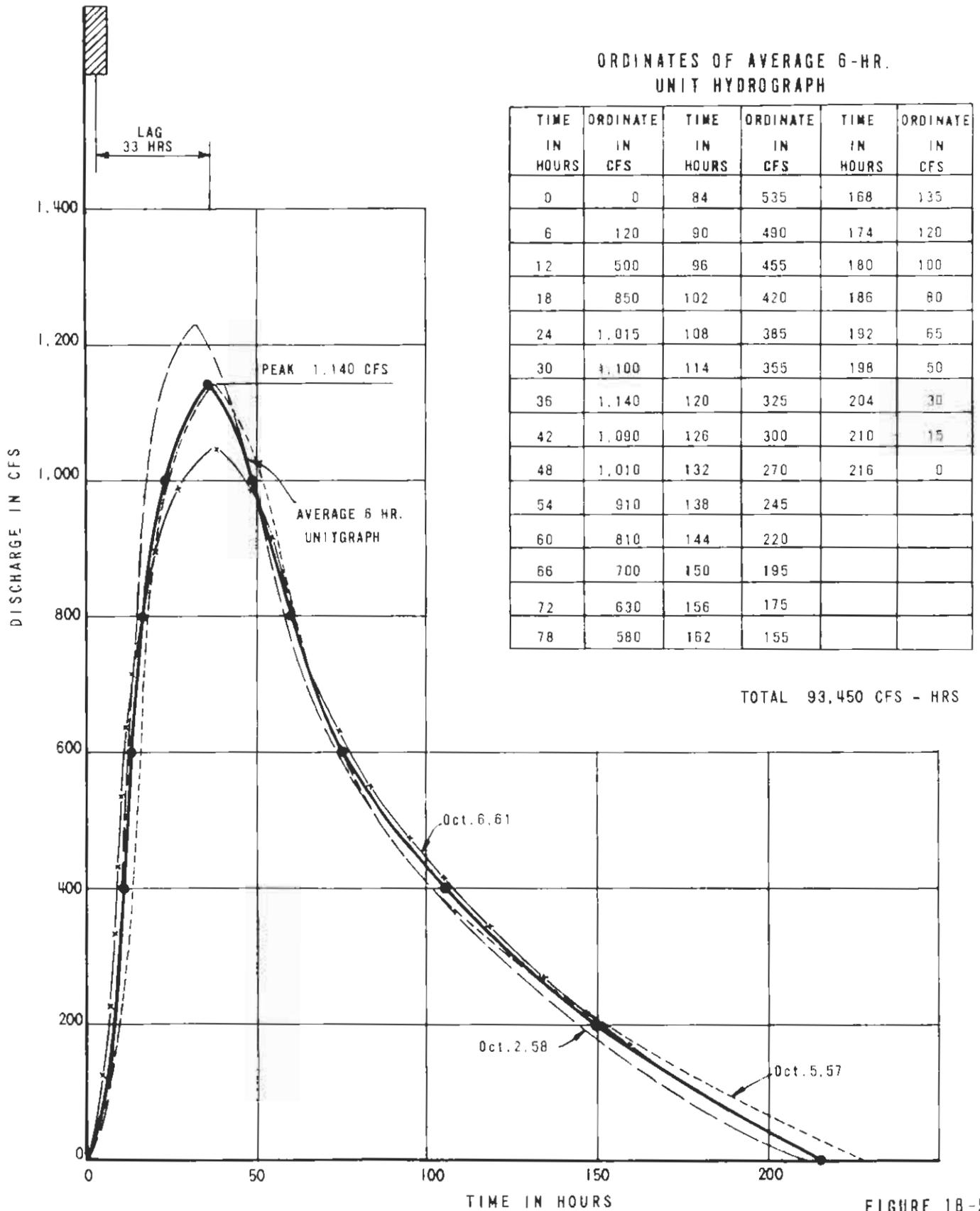


FIGURE 18-5

HINDS BROOK NEAR GRAND LAKE (2YK4)  
 6-HR. UNITGRAPHS

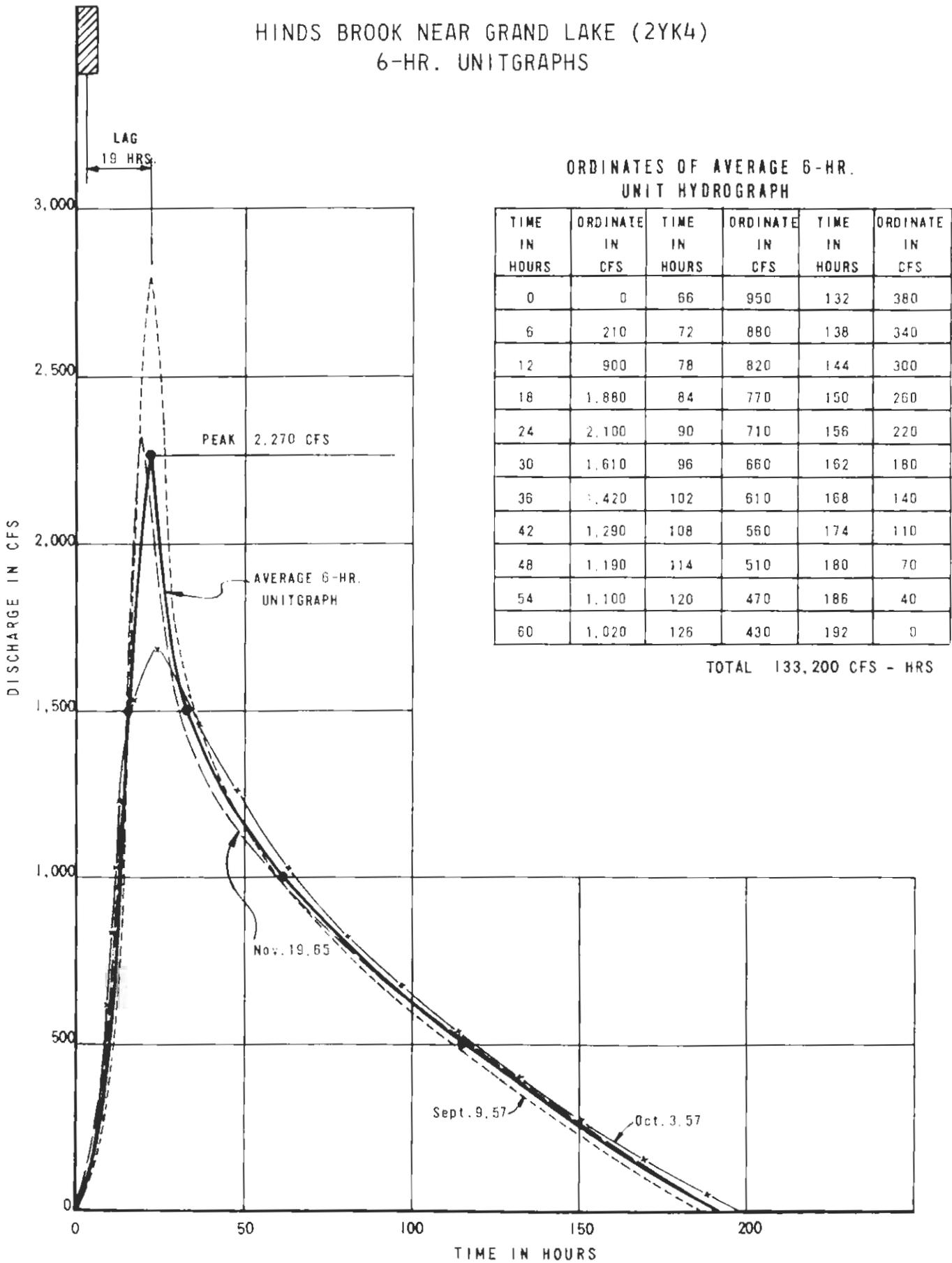
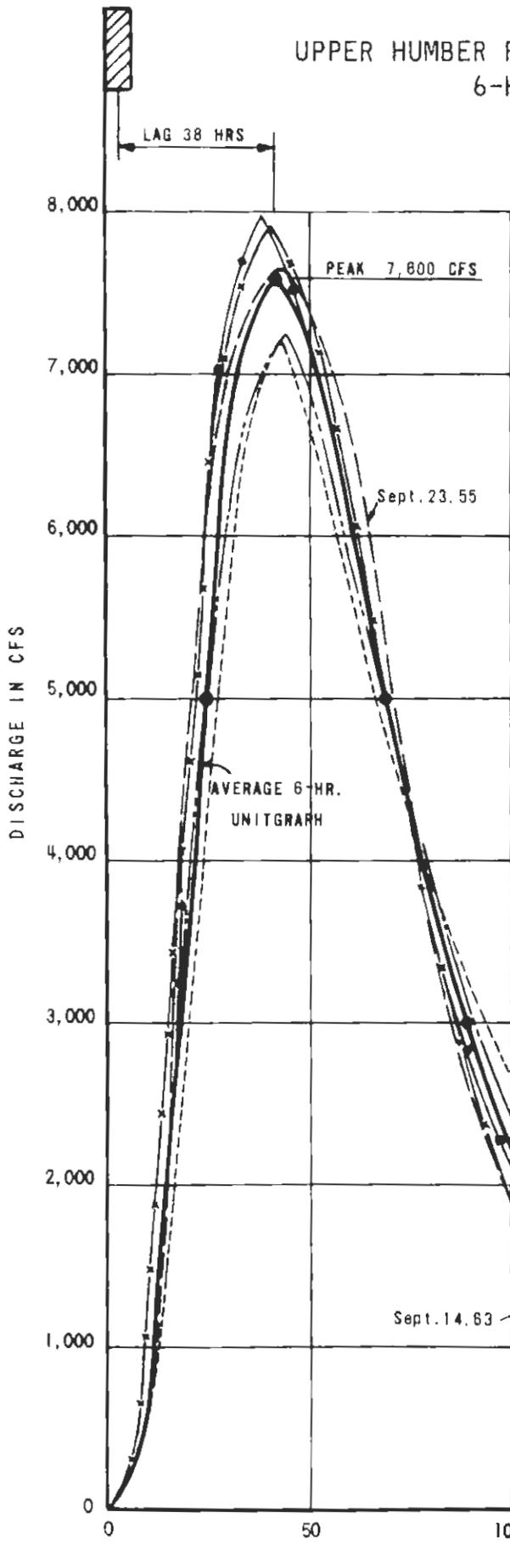


FIGURE 18-6

UPPER HUMBER RIVER AT SEAL POND (2YL1)  
 6-HR. UNITGRAPHS



ORDINATES OF AVERAGE 6-HR. UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	66	5,350	132	950
6	250	72	4,600	138	800
12	1,400	78	3,950	144	650
18	3,100	84	3,400	150	550
24	5,100	90	2,900	156	450
30	6,800	96	2,450	162	350
36	7,350	102	2,100	168	250
42	7,500	108	1,800	174	200
48	7,300	114	1,550	180	100
54	6,800	120	1,350	186	50
60	6,100	126	1,150	192	0

TOTAL 520,200 CFS - HRS

FIGURE 18-7

INDIAN BROOK AT INDIAN FALLS (2YM1)  
6-HR. UNITGRAPHS

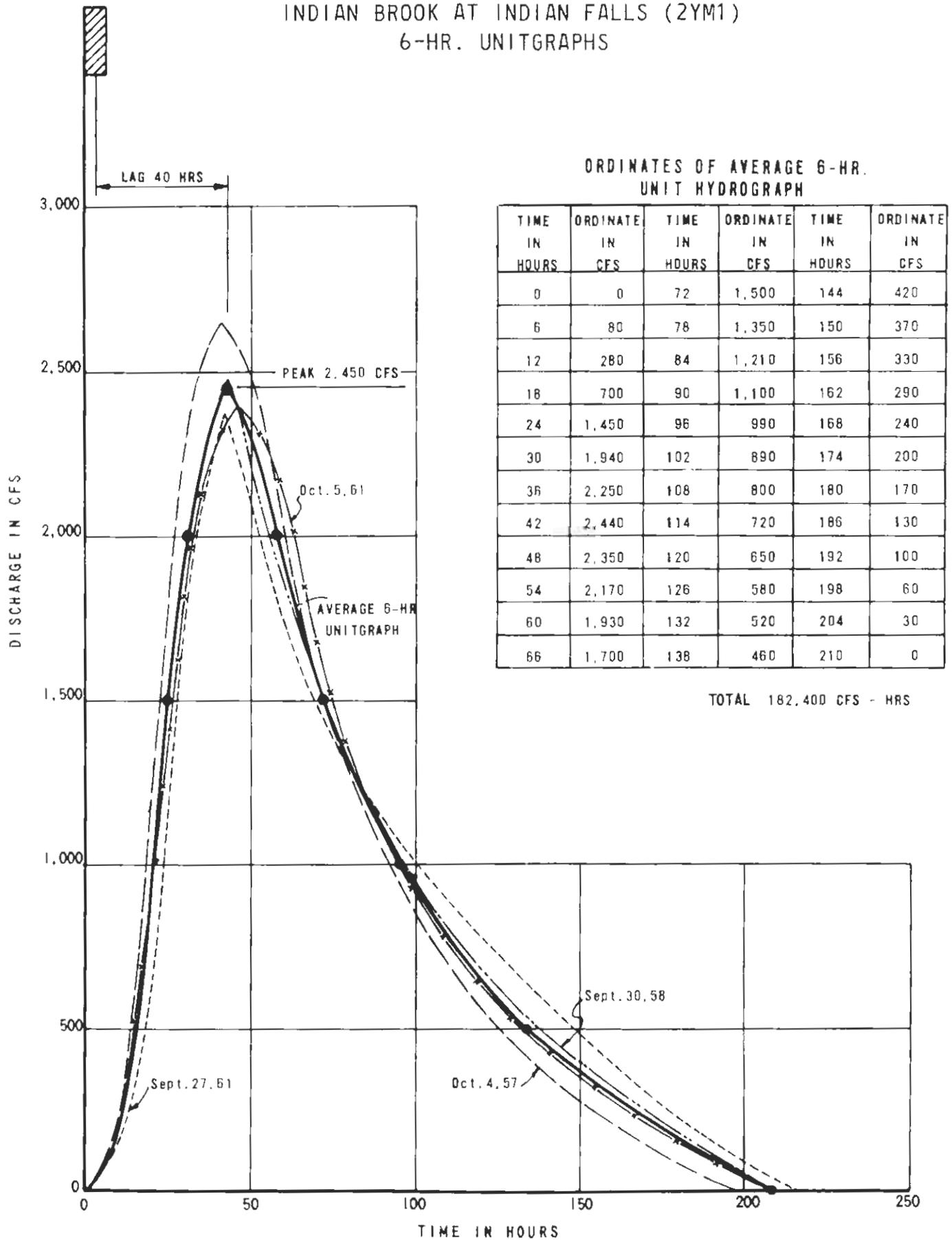
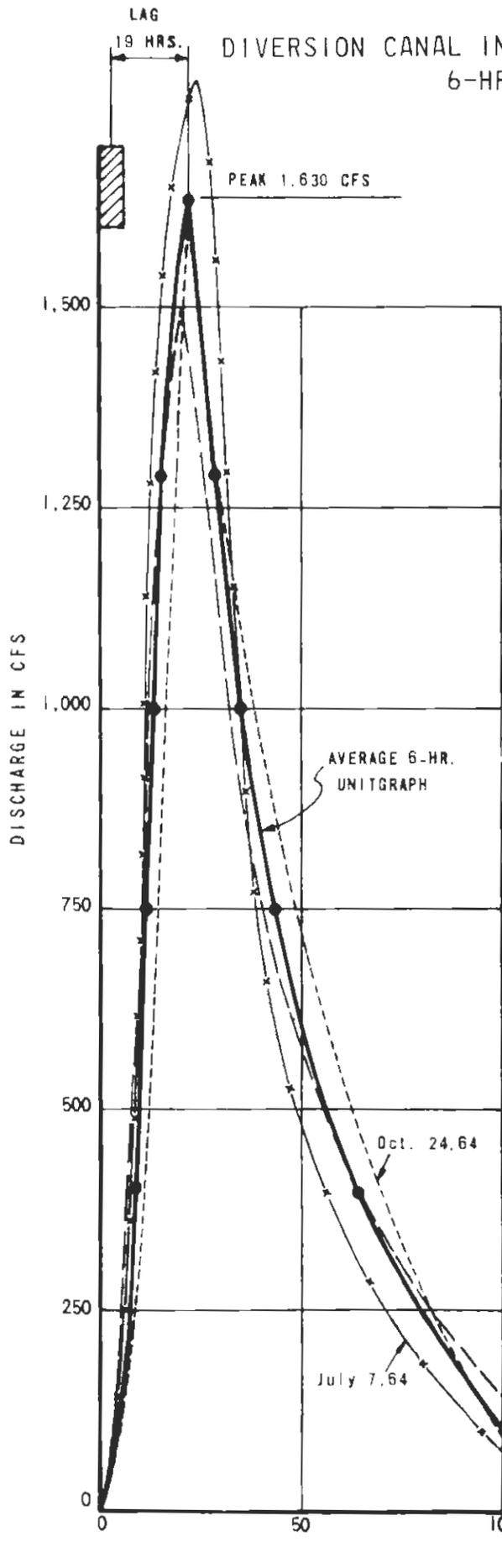


FIGURE 18-8

DIVERSION CANAL INLET AT INDIAN BROOK (ZYM2)  
6-HR. UNITGRAPHS

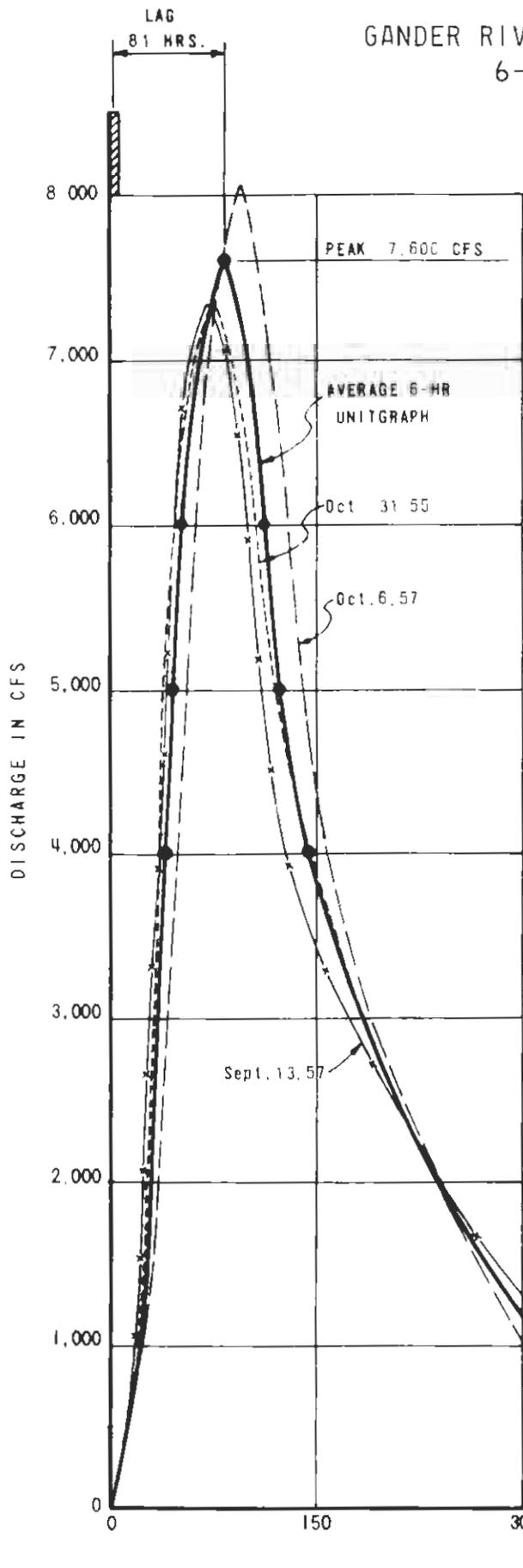


ORDINATES OF AVERAGE 6-HR. UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	42	770	84	210
6	180	48	680	90	170
12	830	54	530	96	130
18	1,470	60	440	102	90
24	1,520	66	370	108	60
30	1,190	72	310	114	30
36	960	78	260	120	0

TOTAL 61,200 CFS - HRS

GANDER RIVER AT BIG CHUTE (2YQ1)  
6-HR. UNITGRAPHS



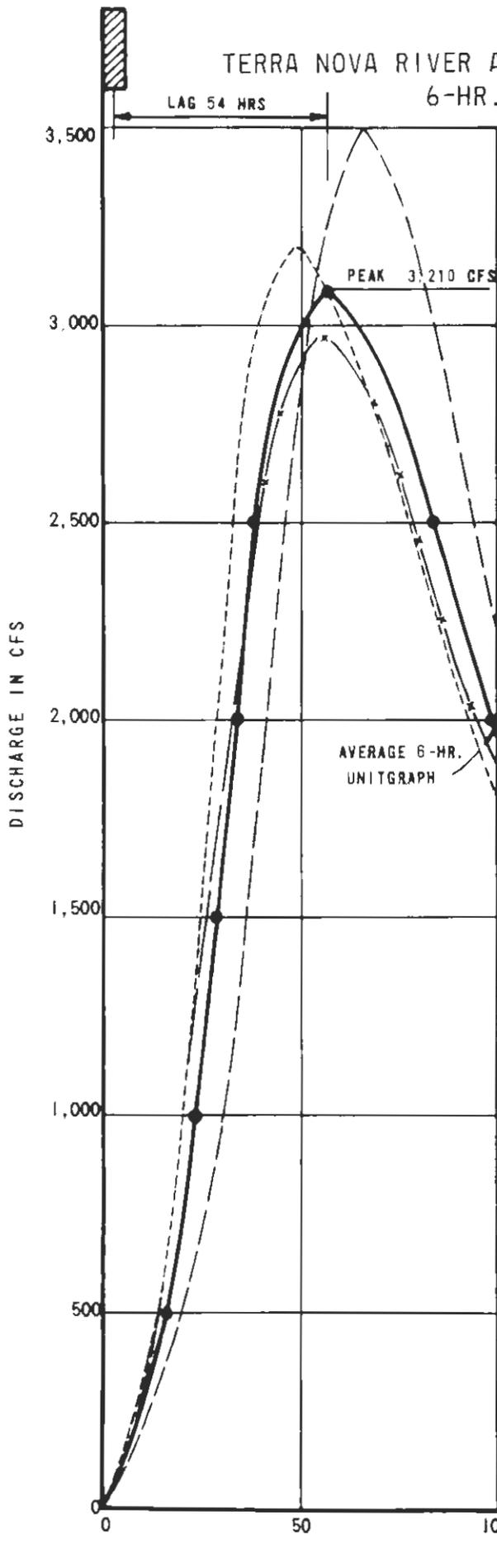
ORDINATES OF AVERAGE 6-HR. UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	144	4,000	288	1,310
6	200	150	3,800	294	1,250
12	400	156	3,650	300	1,170
18	700	162	3,500	306	1,100
24	1,300	168	3,350	312	1,040
30	2,250	174	3,200	318	980
36	3,400	180	3,050	324	920
42	4,400	186	2,900	330	870
48	5,300	192	2,800	336	820
54	6,200	198	2,650	342	770
60	6,650	204	2,550	348	720
66	7,000	210	2,450	356	680
72	7,250	216	2,350	360	640
78	7,450	222	2,250	366	600
84	7,600	228	2,150	372	570
90	7,450	234	2,050	378	540
96	7,200	240	1,970	384	510
102	6,900	246	1,820	390	480
108	6,450	252	1,780	396	450
114	5,800	258	1,700	402	420
120	5,250	264	1,620	408	390
126	4,850	270	1,540	414	360
132	4,600	276	1,460	420	330
138	4,250	282	1,380		

TOTAL 1,124,160 CFS - HRS

FIGURE 18-10

TERRA NOVA RIVER AT EIGHT MILE BRIDGE (2YS1)  
6-HR. UNITGRAPHS



ORDINATES OF AVERAGE 6-HR. UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	84	2,490	168	680
6	150	90	2,280	174	600
12	330	96	2,090	180	510
18	610	102	1,910	186	440
24	1,070	108	1,760	192	360
30	1,640	114	1,630	198	290
36	2,300	120	1,500	204	230
42	2,740	126	1,380	210	170
48	2,940	132	1,270	216	110
54	3,060	138	1,160	222	60
60	3,060	144	1,060	228	0
66	2,980	150	960		
72	2,860	156	870		
78	2,700	162	770		

TOTAL 306,120 CFS - HRS

FIGURE 18-11

ISLE-AUX-MORTS RIVER AT HIGHWAY BRIDGE (2ZB1)  
6-HR. UNITGRAPHS

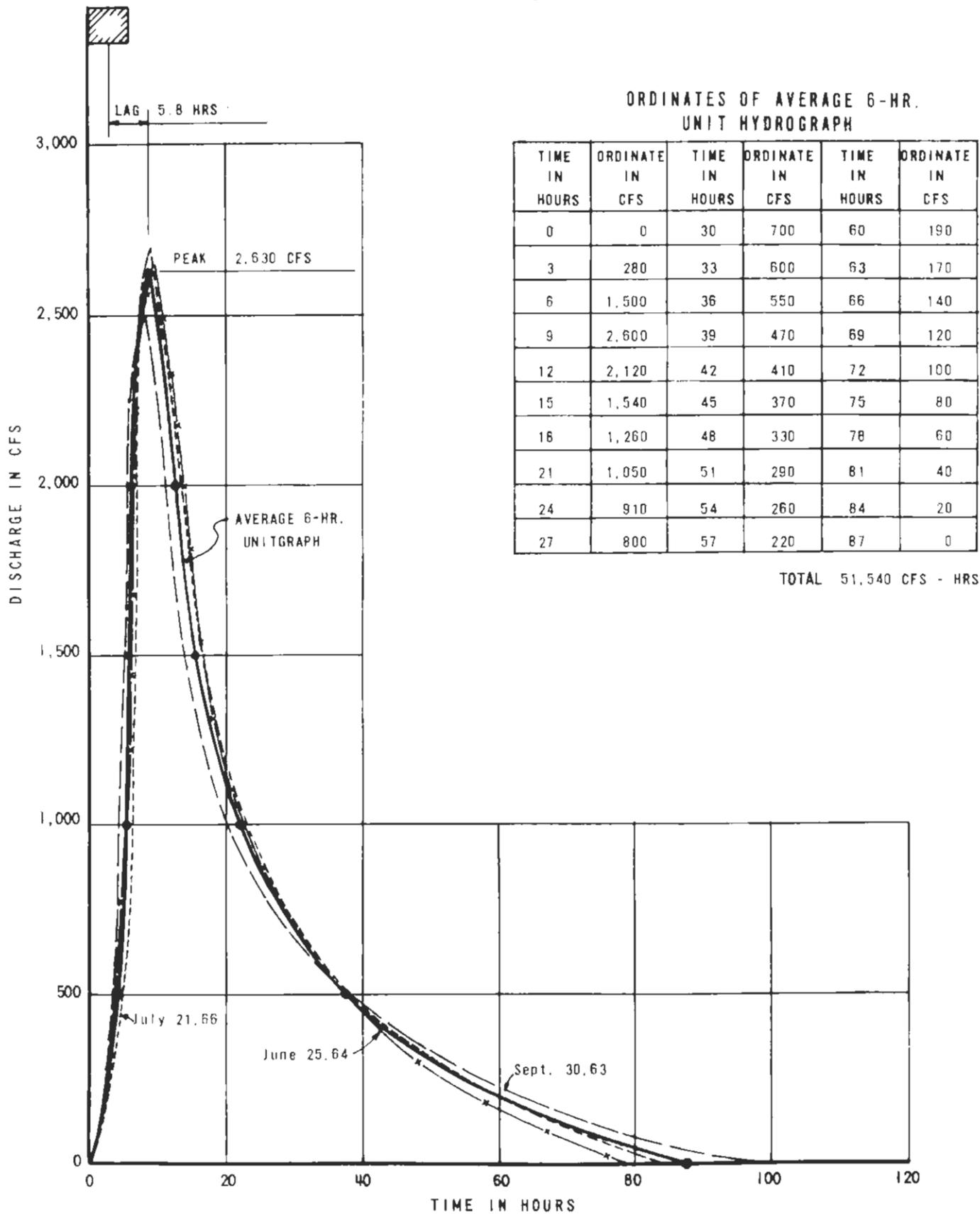
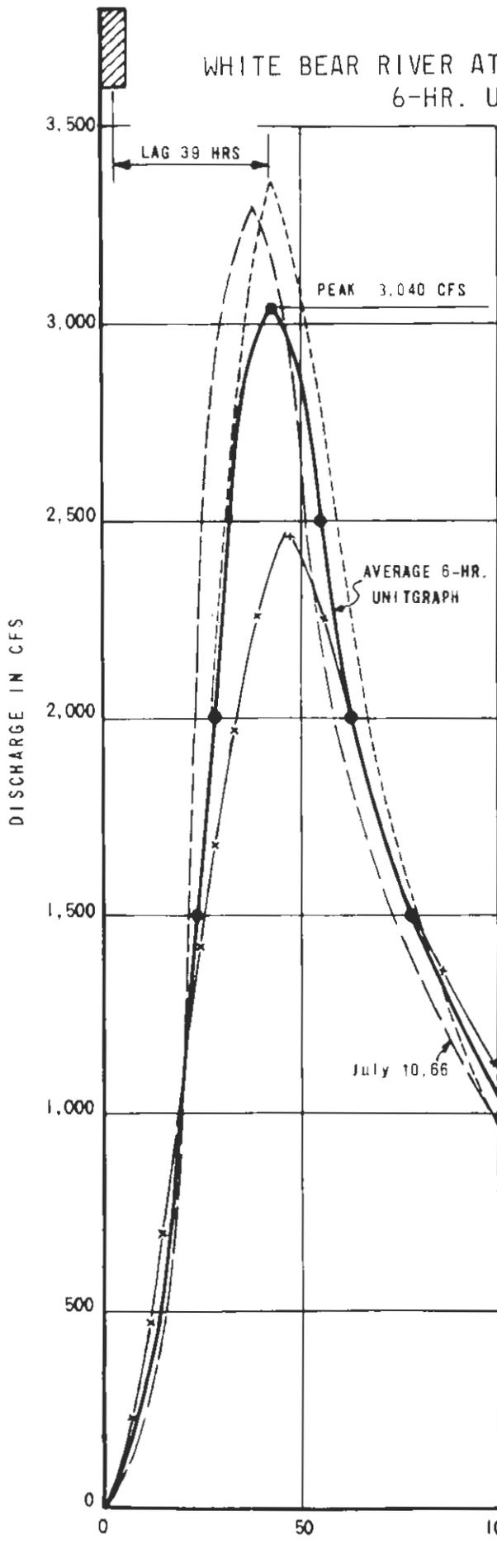


FIGURE 18-12

WHITE BEAR RIVER AT WHITE BEAR LAKE (2ZC1)  
6-HR. UNITGRAPHS



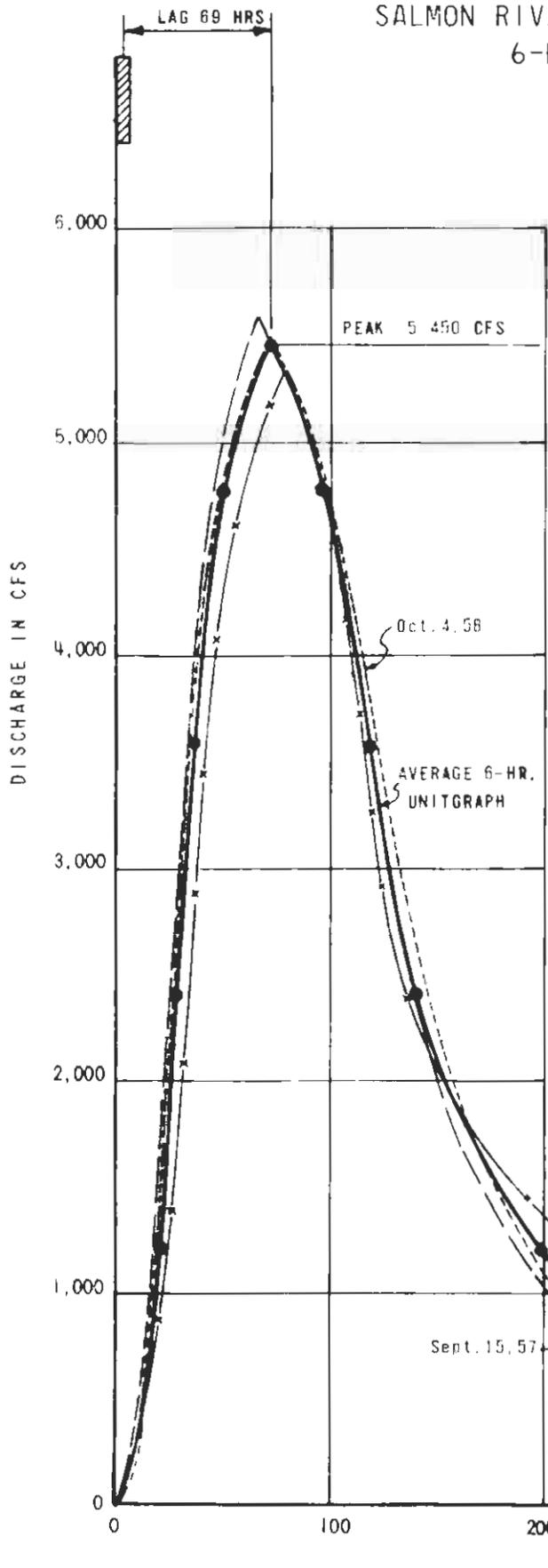
ORDINATES OF AVERAGE 6-HR.  
UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	66	1,860	132	550
6	150	72	1,650	138	480
12	380	78	1,500	144	410
18	900	84	1,360	150	350
24	1,600	90	1,220	156	280
30	2,260	96	1,110	162	220
36	2,880	102	1,000	168	160
42	3,040	108	900	174	110
48	2,920	114	800	180	60
54	2,580	120	720	186	0
60	2,150	126	630		

TOTAL 205,380 CFS - HRS

SALMON RIVER AT LONG POND (2ZE1)  
6-HR. UNITGRAPHS

ORDINATES OF AVERAGE 6-HR.  
UNIT HYDROGRAPH



TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	120	3,470	240	770
6	150	126	3,060	246	720
12	450	132	2,740	252	670
18	940	138	2,460	258	620
24	1,760	144	2,250	264	570
30	2,660	150	2,060	270	520
36	3,550	156	1,930	276	480
42	4,170	162	1,800	282	430
48	4,600	168	1,700	288	390
54	4,920	174	1,590	294	340
60	5,150	180	1,480	300	300
66	5,330	186	1,380	306	260
72	5,450	192	1,300	312	220
78	5,320	198	1,220	318	190
84	5,180	204	1,140	324	150
90	5,000	210	1,070	330	110
96	4,800	216	1,000	336	70
102	4,720	222	940	342	30
108	4,220	228	880	348	0
114	3,900	234	820		

TOTAL 680,460 CFS - HRS

FIGURE 18-14

BAY DU NORD RIVER AT BIG FALLS (2ZF1)  
6-HR. UNITGRAPHS

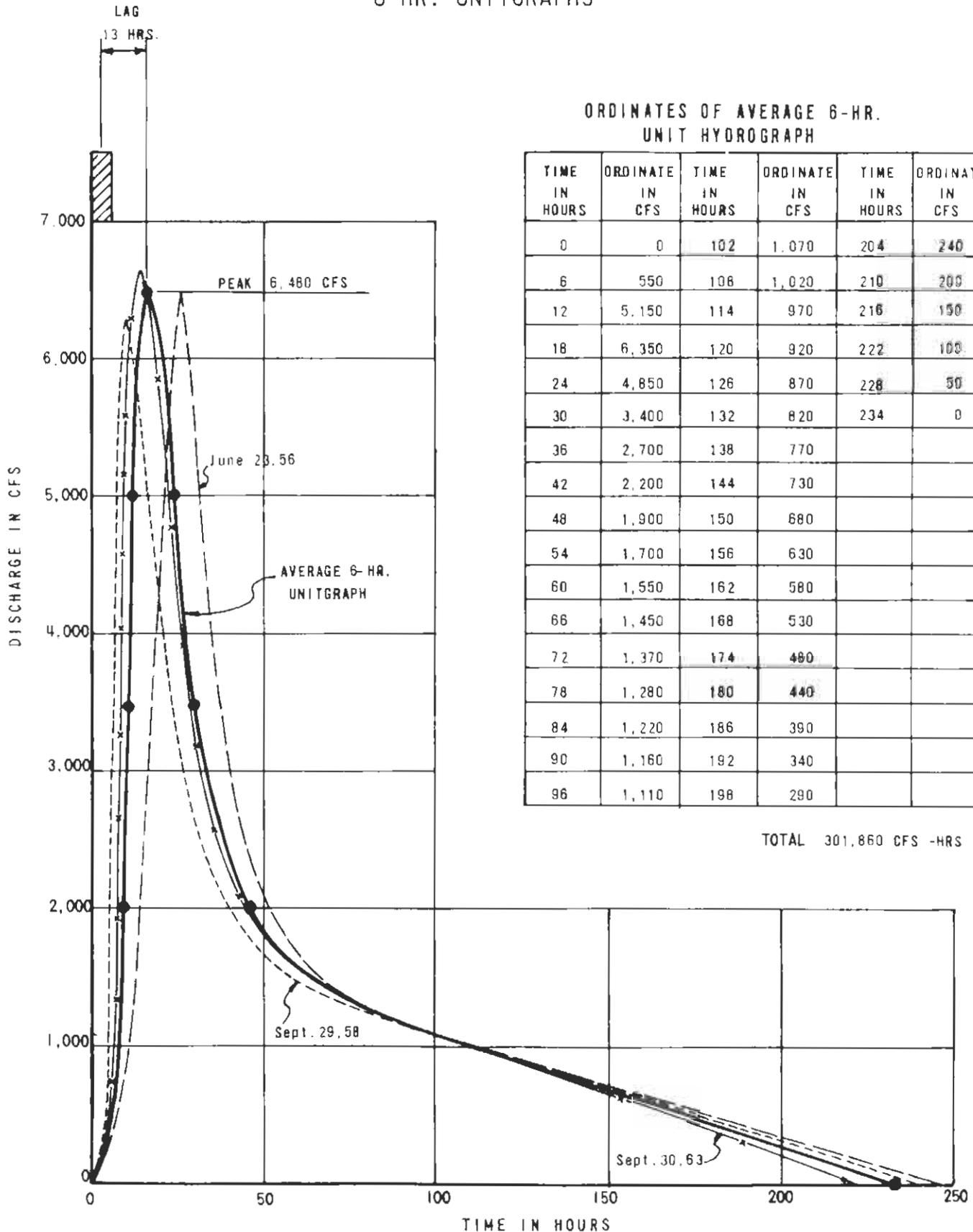


FIGURE 18-15

GARNISH RIVER NEAR GARNISH (2ZG1)  
 6-HR. UNITGRAPHS

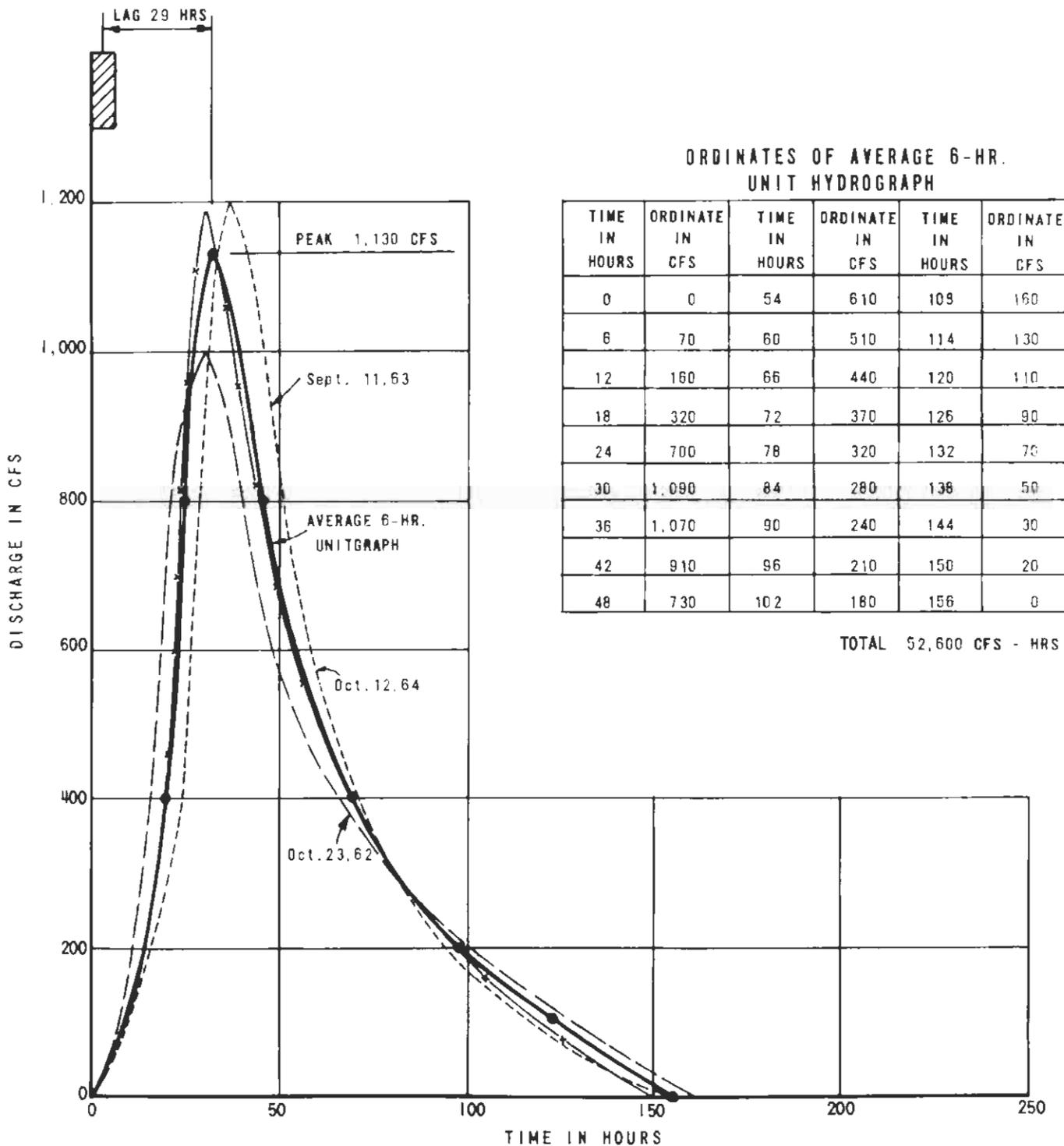
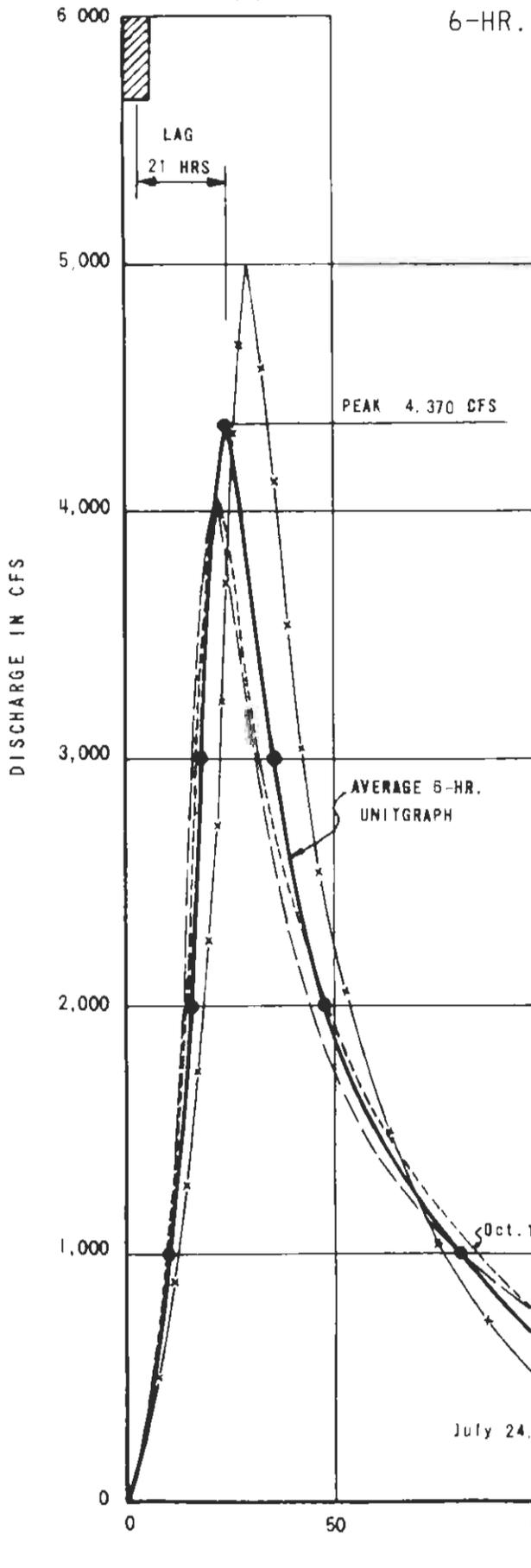


FIGURE 18-16

PIPERS HOLE RIVER AT MOTHERS BROOK (2ZH1)  
 6-HR. UNITGRAPHS



ORDINATES OF AVERAGE 6-HR. UNIT HYDROGRAPH

TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS	TIME IN HOURS	ORDINATE IN CFS
0	0	60	1,500	120	380
6	450	66	1,330	126	320
12	1,200	72	1,170	132	250
18	3,100	78	1,050	138	200
24	4,370	84	920	144	140
30	3,670	90	810	150	90
36	2,920	96	700	156	50
42	2,350	102	610	162	0
48	1,960	108	530		
54	1,700	114	450		

TOTAL 193,320 CFS - HRS

ROCKY RIVER NEAR COLINET (2ZK1)  
 6-HR. UNITGRAPHS

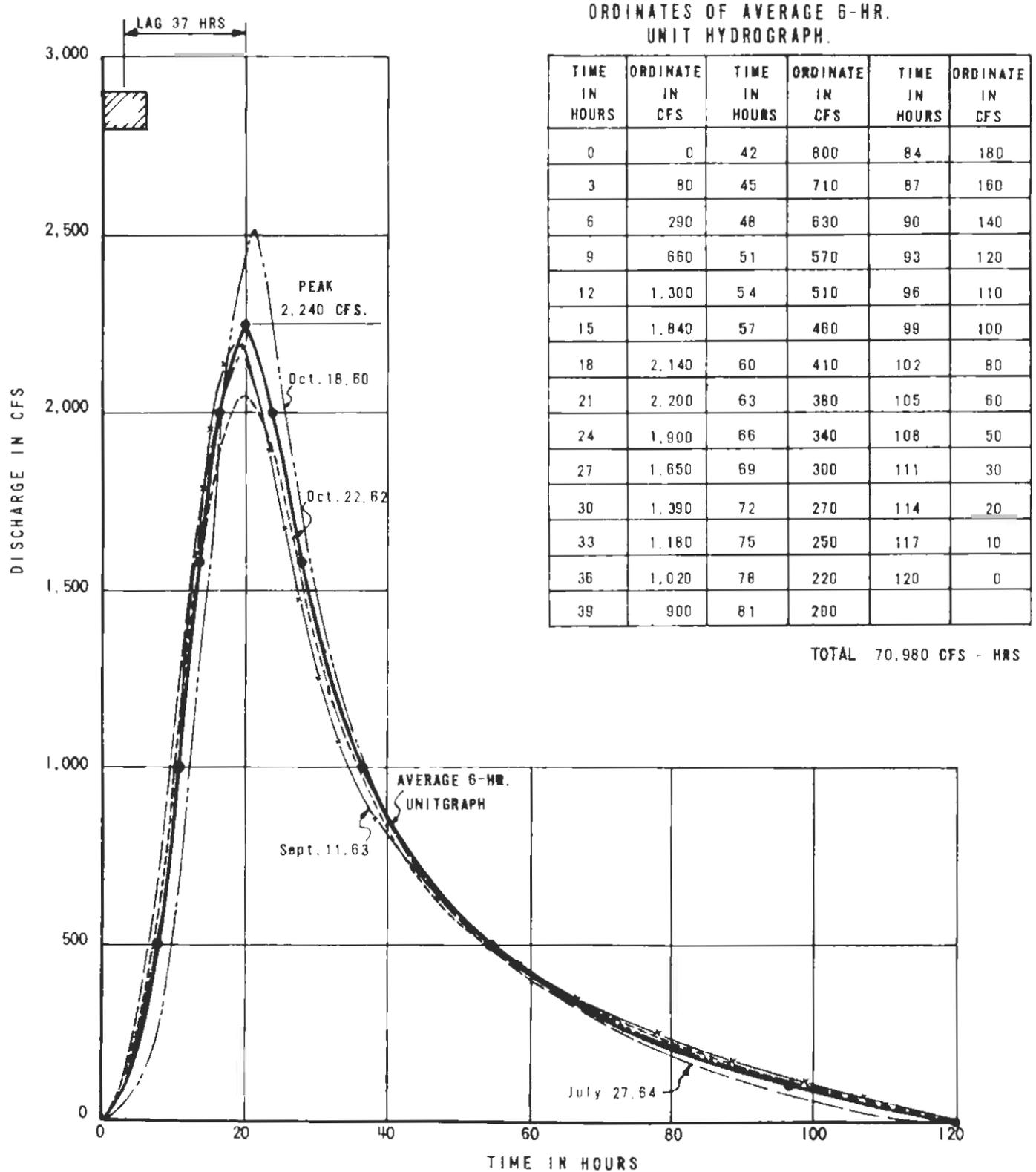
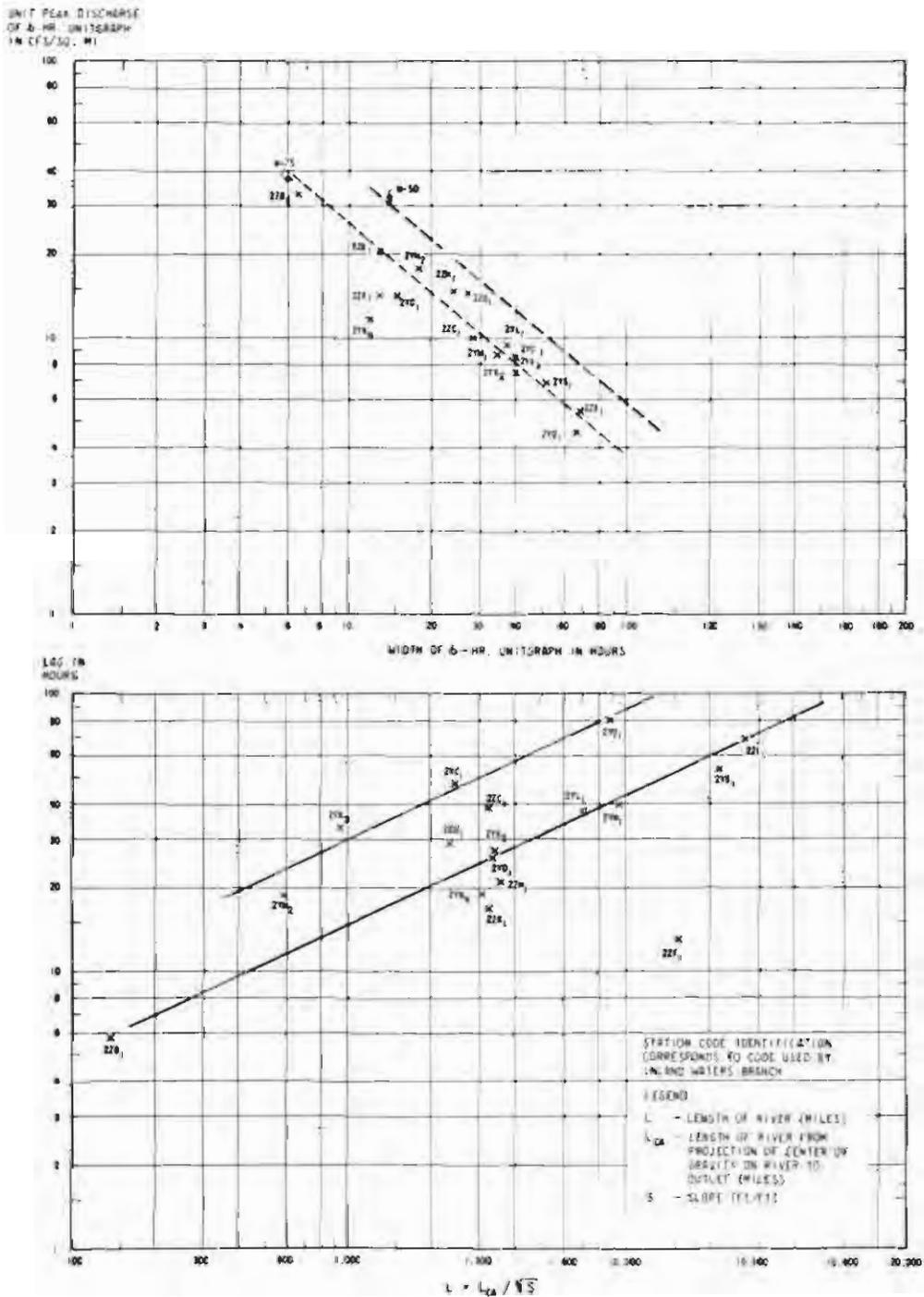
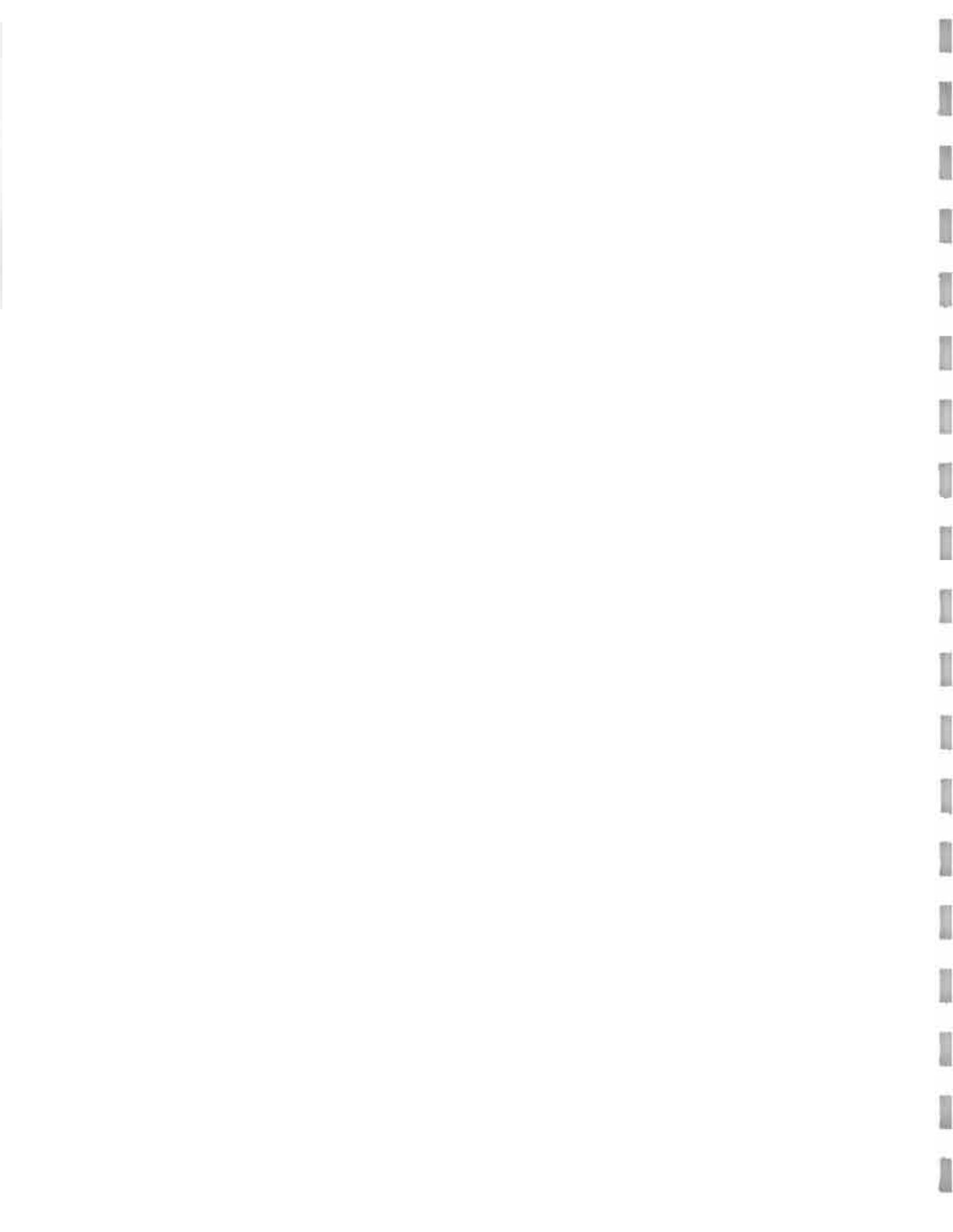


FIGURE 18-18

NEWFOUNDLAND  
 GRAPHICAL RELATIONSHIP FOR ESTIMATING  
 UNIT HYDROGRAPH LAG AND WIDTH





NEWFOUNDLAND  
 SUMMER AND WINTER MAXIMUM FLOWS  
 MAIN CHARACTERISTICS

STATION		SUMMER MAXIMUMS		WINTER MAXIMUMS	
		AVERAGE	STANDARD DEVIATION	AVERAGE	STANDARD DEVIATION
		ACTUAL	ACTUAL	ACTUAL	ACTUAL
TORRENT R (2YC1)	1	2774.99121	1718.99750	6339.99341	1782.99497
BEAVER BROOK (2YD1)	2	1288.99798	609.99884	3219.99074	974.99756
LEWISFELDTZELI R (2YK2)	3	1808.99663	690.99829	2545.99219	493.99878
SHEFFIELD R (2YK3)	4	800.99861	209.99986	2343.99317	654.99841
HINDS BROOK (2YK4)	5	1187.99707	342.99968	2653.99214	691.99829
UPPER HUNTER R (2YL1)	6	13919.99752	4197.99721	18837.99411	4588.99438
INDIAN BROOK (2YH1)	7	2370.99463	789.99889	4900.99434	1438.99858
GANDER R (2YQ1)	8	2199.99794	2719.99414	18699.99836	5589.99002
MIDDLE BROOK (2YR1)	9	905.99872	268.99897	965.99708	244.99954
TERRA NOVA R (2YS1)	10	3468.99979	1138.99760	6001.99348	2147.99463
ISLE AUX MOIS R (2ZB1)	11	4190.99731	1591.99580	2937.99170	603.99840
GREY R (2ZD1)	12	2184.99414	618.99841	2782.99288	618.99841
SALMON R (2ZE1)	13	6127.99242	1993.99960	10061.99096	2848.99317
BAY BU HODD R (2ZF1)	14	3345.99928	1223.99602	4620.99436	1222.99852
GALWISH R (2ZG1)	15	1063.99774	682.99827	1359.99707	459.99878
PIPER'S HOLE R (2ZH1)	16	3239.99824	1097.99052	5914.99341	2836.99214
ROCKY R (2ZK1)	17	2123.99340	870.99772	2893.99247	1189.99731

NEWFOUNDLAND  
CORRELATION BETWEEN AVERAGE SUMMER  
MAXIMUM FLOWS AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DIFFERENCE	
1	2724.99221	3522.56104	-597.56883	TORRENT R (2Y1)
2	1206.99738	1085.44922	121.54816	BEAVER BROOK (2Y1)
3	1908.99461	1929.40478	-20.41017	LEWISSECHJEECH BROOK (2Y2)
4	600.99541	848.33378	-247.33837	SHEFFIELD R (2Y3)
5	1187.99707	1229.39795	-41.40088	HINDS BROOK (2Y4)
6	1391.99712	1134.93129	257.06583	UPPER NUMBER R (2Y1)
7	2370.99483	2371.97811	-0.98328	INDIAN BROOK (2Y1)
8	839.99834	878.95322	-38.95488	GANDER R (2Y1)
9	505.99871	492.98788	13.01083	MIDDLE BROOK (2Y1)
10	3466.99975	3723.98719	-256.98744	TERRA NOVA R (2Y1)
11	4140.99731	4042.98957	97.00774	ISLE AUX MORTS R (2Z1)
12	2194.99414	2140.93252	54.06162	GREY R (2Z1)
13	6192.99243	6952.92891	-760.93648	SALMON R (2Z1)
14	3369.99931	3818.95984	-448.96053	BAY DU NORD R (2Z1)
15	1363.99717	1042.94302	320.05415	GARNISH R (2Z1)
16	3269.98828	2608.94877	661.03951	PIPER'S HOLE R (2Z1)
17	2928.99383	1501.94453	1427.04930	ROCKY R (2Z1)

X - 1 - AREA OF LAKE (SQ. KM.)	LOG. VALUE	STANDARD ERROR OF DEP. VARIABLE =
X - 2 - AREA OF FOREST (SQ. KM.)	LOG. VALUE	0.2752
X - 3 - AREA OF SWAMP (SQ. KM.)	LOG. VALUE	CONSTANT = 0.3209
X - 4 - AVERAGE DEPTH OF OVERBURDEN	LOG. VALUE	
X - 5 - SHORTEST DIST. TO SEA (KM.)	LOG. VALUE	
X - 6 - DIST. TO SEA IN SW. DIRECTION (KM.)	LOG. VALUE	
X - 7 - DIST. TO SEA IN N.W. DIRECTION (KM.)	LOG. VALUE	
X - 8 - AVERAGE SLOPE FT. / 100 FT.	LOG. VALUE	
X - 9 - AVERAGE AZ. OF SLOPES (DEG. FROM N.)	LOG. VALUE	
X - 10 - AVERAGE ELEVATION (FT.)	LOG. VALUE	
X - 11 - AVERAGE BARRIER HT. (FT.)	LOG. VALUE	
X - 12 - AVERAGE ANNUAL FLOW (CFD)	LOG. VALUE	

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X = 1	-0.37023158	0.0099332
X = 2	-0.39926298	0.0117788
X = 3	0.12802986	0.0399138
X = 4	0.1634598	0.1491727

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

DEPENDENT VARIABLE - MEAN SEASONAL MAX. FLOW LOG. VALUE  
COEFFICIENT OF CORRELATION R=0.9611

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION BETWEEN AVERAGE WINTER  
MAXIMUM FLOWS AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	5332.99341	5330.97354	288.00982	TORRENT R (21C1)
2	3215.99324	2286.00947	929.28389	BEAVER BROOK (2YD1)
3	2545.99219	2891.22119	-317.22906	LEWASEECH,EECH BROOK (2YK2)
4	2343.99317	2000.71382	343.27719	SHEFFIELD R (2YK3)
5	2693.99219	2235.75386	448.23838	HINDS BROOK (2YK4)
6	1897.99112	2907.74611	-1178.33227	UPPER NUMBER R (2YL1)
7	4910.99438	4483.15113	427.84325	INDIAN BROOK (2YM1)
8	1969.99336	2049.46020	-179.46684	GANDER R (2YQ1)
9	965.99768	1379.41333	-413.41565	MIDDLE BROOK (2YR1)
10	6601.99049	6656.26075	-54.26026	TERRA NOVA R (2YS1)
11	2977.99370	3188.50337	-210.51370	ISLE AUX MORTS R (2ZB1)
12	2782.99266	2904.36299	-121.37033	GREY R (2ZD1)
13	15061.99085	9857.13098	2044.83020	SALMON R (2ZE1)
14	9920.99438	5291.72364	4629.27074	BAY DU MORO R (2ZF1)
15	1359.99707	1678.35210	-318.35503	GARNISH R (2ZG1)
16	5514.99341	4268.21388	1246.77953	PIPER'S HOLE R (2ZH1)
17	2993.99268	3004.77637	-10.78369	ROCKY R (2ZK1)

X-1	AREA OF LAKE(50,KM <sup>2</sup> )	(LOG VALUES)
X-2	AREA OF FOREST(50,KM <sup>2</sup> )	(LOG VALUES)
X-3	AREA OF SWAMPING(KM <sup>2</sup> )	(LOG VALUES)
X-4	AVG. COEFF. OF OVERBURDEN	(LOG VALUES)
X-5	SHORTEST DIST. TO SEA(KM)	(LOG VALUES)
X-6	DIST. TO SEA IN SE. DIR(KM)	(LOG VALUES)
X-7	DIST. TO SEA IN SW. DIR(KM)	(LOG VALUES)
X-8	AVG. SLOPE(FT./1000 FT.)	(LOG VALUES)
X-9	AVG. ALT. OF SLOPE(50, FT. X 10)	(LOG VALUES)
X-10	AVG. ELEVATION(FT. X 10)	(LOG VALUES)
X-11	AVG. BARRIER HT.(FT. X 10)	(LOG VALUES)
X-12	AVG. ANNUAL FLOW (CFS)	(LOG VALUES)
DEPENDENT VARIABLE = MEAN WINTER MAX. FLOW (LOG VALUES)		
COEFFICIENT OF CORRELATION R=0.9692		

INDEPENDENT VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X = 1	-0.44413799	0.09953975
X = 2	-0.39888007	0.11274326
X = 11	0.30240806	0.09514511
X = 12	1.29155954	0.11272001

STANDARD ERROR OF DEP. VARIABLE = 0.4985  
CONSTANT = 3.2234

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATIONS OF  
SUMMER MAXIMUM FLOWS AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	1018.99780	1350.25024	-331.25238	TORRENT R (2YC1)
2	609.99870	686.99560	-76.99690	BEAVER BROOK (2YD1)
3	690.99853	609.72436	81.27418	LEWASEECHJEECH BROOK (2YK2)
4	205.99966	276.48877	-72.48911	SHEFFIELD R (2YK3)
5	342.99945	292.25547	50.74398	HINDS BROOK (2YK4)
6	4197.98731	3500.33399	697.65332	UPPER HUNBER R (2YL1)
7	709.99865	611.19323	98.80542	INDIAN BROOK (2YM1)
8	2713.99414	2838.76465	-124.77051	GANDER R (2YQ1)
9	268.99957	241.79907	27.20050	MIDDLE BROOK (2YR1)
10	1138.99780	1380.67627	-241.67847	TERRA NOVA R (2YS1)
11	1591.99585	1412.37795	179.61790	ISLE AUX MORTS R (2ZB1)
12	618.99841	645.50073	-26.50232	GREY R (2ZD1)
13	1993.99560	2047.82739	-53.83179	SALMON R (2ZE1)
14	1223.99602	1411.39233	-187.39631	BAY DU MORD R (2ZF1)
15	682.99829	678.16027	4.83802	GARNISH R (2ZG1)
16	1097.99682	895.37646	202.62036	PIPER'S HOLE R (2ZH1)
17	876.99792	844.11447	32.88345	ROCKY R (2ZK1)

X-1 - AREA OF WATERSHED (SQ. KM.)	(LOG VALUES)
X-2 - UNIT AREA OF LAKE	(LOG VALUES)
X-3 - UNIT AREA OF FOREST	(LOG VALUES)
X-4 - UNIT AREA OF SWAMP	(LOG VALUES)
X-5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X-6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X-7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X-8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X-9 - AVGE. SLOPE (FT. / 100 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS / SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEV. - MAX FLOW (LOG VALUES)  
COEFFICIENT OF CORRELATION R=0.9722

STANDARD ERROR OF DEP. VARIABLE = 0.1832  
CONSTANT = 2.8405

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.50233769	0.09770692
X - 11	-0.56180278	0.11486891
X - 13	2.93321610	0.23496812

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$Y_{OEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATIONS OF  
WINTER MAXIMUM FLOWS AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	1782.99487	1472.09043	290.90444	TORRENT R (2Y1)
2	974.99756	691.42822	283.56934	BEAVER BROOK (2Y1)
3	493.99876	944.51538	-450.51662	LEWASEECHJEECH BROOK (2Y2)
4	654.99841	555.05346	99.94495	SHEFFIELD R (2Y3)
5	691.99829	736.58752	-44.58923	HINDS BROOK (2Y4)
6	4386.98436	4036.44873	350.53563	UPPER NUMBER R (2Y1)
7	1436.99658	1173.27138	263.72520	INDIAN BROOK (2Y1)
8	5384.97852	4485.25782	899.72070	GANDER R (2Y1)
9	244.99954	357.73193	-112.73239	MIDDLE BROOK (2Y1)
10	2147.99463	1867.48291	280.51172	TERRA NOVA R (2Y1)
11	603.99890	926.38244	-324.38354	ISLE AUX MORTS R (2Z1)
12	618.99841	1312.32055	-693.32214	GREY R (2Z1)
13	2846.99317	3364.38029	-517.38712	SALMON R (2Z1)
14	1222.99882	1834.85913	-611.86031	BAY DU MORD R (2Z1)
15	489.99878	489.34295	0.65583	GARNISH R (2Z1)
16	2836.99219	1213.19424	1623.79795	PIPER'S HOLE R (2Z1)
17	1189.99731	628.50769	561.48962	ROCKY R (2Z1)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA OF SWAMP	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBUNSEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIR. (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIR. (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE DEC. FROM N. (°)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X 100)	(LOG VALUES)
X-12 - AVGE. BARRIER HT. (FT. X 100)	(LOG VALUES)
X-13 - UNIT AVG. ANNUAL FLOW (CFS/SQ.KM.)	(LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEV. WINTER FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.8426

STANDARD ERROR OF DEP VARIABLE = 0.4599

CONSTANT 3.2976

VARIABLE (X <sub>i</sub> )	COEFF. (RC <sub>i</sub> )	STANDARD ERROR
X - 1	0.00191166	0.000950921
X - 13	0.00070202	0.000359994

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$



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James F. MacLaren Limited

UNIT HYDROGRAPH DATA IN THE PROVINCE OF NEWFOUNDLAND AND LABRADOR												
NO.	STATIONS	DRAINAGE AREA (SQ. MI.)	LONGEST DISTANCE FROM BOUNDARY TO STATION (MI)	DISTANCE FROM CENTROID TO STATION (MI)	AVERAGE SLOPE S	6-HR UNITGRAPH						
						PEAK (CFS)	UNIT PEAK $q_p$ (CFS/SQ.MI)	BASE OF UNITGRAPH (HF)	WIDTH OF 75 Q (HR)	WIDTH OF 50 Q (HR)	LAG (HR)	
1	2YC <sub>1</sub>	240	23	10	0.0088	2,020	8.4	222	40	56	48	
2	2YD <sub>1</sub>	92.2	23	12	0.0094	1,300	14.1	162	15	34	26	
3	2YK <sub>2</sub>	180	26	13	0.010	1,330	7.4	216	40	75	27	
4	2YK <sub>3</sub>	140	17	5.5	0.00988	1,140	8.2	216	40	66	33	
5	2YK <sub>4</sub>	200	23	11.5	0.00734	2,270	11.4	192	12	38	19	
6	2YL <sub>1</sub>	812	29	19	0.00595	7,600	9.4	192	37	59	38	
7	2YM <sub>1</sub>	284	33	18.5	0.0041	2,450	8.6	210	34	61	40	
8	2YM <sub>2</sub>	92	10	5	0.00734	1,630	17.7	120	18	29	19	
9	2YD <sub>1</sub>	1,690	39.5	42	0.00185	7,600	4.5	420	66	114	81	
10	2YS <sub>1</sub>	459	44	23.5	0.0024	3,120	6.8	228	51	88	54	
11	2ZB <sub>1</sub>	79.5	17.5	9	0.0137	2,630	33.1	87	6.5	12	5.8	
12	2ZC <sub>1</sub>	308	28	6.5	0.00321	3,040	9.9	186	28	53	33	
13	2ZE <sub>1</sub>	1,020	46.5	22	0.00146	5,450	5.4	348	67	100	69	
14	2ZF <sub>1</sub>	454	39	22	0.00325	6,480	14.2	234	13	20	13	
15	2ZG <sub>1</sub>	78.9	18.5	9	0.0049	1,130	14.4	156	27	44	29	
16	2ZH <sub>1</sub>	300	24	11	0.00558	4,370	14.6	162	14	28	21	
17	2ZK <sub>1</sub>	110	17.5	9	0.00236	2,240	20.4	120	13	23	17	
18	3PB <sub>1</sub>	3,470	40.5	14	0.00254							

NEWFOUNDLAND

UNIT HYDROGRAPHIC CHARACTERISTICS

NEWFOUNDLAND  
CORRELATION BETWEEN THE PEAK UNIT HYDROGRAPH FLOW  
AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO.

F LEVEL 2.978

STANDARD ERROR OF DEP VARIABLE = 1018.3945

CONSTANT 982.0939

VARIABLE	COEFF	STANDARD ERROR/	AREA OF FOREST (SQ. KM.)
X - 3	-1.32518554	0.76783037	
X - 13	2.59721518	0.54464984	MEAN ANNUAL FLOW (CFS)

$$\text{PEAK (C F S)} = -1.3252 (\text{AREA FOREST}) + 2.5972 (\text{MEAN ANNUAL FLOW}) + 982.09$$

	ACTUAL	PREDICTED	DEVIATION -	GAUGING STATION
1	7600.00098	6753.95997	846.04113	2YCI
2	5450.00098	7104.62891	-1654.62817	2ZCI
3	4370.00096	3072.04199	1297.95874	2ZHI
4	3120.00049	3781.39258	-661.39221	2YSI
5	6480.00098	4141.61427	2338.38721	2ZFI
6	2240.00049	1880.41113	359.58917	2ZKI
7	2450.00049	2367.12744	82.87306	2YMI
8	7600.00098	7440.56153	159.43948	2YCI
9	1140.00024	1644.16870	-504.16851	2YK3
10	2630.00049	2087.19775	542.80285	2ZBI
11	1130.00024	1695.38086	-565.38073	2ZGI
12	1300.00024	1701.29931	-401.29913	2YDI
13	2020.00024	3076.69482	-1056.69458	2YCI
14	2270.00049	2101.17822	168.82229	2YK4
15	1330.00024	2233.71436	-928.71399	2YK2
16	1630.00024	1269.77585	360.22345	2YK2
17	3040.00049	3423.87793	-383.87750	2ZCI

COEFFICIENT OF CORRELATION

r = 0.88

NEWFOUNDLAND

CORRELATION BETWEEN THE BASE DURATION OF THE  
UNIT HYDROGRAPH AND PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 7

F LEVEL 1.956

STANDARD ERROR OF DEP VARIABLE = 27.0592

CONSTANT 144.9592

VARIABLE	COEFF	STANDARD ERROR/
X - 1	-0.03241734	0.02574625
X - 2	0.68186080	0.17126241
X - 10	-0.39308351	0.14499911
X - 12	1.65677237	0.63817548
X - 14	0.00094562	0.00039084

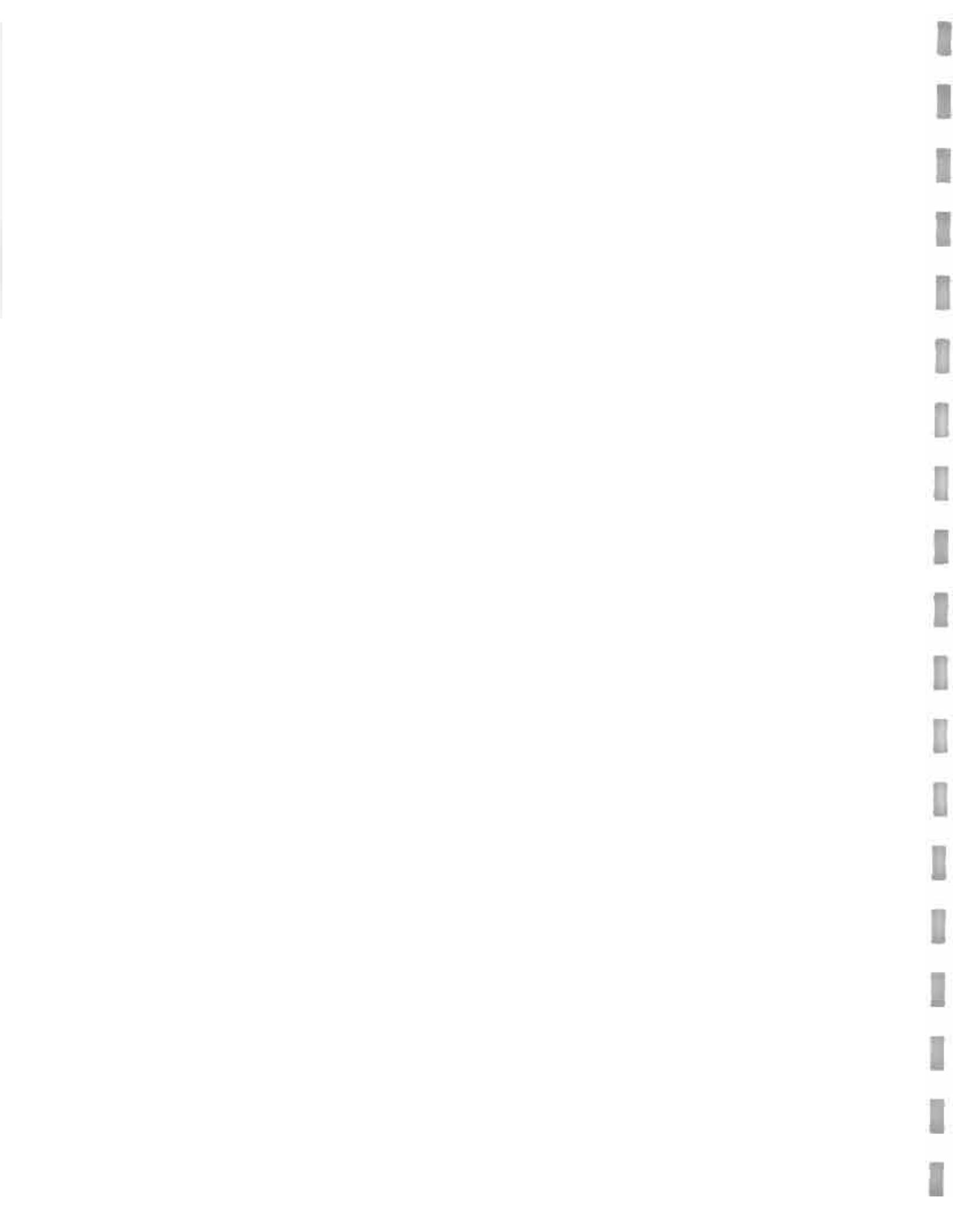
WATERSHED AREA (SQ. KM.)  
AREA OF LAKES (SQ. KM.)  
AVERAGE AZIMUTH OF SLOPE FROM NORTH (DEGREE)  
AVERAGE BARRIER HEIGHT IN SOUTH EAST DIRECTION (FT. X 10)  
LONGEST DIST FROM BOUNDRY TO STATION X DIST FROM CENTROID SLOPE (MI.)<sup>2</sup>

$$\text{BASE OF HYDROGRAPH (HR.)} = -0.0324 (\text{WATERSHED AREA}) + 0.6819 (\text{AREA LAKE}) - 0.3931 (\text{AZ}) + 1.6568 (\text{B H.}) + 0.0009 (L \times LCA/\bar{S}) + 144.96$$

	ACTUAL	PREDICTED	DEVIATION	GAUGING STATION
1	192.00003	199.16079	-7.16076	2YLI
2	348.00006	350.95977	-2.95971	2ZET
3	162.00003	192.64016	-30.64014	2ZHI
4	228.00003	222.72271	5.27731	2YSI
5	234.00003	228.41351	5.58651	2ZFI
6	120.00001	154.66396	-34.66393	2ZKI
7	210.00003	182.99899	27.00104	2YMI
8	420.00006	422.71923	-2.71917	2YDI
9	216.00003	199.72424	16.27579	2YK3
10	87.00001	118.51562	-31.51561	2ZBI
11	156.00003	108.80819	47.19182	2ZGI
12	162.00003	165.90744	-3.90741	2YDI
13	222.00003	202.41098	19.58905	2YCI
14	192.00003	189.89532	2.10470	2YK4
15	216.00003	212.77771	3.22232	2YK2
16	120.00001	149.54223	-29.54220	2YK2
17	186.00003	169.11730	16.88272	2ZCI

COEFFICIENT OF CORRELATION

r = 0.94



19 MINIMUM FLOWS

For reasons discussed in Section 8.2.2, minimum flows have been studied on the basis of data at river gauging stations only. Two series of the low flows have been analyzed:

- a) Summer low flows resulting from depletion of surface and groundwater storage.
- b) Winter low flows resulting from accumulation of snow on the ground and obstruction of lake outlets by ice during a period of low surface and groundwater storage.

After examining the regime curves of flows at river gauging stations, the following seasonal subdivisions were accepted for the analysis of low flows:

Summer	July to November
Winter	December to June

19.1 Statistical Processing

The minimum flows for the summer and winter periods were listed for each year at 17 river gauging stations, all in the Island. For Labrador, the period of record is short and the stations too few to obtain meaningful results from a statistical viewpoint. In addition, all but one of the stations in Labrador have their daily flows affected by changes in storage and therefore the daily minimum flows do not represent natural flows. The missing data were synthesized by correlation for a period of 16 years using the same approach as for maximum flows (Section 18.1).

The series of daily minimum flows were used to compute the average and coefficients of variation of the minimum flows.

The results of the above computations were used with the file on physiographic data for the Island to compute correlations between the minimum flow main statistical characteristics and the aggregate physical characteristics of the basins (Table 19-1 to 19-4). Experience elsewhere indicates that Pearson Type III probability curves generally fit well to the empirical probability curves. However, the short series of data available makes it impossible to compute the coefficients of skew for the minimum flows. The literature indicates<sup>1</sup> that for rivers as those of the Island, where groundwater supply is not very significant, and the effect of below freezing temperatures can be important for the winter minimum flows, the coefficient of skew can be accepted as being equal to the coefficient of variation.

Although all the correlations are good and significant at the 1 percent level and the coefficients of the variables have signs corresponding to the probable influence of these variables on the minimum flows, the winter correlations should be used cautiously because of the inaccuracy involved in estimating minimum winter flows under ice conditions. The correlations obtained are interesting, indicating significant increase in the average minimum flows for both summer and winter with the increase in area of lakes in the basin. The results of these correlations can be used with the file on physiographic data to compute the average minimum flows and the corresponding coefficient of variation for any basin on the Island; and with the assumption indicated above regarding the coefficient of skew, minimum flows with different probabilities can then be computed by using Pearson Type III probability curves. This has been done for the river basins analyzed in more detail (see Volumes Six and Seven). The very low figures indicated by synthesized summer-fall minimum flows for the Gander and Terra Nova basins are questionable. Apparently the results of the correlation overestimate the significance of elevation for minimum flow; and, because of low elevations in this particular river basin, the summer minimum flows are underestimated. Therefore, it can be concluded that the application of the minimum flow correlation for rivers with low average basin elevation may result in underestimation of minimum summer flows. Further investigations to improve this correlation are recommended.

It should be noted that the minimum monthly flows can be obtained from analysis of the average monthly flow and its standard deviation included in Section 17.3, if a satisfactory assumption can be obtained for the coefficient of skew and Pearson Type III probability curves are used. It is suggested that for this purpose the relationships between the coefficients of variation and skew should be analyzed for different gauging stations in Canada having a period of record longer than 30 years.

#### 19.2 Depletion Curves

Further analysis of minimum flows was done by computing the coefficient K in the low flow depletion curve, as shown in Table 19-5, and illustrated in Figure 19-1. An estimate of average storage in drought periods in the respective basins was done on this basis. According to the estimate, the average depth of this storage varies between 0.2 and 1.7 inches. In the conditions prevailing on the Island, it might be presumed that this storage consists of combined ground and surface water. A correlation between the average storage and the physiographic characteristics was developed (Table 19-6).

A graphical correlation between the interchange flow, that is the flow at the moment when the river flow starts to be supplied from the lake and groundwater storage only, and the drainage area has also been obtained (Figure 19-2). By means of these two correlations, that is between average storage and the physiographic characteristics, and the interchange flow and the drainage area, it would be possible to estimate the values of the minimum flows with various frequencies for any river on the Island (with drainage basins larger than 200 square miles), if the length of the drought with the same frequency were known.

In Section 8.6.6 the length of climatologic droughts of various probabilities was analyzed. However, an analysis of the hydrologic droughts (periods with continuously decreasing flows) showed that these are considerably larger than the meteorologic droughts, because small amounts of precipitation may be stored and evaporated without any effect on the river flow. The use of the hydrologic drought frequencies for the computation of minimum flows with various probabilities is, however, not recommended without establishing the combined probability of the hydrologic drought and of the flow at the beginning of the drought, since both these factors influence the flow at the end of the drought. Such a study was considered, however, as outside the scope of this study, but preliminary assessments have indicated that the results obtained would generally confirm the results of the statistical analysis.

REFERENCES

- 1 Solomon, S. , and others. Hydrology (Rumanian).  
Bucharest, Editura Technica, 1956.

DEPLETION CURVE OF THE TORRENT RIVER  
AT BRISTOL POOL

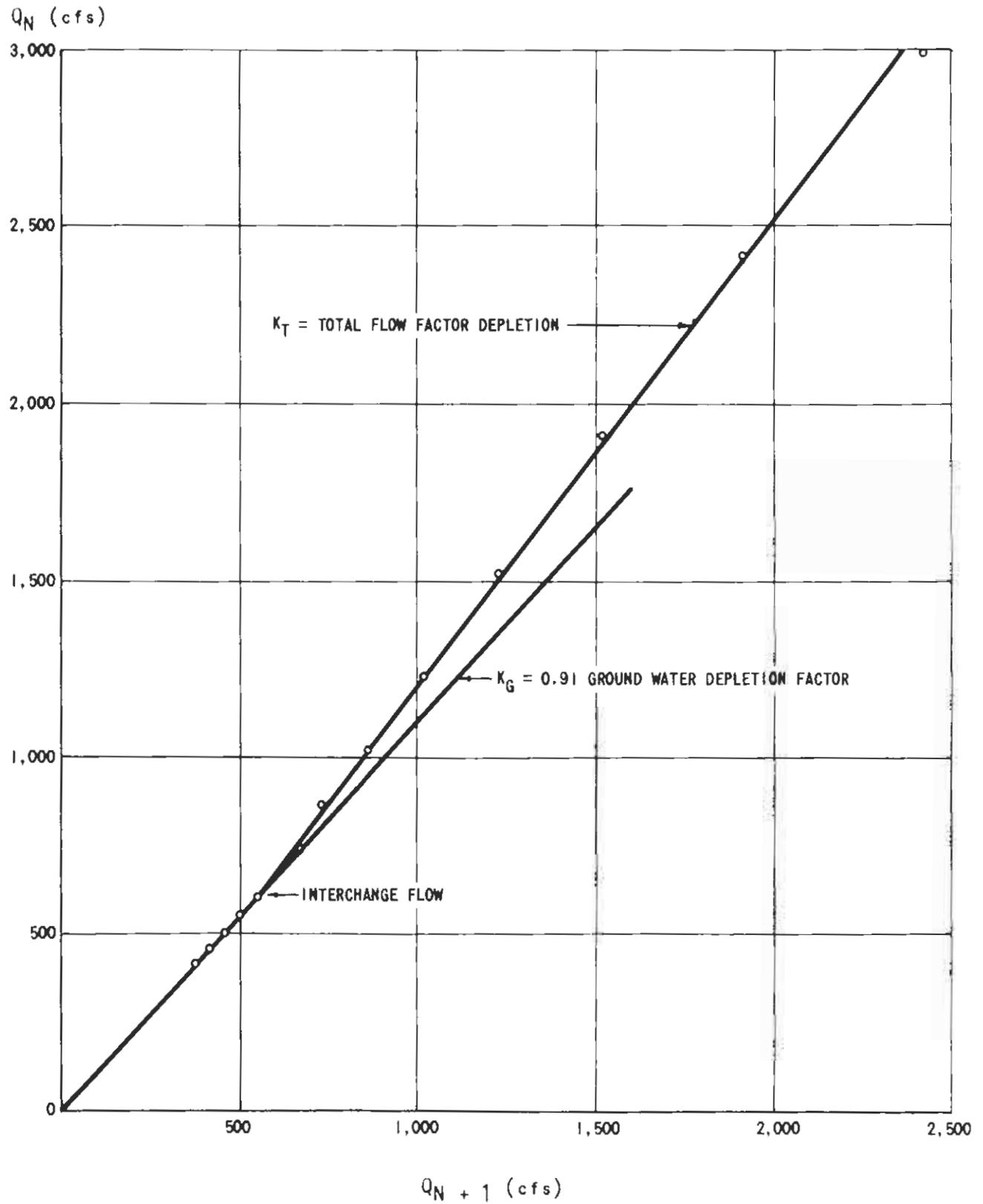


FIGURE 19-1

### NEWFOUNDLAND GRAPHICAL CORRELATION BETWEEN INTERCHANGE FLOW AND DRAINAGE AREA

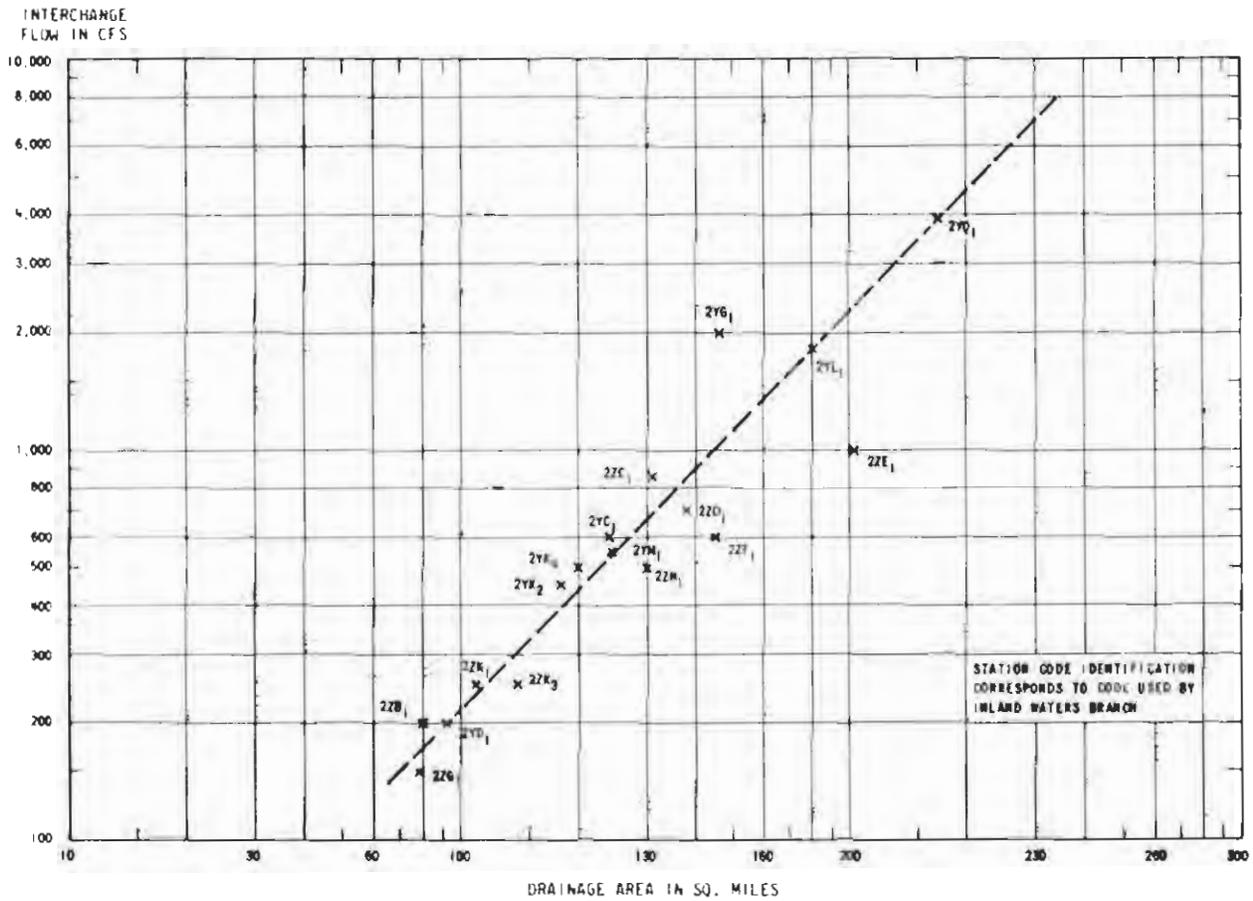


FIGURE 19-2

NEWFOUNDLAND AND LABRADOR  
MAIN STATISTICS OF SPRING - FALL MINIMUM FLOWS  
AT SELECTED RIVER GAUGING STATIONS

STATION	SUMMER MINIMUM		WINTER MINIMUM	
	AVERAGE	STANDARD DEVIATION	AVERAGE	STANDARD DEVIATION
	ACTUAL	ACTUAL	ACTUAL	ACTUAL
1 TORRENT R (2YC1)	253.99939	54.99970	123.99974	52.99989
2 BEAVER BROOK (2YD1)	40.99974	10.99979	22.99996	11.99999
3 LEWASEECHJEECH BROOK (2YK2)	114.99983	45.99993	133.99978	46.99993
4 SHEFFIELD R (2YK3)	71.99986	25.99996	126.99977	24.99996
5 HINDS BROOK (2YK4)	115.99975	61.99990	137.99981	39.99994
6 UPPER HUMBER R (2YL1)	294.99940	120.99933	340.99945	123.99974
7 INDIAN BROOK (2YM1)	111.99975	51.99993	218.99960	69.99989
8 GANDER R (2YQ1)	621.99950	350.99908	1404.99707	487.99988
9 MIDDLE BROOK (2YR1)	27.99997	17.99997	94.99986	26.99996
10 TERRA NOVA R (2YS1)	245.99948	121.99972	299.99939	112.99976
11 ISLE AUX MORTS R (2ZB1)	29.99995	9.99999	49.99993	8.99999
12 GREY R (2ZD1)	287.99943	118.99980	432.99940	104.99993
13 SALMON R (2ZE1)	617.99955	360.99939	1112.99707	337.99989
14 BAY DU NORD R (2ZF1)	331.99939	151.99987	593.99978	150.99968
15 GARNISH R (2ZG1)	39.99974	24.99996	69.99959	24.99986
16 PIPER'S HOLE R (2ZH1)	93.99997	50.99992	175.99966	55.99991
17 ROCKY R (2ZK1)	34.99990	23.99998	57.99991	29.99996

NEWFOUNDLAND  
CORRELATION BETWEEN AVERAGE SUMMER  
MINIMUM FLOWS AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	253.99937	889.84439	64.15501	TORRENT R (2Y01)
2	40.99994	48.15727	-7.15732	BEAVER BROOK (2Y01)
3	114.99983	101.44123	13.55859	LEWISSECHJEECH BROOK (2YK2)
4	71.99986	53.46342	18.53642	SHEFFIELD R (2YK3)
5	110.99975	118.29588	-2.49614	HINDS BROOK (2YH4)
6	284.99945	354.27777	-69.27832	UPPER NUMBER R (2Y11)
7	111.99975	146.85339	-34.85363	INDIAN BROOK (2YM)
8	621.99865	532.94690	89.05177	GAMER R (2YQ1)
9	27.99997	30.15643	-2.15646	MIDDLE BROOK (2YR1)
10	245.99948	170.78329	75.21620	TERRA NOVA R (2YS1)
11	29.99995	34.42996	-4.42999	ISLE AUX MORTS R (2ZB1)
12	287.99945	320.44262	-32.44315	GREY R (2ZD1)
13	617.99885	673.98999	-55.99114	SALMON R (2ZE1)
14	331.99939	284.37878	47.62061	BAY DU MORD R (2ZF1)
15	39.99994	33.10541	6.89453	GARNISH R (2ZG1)
16	93.99987	144.70379	-50.70391	PIPER'S HOLE R (2ZH1)
17	34.99990	37.60913	-2.60916	ROCKY R (2ZK1)

- X-1 - AREA OF WATERSHED (SQ. KM.) (LOG VALUES)
- X-2 - UNIT AREA OF LAKE (LOG VALUES)
- X-3 - UNIT AREA OF FOREST (LOG VALUES)
- X-4 - UNIT AREA OF SWAMP (LOG VALUES)
- X-5 - AVGE. COEFF. OF OVERBURDEN (LOG VALUES)
- X-6 - SHORTEST DIST. TO SEA (KM.) (LOG VALUES)
- X-7 - DIST. TO SEA IN DEGREE (KM.) (LOG VALUES)
- X-8 - DIST. TO SEA IN DEGREE (KM.) (LOG VALUES)
- X-9 - AVGE. SLOPE (FT. / 1000 FT.) (LOG VALUES)
- X-10 - AVGE. HAZ. OF SLOPE (DEGREE KM.) (LOG VALUES)
- X-11 - AVGE. ELEVATION OF TERRAIN (LOG VALUES)
- X-12 - AVGE. BARRIER HT. (FT. / 1000 FT.) (LOG VALUES)
- X-13 - UNIT AVG. ANNUAL FLOW (CFS. / SQ. KM.) (LOG VALUES)

DEPENDENT VARIABLE = MEAN SEASONAL MIN. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9690

STANDARD ERROR OF DEP. VARIABLE = 0.4562

CONSTANT = -3.5779

VARIABLE (X <sub>i</sub> )	COEFF. (BC <sub>i</sub> )	STANDARD ERROR
X-1	1.11471677	0.08820909
X-2	0.56271231	0.15509679
X-6	-0.52615332	0.15807190
X-11	1.02689957	0.22737538

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (BC<sub>i</sub>) IN THE FORMULA  

$$Y_{DEP} = \text{ANYTHING CONSTANT} + \sum_{i=1}^n X_i BC_i$$

NEWFOUNDLAND  
CORRELATION BETWEEN AVERAGE WINTER  
MINIMUM FLOW AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	123.99974	160.49133	-36.49158	TORRENT R (2Y01)
2	22.99996	46.16560	-23.16564	BEAVER BROOK (2Y01)
3	133.99978	113.80668	20.19308	LEWASEECHJEECH BROOK (2Y02)
4	126.99977	102.54678	24.45299	SHEFFIELD R (2Y03)
5	137.99981	127.73001	10.26979	HINDS BROOK (2Y04)
6	340.99945	366.47662	-25.47717	UPPER NUMBER R (2Y11)
7	218.99960	293.19555	-74.19593	INDIAN BROOK (2Y01)
8	1404.99707	1372.36255	32.63452	GANDER R (2Y01)
9	94.99986	65.34671	29.65315	MIDDLE BROOK (2Y01)
10	299.99939	329.75146	-29.75207	TERRA NOVA R (2Y01)
11	49.99993	47.22972	2.77020	ISLE AUX MORTS R (2Z01)
12	432.99890	361.62823	71.37068	GREY R (2Z01)
13	1112.99707	954.46130	158.53577	SALMON R (2Z01)
14	593.99878	397.25006	196.74872	BAY DU MORD R (2Z01)
15	69.99989	38.62115	31.37873	GARNISH R (2Z01)
16	175.99966	270.02819	-94.02851	PIPER'S HOLE R (2Z01)
17	57.99991	86.43577	-28.43585	ROCKY R (2Z01)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA OF SWAMP	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEA (KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIRN (KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIRN (KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE (FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. AZ. OF SLOPE (DEG. FROM N.)	(LOG VALUES)
X-11 - AVGE. ELEVATION (FT. X10)	(LOG VALUES)
X-12 - AVGE BARRIER HT. (FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW (CFS/SQ. KM.)	(LOG VALUES)

DEPENDENT VARIABLE = MEAN SEASONAL MIN. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9456

STANDARD ERROR OF DEP VARIABLE = 0.3574

CONSTANT = -6.7249

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	1.06472897	0.09910906
X - 5	0.93162131	0.41242349

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
SUMMER MINIMUM FLOWS AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	54.99990	49.91079	5.08910	TORRENT R (2Y01)
2	10.99999	14.02398	-3.02399	BEAVER BROOK (2Y01)
3	40.99993	34.03726	11.96266	LEWASEECNJECH BROOK (2YK2)
4	20.99996	23.92430	2.92434	SHEFFIELD R (2YK3)
5	61.99990	60.66389	1.33601	HINDS BROOK (2YK4)
6	120.99993	136.24087	-15.24094	UPPER HUNBER R (2YL1)
7	11.99994	70.08827	-58.08833	INDIAN BROOK (2YM1)
8	350.99998	300.86462	50.13536	GANDER R (2YQ1)
9	17.99997	19.10309	-1.10312	MIDDLE BROOK (2YR1)
10	120.99972	103.79199	17.20773	TERRA NOVA R (2Y51)
11	7.99994	12.06622	-4.06628	ISLE AUX MORTS R (2Z01)
12	118.99980	132.63881	-13.63899	GREY R (2Z01)
13	350.99934	324.77447	26.22487	SALMON R (2ZE1)
14	151.99969	151.27114	0.72855	BAY DU NORD R (2ZF1)
15	24.99996	16.00050	8.99946	GARNISH R (2ZG1)
16	50.99992	92.43009	-41.43017	PIPER'S HOLE R (2ZH1)
17	23.99996	26.06111	-2.06115	ROCKY R (2ZK1)

X- 1 - AREA OF WATERSHED(SQ.KM.)	(LOG VALUES)
X- 2 - UNIT AREA OF LAKE	(LOG VALUES)
X- 3 - UNIT AREA OF FOREST	(LOG VALUES)
X- 4 - UNIT AREA OF SWAMP	(LOG VALUES)
X- 5 - AVGE. COEFF. OF OVERBURDEN	(LOG VALUES)
X- 6 - SHORTEST DIST. TO SEAT(KM.)	(LOG VALUES)
X- 7 - DIST. TO SEA IN SE. DIR(KM.)	(LOG VALUES)
X- 8 - DIST. TO SEA IN SW. DIR(KM.)	(LOG VALUES)
X- 9 - AVGE. SLOPE(FT./1000 FT.)	(LOG VALUES)
X-10 - AVGE. #2. OF SLOPES(DES. FROM W.)	(LOG VALUES)
X-11 - AVGE. ELEVATION(FT. X10)	(LOG VALUES)
X-12 - AVGE. BARRIER HT.(FT. X10)	(LOG VALUES)
X-13 - UNIT AVG. AN. FLOW(CFS/SQ.KM.)	(LOG VALUES)
DEPENDENT VARIABLE - STANDARD DEV. - MIN FLOW	(LOG VALUES)
COEFFICIENT OF CORRELATION R=0.9714	

STANDARD ERROR OF DEP VARIABLE = 0.2581			
CONSTANT -2.5884			
VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR	
X - 1	1.11151789	0.07675577	
X - 2	0.40287745	0.13325855	
X - 3	-0.22687742	0.09549854	

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
CORRELATION BETWEEN STANDARD DEVIATION OF  
WINTER MINIMUM FLOWS AND PHYSIOGRAPHIC CHARACTERISTICS

	ACTUAL	PREDICTED	DEVIATION	
1	56.99987	57.96229	-0.96242	TORRENT R (2Y1)
2	11.99999	13.45557	-1.45558	BEAVER BROOK (2Y1)
3	46.99993	32.67208	14.32785	LEWASEECHJEECH BROOK (2YK2)
4	24.99996	22.43935	2.56061	SHEFFIELD R (2YK3)
5	39.99994	37.40328	2.59665	HINDS BROOK (2YK4)
6	123.99974	148.97705	-24.97729	UPPER HUMBER R (2Y1)
7	59.99984	79.50090	-19.50091	INDIAN BROOK (2Y1)
8	487.99908	412.77113	75.22795	GANDER R (2Y1)
9	26.99996	23.90102	3.09894	MIDDLE BROOK (2Y1)
10	112.99978	131.59229	-18.59251	TERRA NOVA R (2Y1)
11	8.99999	9.88600	-0.88601	ISLE AUX MORTS R (2ZB1)
12	104.99933	121.06805	-16.06872	GREY R (2Z1)
13	337.99935	330.12229	7.87706	SALMON R (2ZE1)
14	155.99963	145.47872	10.52091	BAY DU MORD R (2ZF1)
15	24.99996	19.21221	5.78775	GARNISH R (2ZG1)
16	53.99991	76.07377	-22.07386	PIPER'S HOLE R (2ZH1)
17	29.99996	29.62516	0.37479	ROCKY R (2ZX1)

- X- 1 - AREA OF WATERSHED(SQ.KM.) (LOG VALUES)
- X- 2 - UNIT AREA OF LAKE (LOG VALUES)
- X- 3 - UNIT AREA OF FOREST (LOG VALUES)
- X- 4 - UNIT AREA OF SWAMP (LOG VALUES)
- X- 5 - AVGE. COEFF. OF OVERBURDEN (LOG VALUES)
- X- 6 - SHORTEST DIST. TO SEACK. I (LOG VALUES)
- X- 7 - DIST. TO SEA IN SE. DIRN(KM.) (LOG VALUES)
- X- 8 - DIST. TO SEA IN SW. DIRN(KM.) (LOG VALUES)
- X- 9 - AVGE. SLOPE(FT./100 FT.) (LOG VALUES)
- X-10 - AVGE. AZ. OF SLOPE( DEG. FROM N.) (LOG VALUES)
- X-11 - AVGE. ELEVATION(FT. X10) (LOG VALUES)
- X-12 - AVGE. BARRIER HT. (FT. X10) (LOG VALUES)
- X-13 - UNIT AVG. AN. FLOW(CFS/SQ.KM.) (LOG VALUES)

DEPENDENT VARIABLE - STANDARD DEV. - MIN. FLOW (LOG VALUES)

COEFFICIENT OF CORRELATION R=0.9787

STANDARD ERROR OF DEP VARIABLE = 0.2210  
CONSTANT = -2.5922

VARIABLE (X <sub>i</sub> )	COEFF (RC <sub>i</sub> )	STANDARD ERROR
X - 1	1.17359495	0.07353362
X - 2	0.46162307	0.11906875
X - 3	-0.24027964	0.09422014

THE EQUATION OF THE CORRELATION IS FOUND BY REPLACING THE REGRESSION COEFFICIENTS (RC<sub>i</sub>) IN THE FORMULA

$$X_{DEP} = \text{ANTILOG CONSTANT} \prod_{i=1}^n X_i^{RC_i}$$

NEWFOUNDLAND  
ESTIMATE OF GROUND AND SURFACE WATER STORAGE  
DURING LOW FLOW PERIODS

STATION	DRAINAGE AREA A	GROUND WATER DEPLETION FACTOR $K_G$	$\text{LOG}_e K_G$	INTERCHANGE FLOW gt	STORAGE IN BASIN* $S_t = \text{gt}/\text{Log}_e K_G$ IN CFS - DAYS	AVERAGE LAYER OF GROUND WATER STORAGE $G = \frac{S_t}{A}$	
						IN CFS - DAYS PER SQ. MILE	IN INCHES
2YC <sub>1</sub>	240	0.91	-0.094	600	6,400	26.7	0.99
2YD <sub>1</sub>	92.2	0.82	-0.198	200	1,010	11.0	0.41
2YK <sub>2</sub>	180	0.91	-0.094	460	4,780	26.5	0.98
2YK <sub>3</sub>	140	0.96	-0.041	250	6,100	43.6	1.62
2YK <sub>4</sub>	200	0.94	-0.062	500	8,080	40.4	1.50
2YL <sub>1</sub>	812	0.85	-0.163	1,800	11,000	13.6	0.50
2YM <sub>1</sub>	284	0.91	-0.094	550	5,860	20.6	0.77
2YQ <sub>1</sub>	1,690	0.95	-0.051	3,900	75,600	44.7	1.68
2YS <sub>1</sub>	459	0.96	-0.041	200	4,880	10.6	0.40
2ZB <sub>1</sub>	79.5	0.74	-0.301	200	660	8.3	0.31
2ZC <sub>1</sub>	308	0.92	-0.083	850	10,200	33.2	1.23
2ZD <sub>1</sub>	379	0.94	-0.062	700	11,300	29.9	1.11
2ZE <sub>1</sub>	1,020	0.95	-0.051	1,000	19,600	19.2	0.71
2ZE <sub>1</sub>	454	0.95	-0.051	600	11,800	26.0	0.96
2ZG <sub>1</sub>	78.9	0.90	-0.105	150	1,430	18.1	0.49
2ZH <sub>1</sub>	300	0.86	-0.151	500	3,300	11.0	0.41
2ZK <sub>1</sub>	110	0.75	-0.288	250	870	7.9	0.30
2ZM <sub>6</sub>	1.4	0.79	-0.236	2	8.5	6.1	0.23

$$Q_t = Q_0 K_G^t$$

$K_G$  - GROUND WATER DEPLETION FACTOR = RATIO OF FLOWS IN ONE DAY ( $Q_t$ ) TO THE FLOW IN PRECEDING DAY ( $Q_0$ ) DURING LOW FLOW PERIOD

$q_t$  - FLOW AT THE BEGINNING OF LOW FLOW PERIOD, WHEN GROUND WATER SUPPLY BECOMES PREDOMINANT.

\* R.K. LINSLEY, M.A. KOHLER AND J.L.H. PAULHUS, APPLIED HYDROLOGY, P. 396 EQ. 15-5

TABLE 19-6

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

NEWFOUNDLAND  
CORRELATION OF GROUND WATER AND LAKE STORAGE  
TO PHYSIOGRAPHIC CHARACTERISTICS

STEP NO. 8

F LEVEL 2.746

STANDARD ERROR OF DEP VARIABLE = 0.2767

CONSTANT -0.1691

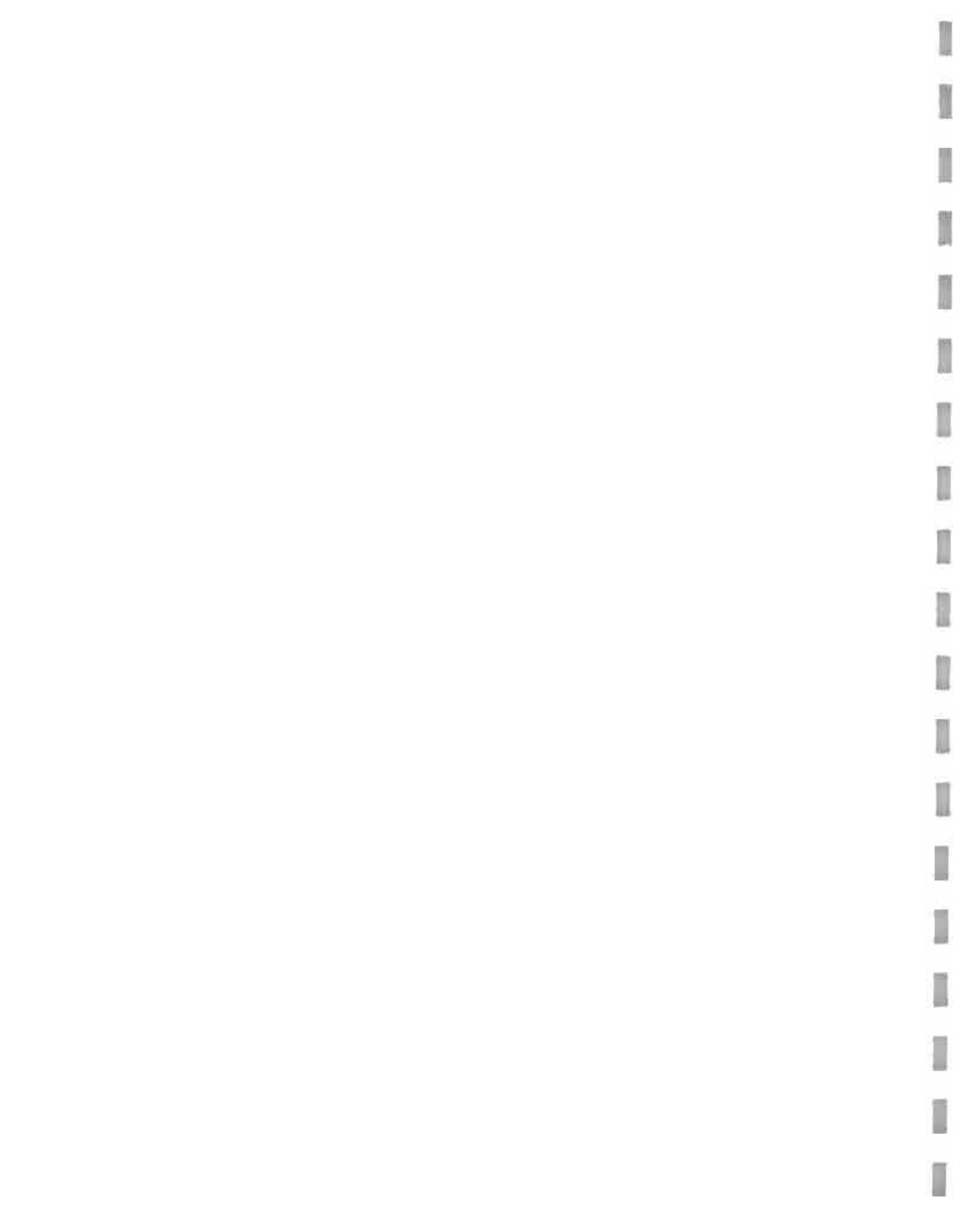
VARIABLE	COEFF	STANDARD ERROR/	
X - 1	0.00160843	0.00036836	WATERSHED AREA (SQ KM)
X - 11	0.01037072	0.00226589	AVERAGE ELEVATION (FT X 10)
X - 12	0.00881287	0.00531730	AVERAGE BARRIER HEIGHT IN SOUTH EAST DIRECTION (FT X 10)
X - 13	-0.00146558	0.00036974	MEAN ANNUAL FLOW (C.F.S.)

GROUND WATER FLOW STORAGE INCHES 0.0018 AREA = 0.0104 ELEV = 0.0088 LB H  
0.0018 FC00 0.1691

	ACTUAL	PREDICTED	DEVIATION	GAUGING STATION
1	0.50000	0.46042	0.03957	2YLI
2	0.71000	0.92597	-0.21597	2ZEI
3	0.41000	0.59313	-0.18313	2ZHI
4	0.40000	0.58657	-0.18657	2YSI
5	0.96000	0.52083	0.43916	2ZFI
6	0.30000	0.38246	-0.08246	2ZKI
7	0.77000	1.09235	-0.32235	2YMI
8	1.68000	1.58969	0.09030	2YQI
9	1.62000	1.10408	0.51591	2YK3
10	0.31000	0.57359	-0.26359	2ZBI
11	0.49000	0.17929	0.31070	2ZGI
12	0.41000	0.57874	-0.16874	2YDI
13	0.99000	0.92651	0.06348	2YCI
14	0.23000	0.28685	-0.05685	2ZMB
15	1.50000	1.46446	0.03553	2YK4
16	0.98000	1.22318	-0.24318	2YK2
17	1.11000	1.07544	0.03455	2ZDI
18	1.23000	1.03613	0.19386	2ZCI

COEFFICIENT OF CORRELATION

r = 0.80



20 WATER LEVELS AND ICE CONDITIONS

Water levels of the rivers and the lakes in the Province are governed by three main factors:

- a) The size of the drainage area.
- b) The general topography including the size and location of the natural storage.
- c) The ice conditions.

Because the drainage system is still young, in the sense that river valleys are generally a result of glaciation rather than erosion, most of the rivers in the Province have not yet "adjusted" their valleys to the flow, and as such the flow interval usually varies with the level interval. Figure 20-1 illustrates the graphical relationship between the flow intervals and the level intervals recorded in 1965 and 1966 at a series of river gauging stations in the Province. Deviations from the correlations are probably related largely to the local topography and the slope variation, with obstructions and expansions playing an obvious role in the level variations. On the other hand, the flow interval is a function of the size of the drainage basin, the runoff variation, and the natural (and sometimes artificial) storage. As was indicated in the preceding sections (15-19) runoff in its turn is very much a function of the topography. The factors reducing the flow variation generally also reduce the level variation. Consequently, although a correlation between level interval and physiographic characteristics was not attempted because water level data were not readily available, it may be surmised that such a correlation could be established.

It must, however, be emphasized that in some cases the ice conditions can play an essential role in the level variation. The usual ice cover changes the level discharge relationship because of additional friction and obstruction of the cross section. Although both factors can be important in increasing the water levels, they do not usually contribute to an increase of the water level interval since, in most cases, the maximum flow does not occur when the river has an ice cover. However, the accumulation of ice floes and the formation of ice jams under certain conditions of unstable weather and flow characteristic of the Island may result in significant increases of the water levels; the maximum levels being reached sometimes independently of the maximum flows. Such occurrences have been observed on the Exploits River downstream of Grand Falls.

An examination of the levels for the period September 1964 to October 1966 shows, for example, that the maximum level of the Isle aux Morts River in 1964/65 occurred in February, whereas the maximum flow occurred in August. The flow at the time of the maximum level was only 2000 cfs compared to the maximum flow of 8200 cfs. Similar conditions were observed on the Terra Nova River in 1964/65 and 1965/66, the Garnish River in 1964/65, and the Rocky River in 1965/66. In these cases, the correlation with physiographic characteristics as well as the relation between flow interval and level interval may be disturbed.

It should be kept in mind that ice jams may be generated by natural or artificial factors or a combination of both, such as:

- a) The existence of open water section of velocities in excess of about 2.25 feet per second in a generally ice covered river, which favours the formation of frazil ice. High velocities can occur either naturally at rapids, or artificially at spillways, although in some cases spillways improve the overall conditions.
- b) Sudden variations in river flows and levels resulting in the rapid breaking up of large portions of the ice cover. Such sudden variations can be produced by natural causes, for example, rapid snow melt or artificially due to the operation of power plants.

In the case of the Exploits River, where there is an undeveloped rapids downstream of the powerhouse, both natural and artificial causes may contribute to the formation of ice jams.

#### 20.1 Island of Newfoundland

The variation of levels on the Island, when not affected by ice jams, is generally small because of the relatively small flows and of considerable natural storage.

Two of the largest rivers (Exploits and Humber) and a score of smaller ones have their water level influenced by hydro-electric plant operations. While for the largest plants the levels downstream of the plants are regulated by the operation, the levels downstream of the small power plants have large variation of flow and, consequently, of levels during short time intervals.

Continuous observations on ice level conditions are not available. Some data on the depth of the ice in water are available from the flow measurements and are summarized for the period 1965/67 in Table 20-1. It should be emphasized that the thickness of the ice is greater by at least 10 percent and sometimes more than that indicated in the table. The measurements are usually carried out at sections with larger than average velocities and refer only to that part of the ice which is below the water level in the measurement hole. The table indicates that the ice thickness may reach up to three feet, and that the greatest thickness is usually recorded in March.

## 20.2 Labrador

The data available on the variation of river levels are very limited for this area. The little information on the Churchill River levels indicates that variations up to 40 feet are possible. These data also indicate that the general pattern of relationship between level and annual flow variation (Figure 20-1) might be applicable also for Labrador. However, more data would be required to confirm this.

The available data on ice thickness summarized in Table 20-1 indicate that the thickness of the ice cover on the Labrador rivers reaches 3 to 4 feet and more. It is also interesting to mention that the ice cover on these rivers is apparently at its maximum about the middle of April.



NEWFOUNDLAND AND LABRADOR  
 PRELIMINARY RELATIONSHIP BETWEEN FLOW  
 VARIATION AND LEVEL VARIATION

ANNUAL INTERVAL OF  
 FLOW VARIATION (CFS)

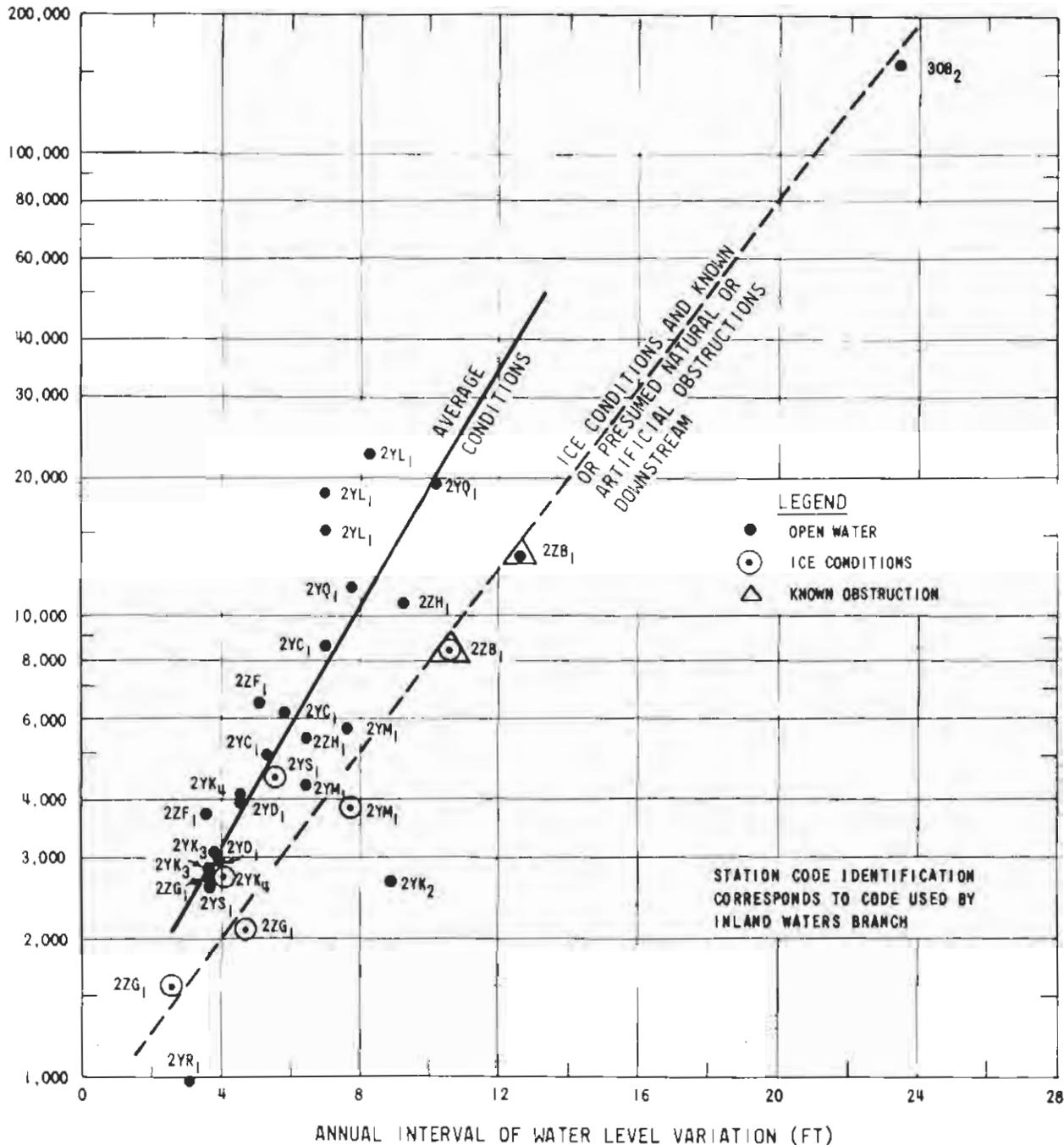


FIGURE 20-1





21 HYDROLOGIC REGIONS

The examination of the hydrologic characteristics recorded at the hydrometric stations (river gauging stations and flow-reporting power plants) and of the relationships between hydrologic and physiographic characteristics suggested that the Island can be divided into four hydrologic regions rather than the two runoff regions delineated in Section 16. 1. Since there is more detailed hydrologic information for the Island, its hydrologic regions can be well enough defined. The level of detail available for Labrador does not permit division into more than two regions. The hydrologic characteristics of the southern Labrador region could be defined in a preliminary way from the available data, those of the northern region were estimated by analogy with other more or less similar regions. The climatologic regions were also used in delineating the hydrologic regions, especially for their subdivision into sub-regions (Section 8. 8).

21.1 Island of Newfoundland

The four hydrologic regions suggested for the Island are:  
(Figure 21-1)

Region H<sub>1</sub>

The Avalon Peninsula up to a line approximately following the Long Harbour-Chapel Arm highway and the Burin Peninsula south of the Paradise River basin.

Region H<sub>2</sub>

Southeastern Newfoundland including all the basins east of the La Poile River, whose rivers flow south, and those on the eastern seacoast south of Middle Brook, but north of Long Harbour-Chapel Arm.

Region H<sub>3</sub>

Western Newfoundland including the basins of the rivers flowing to the south, west of but including the La Poile River, to the west and including all of the Great Northern Peninsula.

Region H<sub>4</sub>

The rivers flowing into White Bay south of, but excluding, the Main River, and all the basins of the rivers above Middle Brook flowing to the north and east.

Regions H<sub>1</sub>, H<sub>2</sub>, and H<sub>4</sub> belong to the eastern runoff region. Region H<sub>3</sub> covers approximately the same area as the western runoff region. There is no complete correspondence between the two series of regions because of the limitations imposed by the square grid approach.

The index hydrographs of the average, maximum, and minimum monthly flows of the rivers belonging to the various regions are shown in Figure 17-3

#### 21. 1. 1 The Avalon and Burin Peninsula (H<sub>1</sub>)

This is a region of generally high average runoff, mainly between 40 and 60 inches per year. However, because of the very small drainage basins (from less than a square mile to about 100 square miles) and the rough topography, the variation of levels and flow is very rapid. Maximum runoffs with a probability of 1 in 20 years are of the order of 100 cfs per square mile for small basins and 50 cfs per square mile or less\* for larger ones. The minimum flows with the same probability can be considered practically equal to zero.

The maximum monthly flows usually occur in April due to a combined effect of snowmelt and precipitation, although a secondary peak is also recorded in late fall because of unstable weather conditions after a few snowfalls. The minimums usually occur in late summer to early fall, but winter flows can occasionally be as low as the summer flows, after a persistent spell of cold weather. Although this hydrologic region consists of two meteorologic sub-regions, the available information does not indicate significant differences between them.

#### 21. 1. 2 Southeastern Newfoundland (H<sub>2</sub>)

This region has watersheds of a limited size because of the general tilting of the Island's plateau towards the northeast. The area is covered mainly by barrens, lakes, bogs and swamps, and to a lesser degree by forests. The eastern basins have a more developed forest cover.

There are many small rivers with small or very small drainage areas (a few square miles to a few tens of square miles), but also a few with drainage areas of several hundred and one above a thousand square miles. The average runoff in the area varies mainly between 35 and 50 inches per year. Since most of the basins have significant natural storage, especially in lakes, the maximum runoff with a probability of 1 in 20 years is lower than in region H<sub>1</sub> namely of the order of 20 to 50 cfs per square mile occasionally larger, for very small basins. For the same reason the minimum runoff with the same probability is higher than in region H<sub>1</sub>, being of the order of 0.03 to 0.10 cfs per square mile.

\*Note: All runoff figures quoted represent synthesized data.

(An exceptionally low flow on the Pipers Hole River in September 1961 of about 0.01 cfs per square mile is probably related to the severe forest fire which occurred in the fall of that year. )

The maximum monthly flows are recorded in April and May, the higher flow occurring in April in the eastern and lower portion, and in May in the higher and western portion. A secondary peak takes place in late fall, with floods which may occasionally exceed those in the spring.

The minimum monthly flows are recorded in summer. However, there are indications that in the higher part of the region the winter minimums may be lower than the summer ones.

This region covers roughly the climatologic sub-regions 4C, 5A, and 6B. The main climatic differences between these three sub-regions consist in the variation in temperature (the average temperature being slightly higher in sub-region 6B than in sub-regions 5A and especially 4C) and in the maximum possible seasonal snow accumulation (the snow accumulation in sub-region 4C being significantly higher than in sub-regions 5A and 6B). There is not sufficient hydrologic information available to indicate whether indeed region H<sub>2</sub> might be subdivided into three hydrologic sub-regions (H<sub>24C</sub>, H<sub>25A</sub>, and H<sub>26B</sub>). However, as expected from the climatologic data in these three sub-regions, some differences exist between the regimes in the spring flows. The maximum monthly flows occur in the region H<sub>26B</sub>, and partially in H<sub>25A</sub>, earlier than in region H<sub>24C</sub> and the volume of spring runoff is also varied to some extent. Only further, more detailed studies would enable the drawing of conclusions on the possible subdivisions of region H<sub>1</sub> into the three sub-regions mentioned above.

### 21. 1. 3 The Western Region (H<sub>3</sub>)

This actually expands over the Long Range Mountains and includes (with the exception of the Humber River) only small and average size basins of up to a few hundred square miles.

The average runoff is variable according to topography, but generally is very high, varying mainly between 35 to 70 inches per year. Because of the rugged topography in those basins which have no significant natural storage (especially in the southern portion of the region), the maximum runoff with a probability of 1 in 20 years may be presumed to reach up to 150 cfs per square mile and more for basins smaller than 50 square miles. However, this figure decreases rapidly with the size of the basin and, for basins of about 300 square

miles with some natural regulation capacity, the maximum 1 in 20 years runoff is in the order of 30 to 50 cfs per square mile. The minimum runoff with the probability of 1 in 20 years is high - about 0.10 to 0.25 cfs per square mile.

The maximum mean monthly flows occur as a rule in May. Although secondary peaks in the fall are occasionally recorded, these are much less significant than in regions H<sub>1</sub> and H<sub>2</sub>.

The minimum mean monthly flows are observed in February, with a secondary low in July.

This region coincides roughly with the climatic sub-regions 1, 2A, 3A, and 4A. These sub-regions present differences in temperature, potential evaporation, and storm precipitation (Table 8-19), and it is probable that, if data at more gauging stations were available, a subdivision of the region into four sub-regions H<sub>31</sub>, H<sub>32A</sub>, H<sub>33A</sub>, and H<sub>34A</sub> would be possible. The index hydrographs (Figure 21-1) distinctly indicate such a possibility, but the available data are not sufficient to substantiate such conclusions. An increase in the number of gauging stations in this area is required for a better delineation of the hydrologic sub-regions.

#### 21.1.4 The Northeastern Region (H<sub>4</sub>)

Because of the general tilting of the central plateau towards the northeast, this region has rivers with large drainage basins in addition to the many smaller ones which are characteristic of the whole Island. The two main river basins, the Exploits and the Gander, have drainage areas of 4400 and 2000 square miles respectively. The basins are well endowed with lakes and are generally heavily wooded.

Since this area is downwind of the humid southeastern and southwestern winds and has a rather low topography, the average runoff is lower than in the remainder of the Island, varying mainly between 25 and 35 inches per year.

The maximum flows with a probability of 1 in 20 years are relatively low because of large natural storage. The maximum runoff with this probability varies between 15 cfs per square mile for larger basins and about 30 cfs for the smaller ones. Obviously very small basins (under 100 square miles) may occasionally have a larger maximum runoff.

The minimum runoff with the probability of 1 in 20 years is close to 0.1 cfs per square mile and decreases only for the small rivers without significant storage. However, the correlations for synthesizing minimum flows indicate a very low minimum runoff for the Gander River and this requires further investigation, as indicated in Section 19.1.

The maximum mean monthly flows occur in May, with a secondary peak in November. The minimum mean monthly flows occur in July-August, with a secondary minimum in February.

This region coincides roughly with the climatic sub-regions 2B, 3B, and 4C. Sub-region 4C has a larger precipitation than the other two, while sub-region 3B has a lower "maximum possible" storm and seasonal snow accumulation than the other two. The few data available in the three potential sub-regions indicate indeed that the sub-division of region H4 into three sub-regions (H42B, H43B, and H44C) has to be considered as a distinct possibility. This requires substantiation, however, by further investigations.

Figure 21-2 shows the mean monthly runoff at the hydrometric stations, based on the period of recorded data. The hydrographs of stations within the same region were superimposed to indicate the average variation of the mean monthly flows within a region.

## 21.2 Labrador

Two regions were tentatively delineated in Labrador; a) South of and including the Kanairiktok River basin, and b) North of the Kanairiktok River basin. Hydrometric data are available for only the southern region, and even these are not distributed over the whole area concerned. Therefore, the regions indicated for Labrador represent only a rough approximation which should be re-considered when more data are made available.

### 21.2.1 The Southern Region (H5)

The topography favoured the development of medium and large river drainage basins (of the order of two thousand square miles and up to 31,500 square miles for the Churchill River) although some smaller basins are spread all along the seacoast. The area is heavily wooded and the rivers have very extensive volumes of natural storage in lakes and marshes.

The runoff is generally lower than that in the Island, varying mainly between 20 and 25 inches per year.

Due to the very large natural storages, the maximum runoff with the probability of 1 in 20 years is generally low, varying between 10 and 20 cfs per square mile and the minimum runoff with the same probability is unlikely to be below 0.2 cfs per square mile. However, smaller basins in the southeastern portion without significant storage may have greater maximum and lower minimum runoff.

The maximum mean monthly flows occur in June, because of late snowmelt and large natural storage. The minimum mean monthly flows occur in April, related to the effect of prolonged low temperatures and natural storage.

This region covers roughly the climatic sub-regions 7A and 7B. The climatic and physiographic characteristics of the two sub-regions indicate that two hydrologic sub-regions (H57A and H57B) may be delineated in the area, but since there are no hydrologic data on sub-region 7A, it is not possible for the time being to finalize such a subdivision.

Figure 21-2 includes superimposed hydrographs of the mean monthly runoff of the hydrometric stations in the southern region.

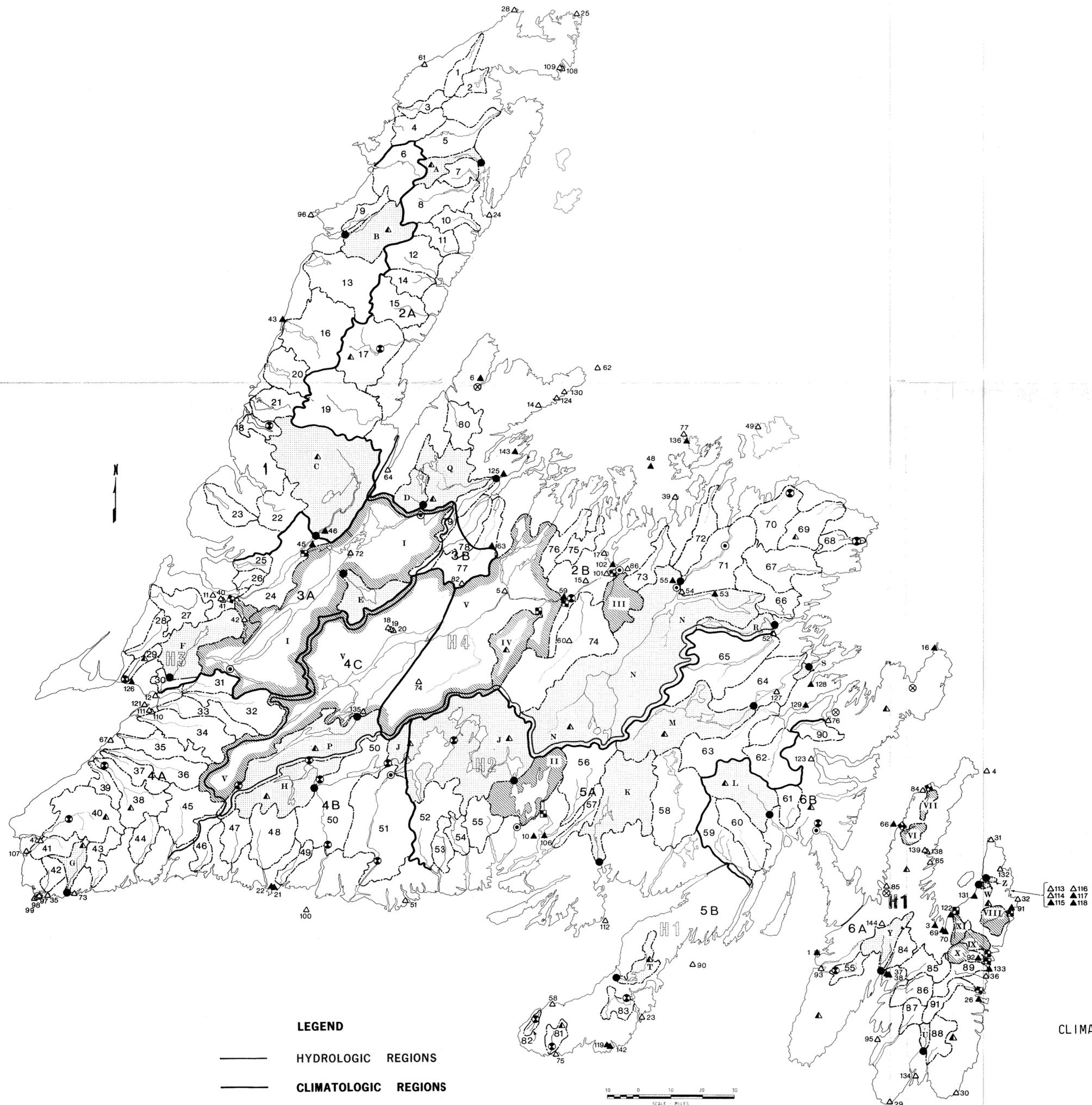
#### 21.2.2 Northern Region (H<sub>6</sub>)

Because of the short distance between the main divide of the area and the seacoast, the rivers of this region have average to small drainage basins (the largest, Adlatok River, has 4806 square miles).

The area is covered with patches of lichen, forest, bogs (to the south), barrens, lakes, and glaciers. The natural storage is smaller than in the southern region.

From the existing climatologic data, trends observed in the southern region and hydrometric measurements in neighbouring areas, it may be estimated that the average runoff in the region is lower than that observed in the south, probably between 15 and 25 inches per year. The maximum mean monthly flows occur probably in June and the minimums in March-April, both occurring later as the latitude increases. It can be presumed that the maximum runoff is larger and the minimum runoff smaller than in the south, due to less natural storage and because of very low temperatures in winter.

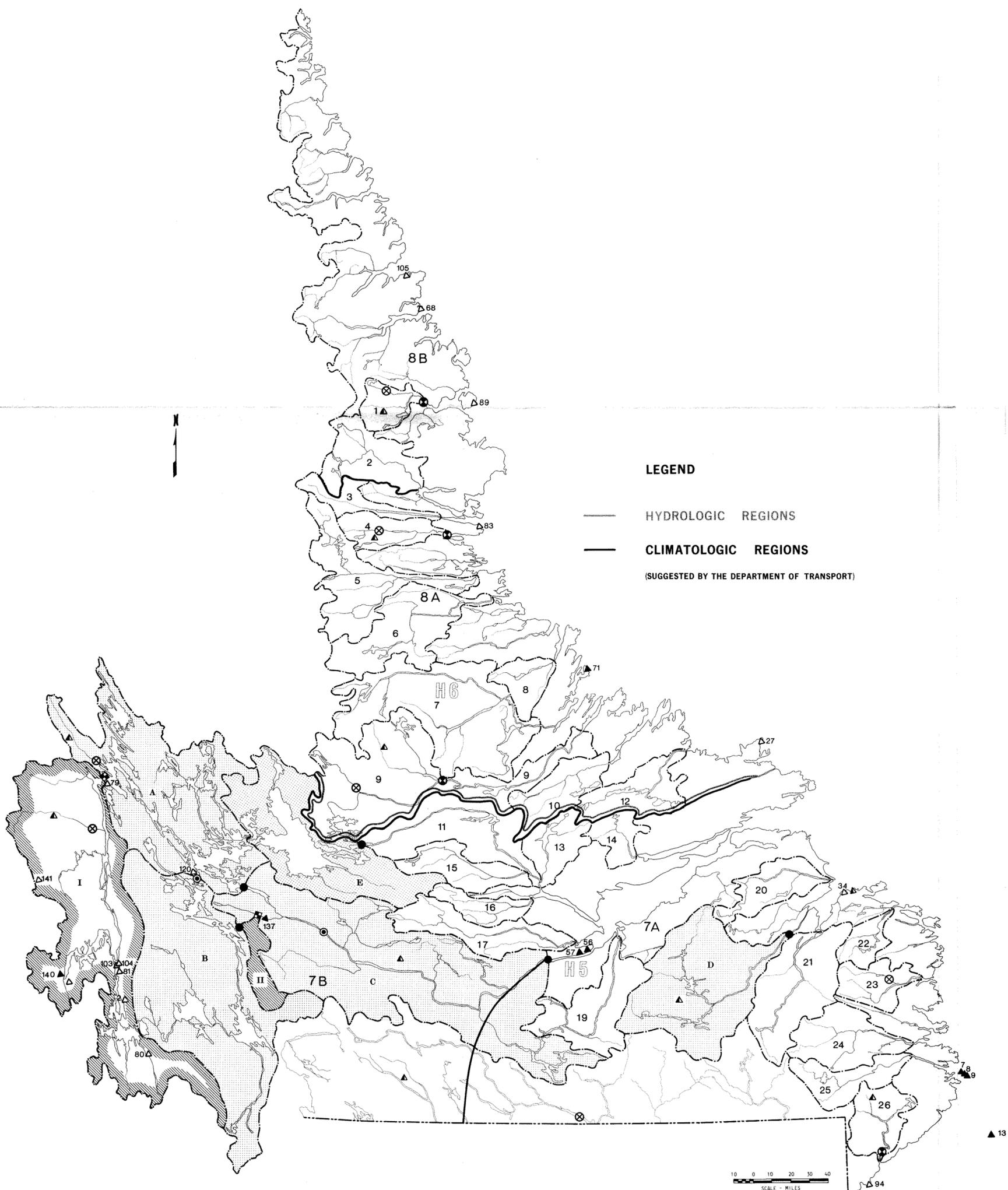
Further subdivision of the region into sub-regions will have to await the obtaining of more climatologic and hydrologic data.



**LEGEND**  
 ——— HYDROLOGIC REGIONS  
 - - - CLIMATOLOGIC REGIONS  
 (SUGGESTED BY THE DEPARTMENT OF TRANSPORT)

NEWFOUNDLAND  
CLIMATOLOGIC AND HYDROLOGIC REGIONS

FOR LEGEND OF CLIMATOLOGIC AND HYDROMETRIC NETWORK SEE FIGURE 8-1

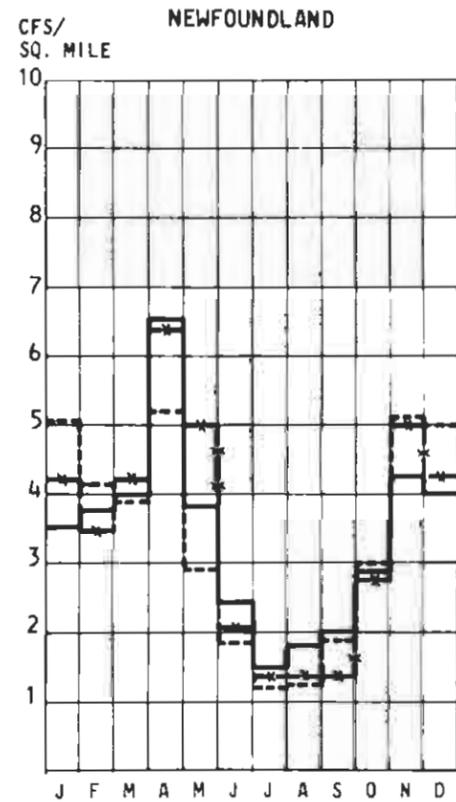


**LEGEND**

- HYDROLOGIC REGIONS
- CLIMATOLOGIC REGIONS  
(SUGGESTED BY THE DEPARTMENT OF TRANSPORT)

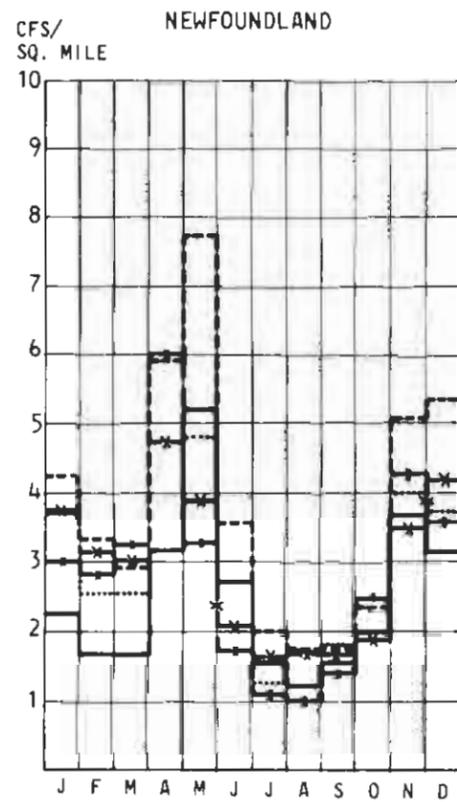
LABRADOR  
CLIMATOLOGIC AND  
HYDROLOGIC REGIONS

FOR LEGEND OF CLIMATOLOGIC AND HYDROMETRIC NETWORK SEE FIGURE 8-2



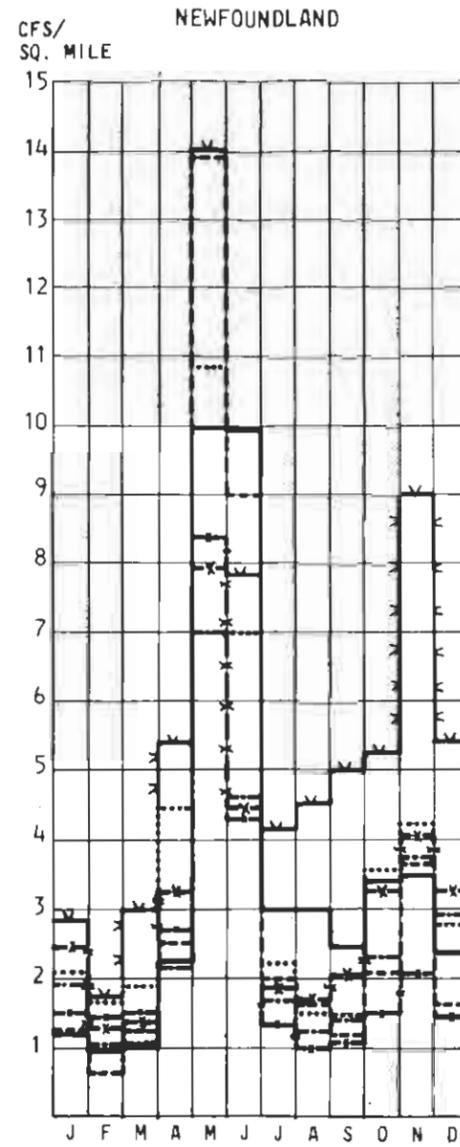
AVALON - BURIN REGION (H<sub>1</sub>)

LEGEND:  
GARNISH R. ———  
ROCKY R. - - - - -  
NORTHEAST POND R. —X—X—



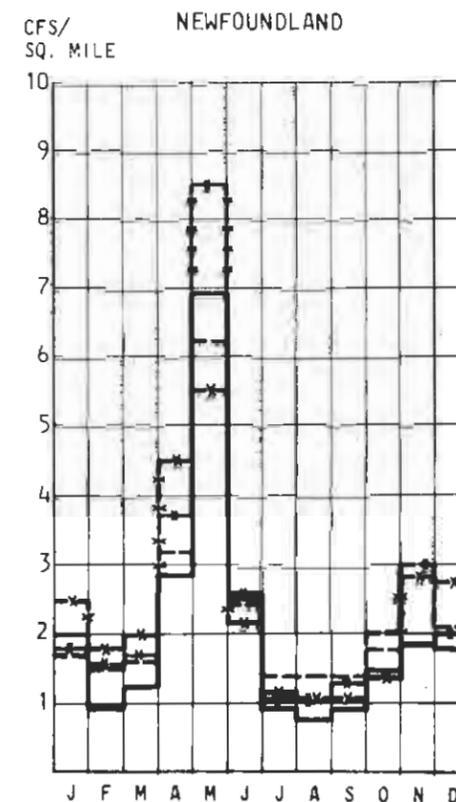
SOUTH EAST REGION (H<sub>2</sub>)

LEGEND:  
GREY R. ———  
SALMON R. - - - - -  
BAY DU NORD R. —X—X—  
PIPERS HOLE R. —||—||—  
TERRA NOVA R. ······



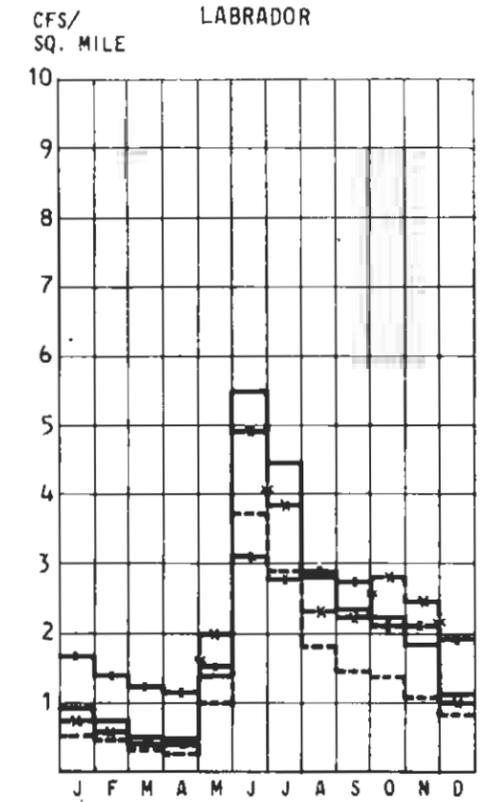
WESTERN REGION (H<sub>3</sub>)

LEGEND:  
TORRENT R. ———  
BEAVER R. - - - - -  
LEWASEEQUEECH B. —X—X—  
SHEFFIELD R. —||—||—  
HINDS B. - - - - -  
UPPER HUMBER R. ······  
ISLE-AUX-MORTS R. —X—X—



NORTH EAST REGION (H<sub>4</sub>)

LEGEND:  
INDIAN B. (INDIAN FALLS) ———  
EXPLOITS R. (GRAND FALLS) - - - - -  
GANDER R. (BIG CHUTE) —X—X—  
RATTLING B. (RATTLING L.) —||—||—



SOUTHERN REGION (H<sub>5</sub>)

LEGEND:  
CHURCHILL R. (FLOUR LAKE) ———  
UNKNOWN R. - - - - -  
CHURCHILL R. (MUSKRAT FALLS) —X—X—  
MASKAUPI R. —||—||—

NEWFOUNDLAND AND LABRADOR  
SUPERIMPOSED RUNOFF HYDROGRAPHS  
IN THE REGIONS

## 22 RECOMMENDATIONS FOR FURTHER HYDROLOGIC STUDIES

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The analysis of the available hydrometric data and the results of the hydrologic studies discussed in Sections 15 to 20 have indicated that extension of the hydrometric network, review and correction of data, and more detailed hydrologic studies are required, the latter primarily in Labrador.

### 22.1 Hydrometric Network Extension

As indicated in Section 15.1, from the viewpoint of both distribution and density, the hydrometric network of the Island is in a better position than Labrador.

#### 22.1.1 Island of Newfoundland

Suggestions for the extension of the Island's hydrometric network, made by the Inland Water Branch<sup>1</sup>, are justified inasmuch as some of the hydrologic sub-regions are not yet covered by the existing network. Additional suggestions have been made to those included in the above-mentioned assessment to cover all sub-regions and include a few small basins with areas up to 50 square miles at high altitudes in the Long Range Mountains. One of these stations should be located at the outlet of the upper reservoir of the proposed Western Brook Pond development which forms part of a possible pumped storage hydro power development referred to in Volume Four, Section 1. During the preparation of this report, a recommendation was made, and accepted by the Inland Waters Branch, to install two additional temporary stations, one downstream of the Grand Falls power plant on the Exploits River, and the other on the Cat Arm River at a potential dam site.

The station on the Exploits River should preferably be of the telemetering type and should include a water quality monitoring station. The data could be telemetered to the pulp and paper mill which controls both the release of wastes and flow. On the basis of such information emergency measures could be taken when pollution conditions became critical. A special agreement, initiated by the Canada Department of Energy, Mines and Resources, would be required with the Price (Nfld) Pulp and Paper Limited. This station could serve several purposes:

- a) To check the apparent inconsistencies in the flow reports from the Grand Falls and Bishops Falls plants.

- b) To check the hydrologic assumptions on which the study of diversion of the Victoria and Lloyds Rivers were based.
- c) To monitor the level flow and pollution in relation to the different uses of the river water (Volume Two B, Section 18.1 and Volume Six A, Part I).

It would be advisable to reinstate, at least for a few years, the station on the Come By Chance River which functioned for about a year in 1960/61, because of the important and complex water demand likely to develop in this area.

The location of the suggested hydrometric stations included in the Inland Waters Branch report<sup>1</sup> and those discussed above are shown on Figure 8-1.

#### 22.1.2 Labrador

The extension of the hydrometric network in Labrador suggested in Reference 1 is considered insufficient on account of the sparse coverage and the concentration of all hydrometric stations in the southern portion. Although it is recognized that hydrometric measurement and network maintenance in Labrador is expensive and technically difficult, the hydrologic investigation of the area is very important from the technical, economic, and general scientific viewpoint.

Attention should be given in this area to the use of developing automatic telemetering equipment. Furthermore, consideration of the use of aerial photography and eventually the use of satellites to supplement the hydrometric information obtained directly is considered advisable.

On the basis of the work carried out for this study, the Labrador network should be expanded initially by at least six permanent gauging stations in northern Labrador, and five or six permanent gauging stations on basins of various sizes located at higher altitudes in the southern area. Tentative locations for some of these are indicated in Figure 8-2.

A more detailed analysis of the Labrador hydrometric network, including data from adjacent regions, should be carried out to confirm the number and location of these initial stations, and to evaluate more specifically the requirements for the future network.

## 22. 2 Improvement of Quality of Hydrometric Data

Further hydrologic analyses are considered necessary to improve the quality of available data and to complete the hydrologic relationships already developed for one part of the Province. It is recommended that all the activities related to this problem should be co-ordinated by the Inland Waters Branch of the Canada Department of Energy, Mines and Resources.

Further efforts should be made by the Inland Waters Branch to correct the errors in interpreting river flows during the winter period. The data obtained from flow-reporting hydro-electric plants are less affected by this type of error. However, since they are affected by other factors related especially to the estimation of changes in storage, they cannot be considered as reliable data for checks by correlation. It is therefore recommended that, for locations where stable ice covers occur, measurements of ice thickness should be carried out for at least a few winters and that the results be correlated with measured flows and air temperatures to obtain reliable flows, and relationships between flow, ice thickness, and temperature. Such correlations could then be used to correct past flow data.

The Canada Department of Energy, Mines and Resources should make arrangements with the responsible provincial authorities for the installation of the equipment and the transmittal of the data to the Department. The first priority in this area is the provision of equipment at all existing and future hydraulic structures, such as power plants, dams, and canals, where hydrologic information can be obtained, capable of recording the data in such a way that the three types of errors mentioned in Section 15. 2. 2 will be avoided. The operating personnel should be properly instructed in the operation and maintenance of this equipment. Without this data it will become more and more difficult to assess the natural hydrologic conditions since the increasing complexity of the use of water will change the natural hydrologic pattern to an ever increasing extent. Special attention should be paid to gauging the diversion canals and spillways of the Bay D'Espoir development as indicated in Figure 8-1.

Revised relationships between storage and levels (including as a third variable the rate of outflow), if successfully established, could be used to correct past records. This would also produce a better basis for checking by correlation the flows at the gauging stations during the winter months.

### 22.3 Additional Hydrologic Studies

The re-assessment of the distribution of average precipitation, temperature, evaporation, and runoff in Labrador, including the portion north of latitude  $56^{\circ} 30'$ , will require the expansion of the meteorologic and hydrologic networks, the collection and processing of at least 3 to 4 years of record, the completion of the 1:250,000 scale maps and the extension of the study area to neighbouring gauged basins.

The checking of the distribution of average precipitation, temperature, evaporation, and runoff in some of the ungauged areas of the Island, especially in the western region, will require the expansion of the hydrologic and meteorologic networks, as indicated in Sections 8.9 and 22.1, and the correction of winter flows after collecting the required data as indicated in Section 22.2.

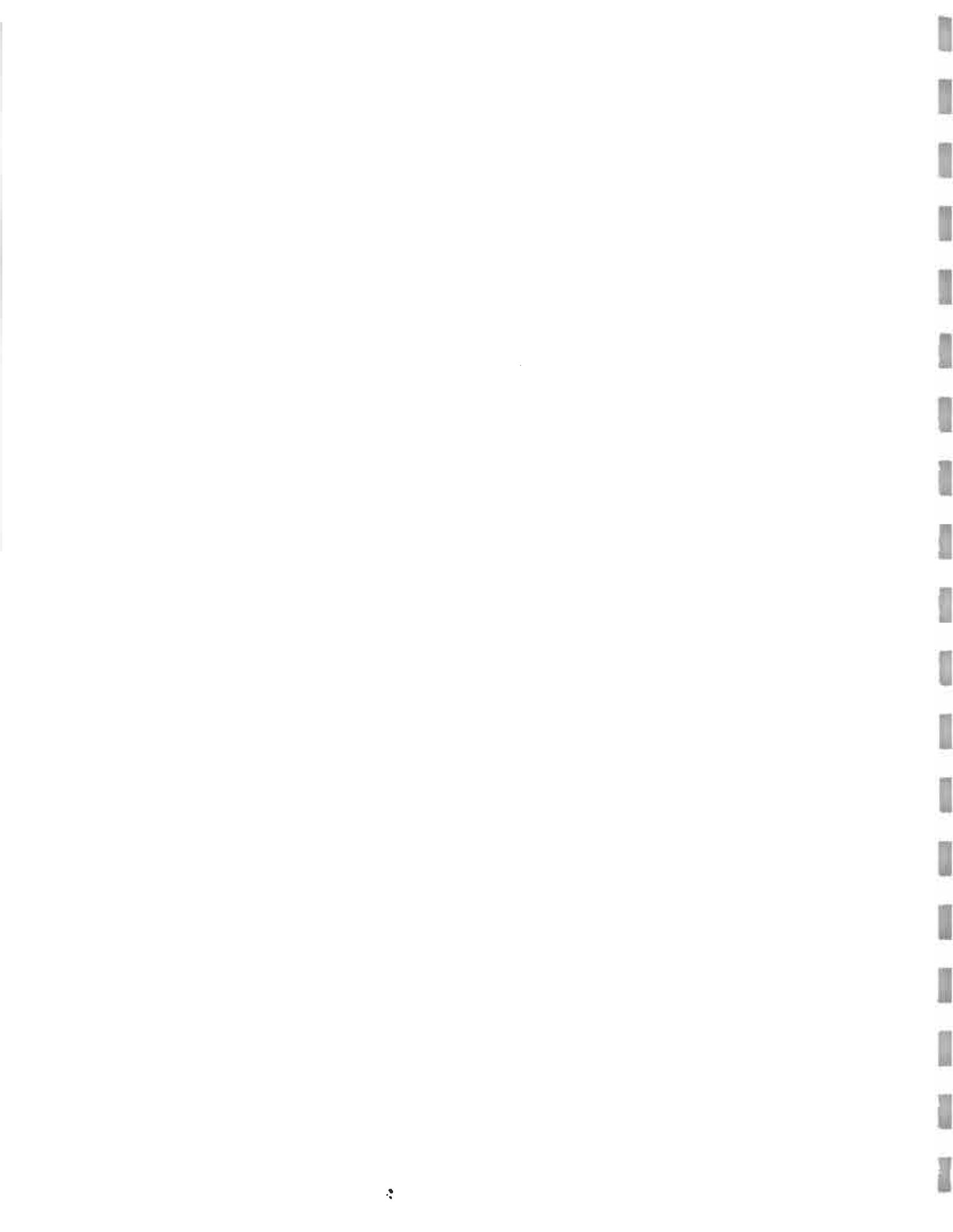
The review of the correlation between the various hydrologic characteristics and statistics (annual, seasonal, monthly, minimum and maximum flows, their standard deviation and coefficients of skew) with the physiographic characteristics, including attempts to establish such correlations for Labrador, and factor analysis and principal component computations to assess the influence of the different physiographic factor, will require obtaining results from the expanded hydrometric network for a minimum period of 8 to 10 years, and the checking of the already available data for errors in the estimation of monthly and daily flows (Section 22.2).

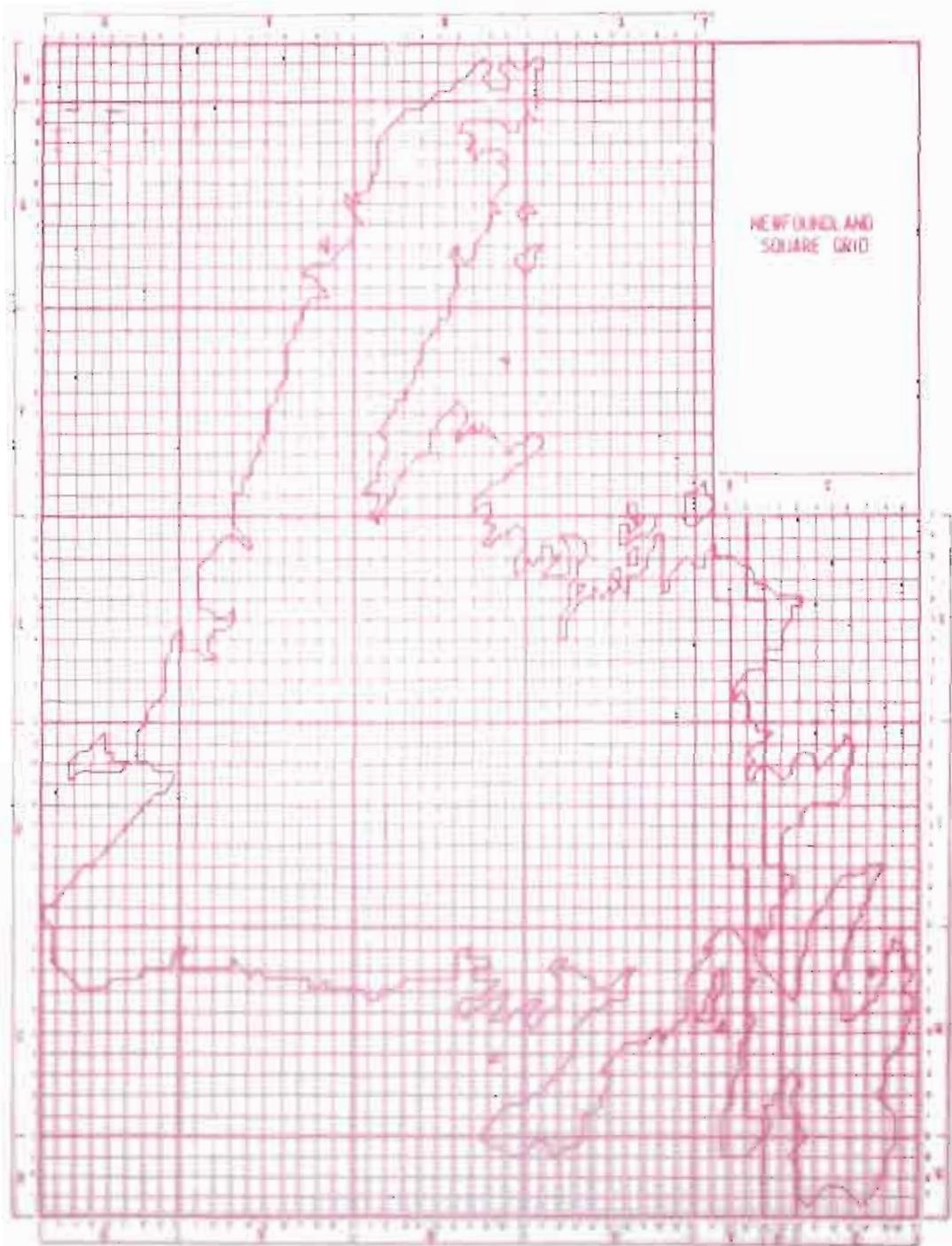
The establishing of frequency - area - intensity duration curves for storm precipitation and snow accumulation depth - melting rate compounded probability for the Province, and its use with the unit hydrographs or more advanced deterministic techniques to compute flood hydrographs of various probabilities, will require the analysis of all available data on snow and storm precipitation from a probabilistic viewpoint. The clarification of the problems of snow density, possibly in correlation with other meteorologic factors such as humidity, temperature, wind, and the additional information obtained for a minimum period of 8 to 10 years from the new meteorologic stations located inland, will also be required for the flood analyses.

The establishing of the compound probability of flow-hydrologic drought duration and its use with the depletion curves correlations (Section 19.2) to estimate minimum flows with various probabilities will require the statistical processing of the available information on hydrologic droughts together with the additional data at new hydrometric stations for a period of 8 to 10 years. The establishing of relationships between hydrologic and meteorologic droughts could be helpful in this problem.

The Shawinigan Engineering Company Limited  
James F. MacLaren Limited

The substantiation by means of flow record and climatologic data of the hydrologic region delineation, and confirmation or otherwise, as the case may be, of the further subdivision into sub-regions, will have to await additional information from the expanded hydrologic and meteorologic networks for a period of at least 3 to 4 years.









1, 2, & parts of 11 & 12

GEOLOGICAL SURVEY OF CANADA  
DEPARTMENT OF ENERGY, MINES AND RESOURCES

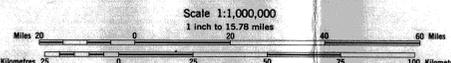
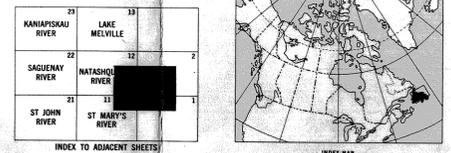
LEGEND  
SEDIMENTARY AND VOLCANIC ROCKS

- CARBONIFEROUS**  
C Conglomerate, sandstone, siltstone, shale, limestone, gypsum, anhydrite, some coal; Ca, ANGUILE GROUP and probable equivalents (Lower Mississippian); Cc, CODROY GROUP and probable equivalents (Middle and Upper Mississippian); Csb, SEARSTON BEDS, BARACHOIS GROUP, HOWLEY BEDS and probable equivalents (Upper Mississippian and Pennsylvanian)
- DEVONIAN**  
UPPER DEVONIAN  
UD Conglomerate, arkose, acidic volcanic rocks (mainly contemporaneous or post-Acadian orogeny); uDg, GREAT BAY DE L'EAU FORMATION; uDt, TERRENCEVILLE FORMATION; uDp, POOLS COVE FORMATION; (uDg and uDt Upper Devonian, others undated)
- LOWER DEVONIAN  
ID Shale, sandstone, conglomerate and metamorphic equivalents (pre-Acadian orogeny); IDb, BAY DU NORO GROUP (Lower and/or Middle Devonian)
- SILURIAN**  
S Sandstone, conglomerate, acidic to mafic volcanic rocks, gneiss, limestone; Sb, BOTWOOD GROUP; Si, INDIAN ISLANDS GROUP; Sv, volcanic rocks; Sw, White Bay Silurian rocks (Sb, Si, Sv, and Sw Lower and Middle Silurian age); Ss, SPRINGDALE GROUP; Sc, CAPE ST. JOHN GROUP (Ss, Sc, and other Silurian rock undated); Sf, possibly Ordovician or in part late Hadrynian
- WESTERN NEWFOUNDLAND**  
O1 Limestone, dolomite, quartzite, sandstone, shale (comprising Lower and early Middle Ordovician carbonate-quartzite-shale facies); unseparated ST. GEORGE GROUP, TABLE HEAD FORMATION and equivalents
- CENTRAL NEWFOUNDLAND**  
O2 Intermediate to mafic volcanic rocks; slate, greywacke, siltstone, chert, conglomerate, minor limestone (comprising Lower and Middle Ordovician volcanic-slate-greywacke facies); O2g, GANDER LAKE GROUP, middle and upper units; O2b, BAIE DESPOIN GROUP, upper unit; O2h, HEADLANDS GROUP; O2w, WILD BIGHT GROUP; O2bv, BAIE VERTE GROUP
- EASTERN NEWFOUNDLAND**  
O3 Shale, siltstone, sandstone, hematite beds (comprising Lower Ordovician shale-sandstone facies); O3w, WABANA GROUP; O3b, BELL ISLAND GROUP; O3c, CLARENVILLE GROUP
- ORDOVICIAN OR EARLIER**  
O7 Siltstone, quartzite, slate, greywacke and metamorphic equivalents; O7g, GANDER LAKE GROUP, lower unit; O7b, BAIE DESPOIN GROUP, lower part; O7h, mainly granitic gneiss
- CAMBRIAN**  
C1 Limestone, quartzite, shale, dolomite, slate, with arkose, conglomerate and basalt locally at base (comprising Lower to Upper Cambrian carbonate-quartzite facies). Basal unfossiliferous beds may be of late Helderian age. Trilobite faunas typical of North American or Pacific faunal realm; C1h, unseparated BRADORE, FORTEAU, HAWKE BAY FORMATIONS and equivalents of Lower Cambrian; LABRADOR GROUP, Cfm, Middle and Upper Cambrian MARCH POINT and PETIT JARDIN FORMATIONS
- CAMBRIAN OR EARLIER**  
C7 Psammite to pelitic gneiss and schist, meta-igneous, chloritic green schists, amphibolite, meta-conglomerate, unseparated metamorphosed intrusive rocks; C7h, FLEUR DE LYS GROUP
- LATE HADRYNIAN AND/OR CAMBRIAN**  
H2 Quartzite, conglomerate, siltstone, arkose; RANDOM FORMATION and equivalents
- HADRYNIAN**  
H1 Siltstone, arkose, conglomerate, slate, acidic to intermediate volcanic rocks; H2m, MUSGRAVETOWN GROUP or equivalents; H2h, HODGEWATER GROUP; H2c, CABOT GROUP (H2m, H2h and H2c all equivalent in part); H2i, possibly Palaeozoic
- HADRYNIAN OR EARLIER (?)**  
H1c Acidic to mafic volcanic rocks, slate, greywacke, conglomerate and metamorphic equivalents; H1h, HARBOUR MAIN GROUP; H1i, LOVE COVE GROUP
- HELMIAN OR EARLIER (?)**  
H1 Quartzite, felspathic gneiss and schist, psammite to pelitic gneiss and schist, amphibolite, unseparated intrusions, all of LONG RANGE COMPLEX
- DEVONIAN AND EARLIER**  
7a Granite, granodiorite, syenite, monzonite, quartz diorite and related rocks (mainly Devonian); 7b, coarse-grained porphyritic biotite granite; 7c, gneissous muscovite leucogranite; 7d, granites of Ordovician or presumed Ordovician age
- Gabbro, diorite, pyroxenite, quartz diorite, granodiorite, mafic syenite and related rocks (mainly Devonian and (?) Upper Silurian); 7a, intermediate to mafic intrusive rocks of Ordovician or presumed Ordovician age**
- Pendolite, serpenitized pendolite, altered pyroxenite, dunite, talc-carbonate alterations of mafic to ultramafic rocks; 7a, mafic to ultramafic rocks of Ordovician or presumed Ordovician age**
- CAMBRIAN (?)**  
5a diabase dykes of northwestern Newfoundland probably related to Lower Cambrian (or late Hadrynian?) nearby volcanic rocks; C1; 5b, gabbroic intrusions of eastern Newfoundland probably related to Middle Cambrian and (?) late Hadrynian (H2m) volcanic rocks
- HADRYNIAN**  
Granodiorite, quartz monzonite, granite, quartz diorite of Holyrood plutonic series
- Quartz diorite, diorite, gabbro, monzonite of Holyrood plutonic series**
- HELMIAN**  
Massive to foliated granitic rocks that include large areas of metamorphic rocks; 2a, granitic rocks of LONG RANGE COMPLEX; 2b, granitic rocks of INDIAN HEAD RANGE COMPLEX
- Anorthosite, gabbroic anorthosite, gabbro and related rocks; 1a, mafic intrusions of LONG RANGE COMPLEX; 1b, mafic intrusions of INDIAN HEAD RANGE COMPLEX**

PLUTONIC ROCKS

- REGIONAL METAMORPHIC ROCKS, MAINLY MEDIUM TO HIGH GRADE**  
Regional metamorphic rocks, mainly medium to high grade
- ACIDIC TO MAFIC VOLCANIC ROCKS**  
Acidic to mafic volcanic rocks
- CONGLOMERATE (PROBABLY EQUIVALENT IN LARGE PART TO HARBOUR MAIN AND LOVE COVE GROUPS)**  
Conglomerate (probably equivalent in large part to Harbour Main and Love Cove Groups)
- METALLIC MINERAL SYMBOLS**
- |          |    |           |    |                |     |              |     |
|----------|----|-----------|----|----------------|-----|--------------|-----|
| Antimony | As | Lead      | Pb | Asbestos       | asb | Limestone    | ls  |
| Arsenic  | As | Manganese | Mn | Barite         | ba  | Pyrophyllite | pph |
| Chromium | Cr | Pyrite    | py | Building stone | bs  | Shale        | sh  |
| Copper   | Cu | Silver    | Ag | Florentine     | fl  | Slate        | sl  |
| Gold     | Au | Titanium  | Ti | Granite        | gr  |              |     |
| Iron     | Fe | Zinc      | Zn | Gypsum         | gyp |              |     |
- NON-METALLIC MINERAL SYMBOLS**
- |  |  |
|--|--|
| 1. Pettis Quarry gr  | 31. Lady Pond Cu, Fe   |
| 2. Rose Blanche Quarry gr  | 32. Sterling Cu, Zn  |
| 3. Ryan Quarry ls  | 33. Crescent Lake Mine Cu  |
| 4. Flintville Co. Ltd., Quarry, Flat Bay gyp                       | 34. Miles Cove Mine Cu   |
| 5. Gull Pond Fe, Ti  | 35. Pelley Island Mine py, Cu                                      |
| 6. Dosco Steel Ltd., Quarry, Agathuna ls                           | 36. Freeman Cu   |
| 7. Lewis Bk. Mine and  | 37. Lockport Mine Cu   |
| 8. Bluff Head Mine Cu  | 38. Fortuna Harbour Fe, Mn   |
| 9. York Harbour Mine Cu, Zn  | 39. Moreton's Harbour Mine Sb, As, Au, Pb, Zn                      |
| 10. Summerside Quarry sh   | 40. Little Harbour As  |
| 11. Carling Quarry sh  | 41. Taylor River Au  |
| 12. North Star Cement Ltd. Quarry, Corner Brook sh                 | 42. Newfoundland Lime Manufacturing Co. Ltd., Quarry, Cobbs Arm ls |
| 13. North Star Cement Ltd. Quarry, Corner Brook ls (merble)        | 43. Benson gr  |
| 14. Junction Quarry ls   | 44. C & M Pelley Ltd. Brick Plant, Monro Island sh                 |
| 15. Cormack Quarry ls  | 45. C & M Pelley Ltd. Quarry, Ramton sh                            |
| 16. American Smelting and Refining Co., Buchans Cu, Pb, Zn, Au, Ag | 46. Cloniss Cove clay  |
| 17. Victoria Mine Cu, Zn   | 47. Snooks Harbour clay  |
| 18. Quarry Station gr  | 48. Burn Point sh  |
| 19. Gutteridge Mines Ltd., Quill Pond Cu                           | 49. Wickham Harbour sh   |
| 20. Brownings Mine Au, Cu, Pb, Zn                                  | 50. Le Marche Mine Pb, Zn, Au, Ag                                  |
| 21. Goldenville Mine Au  | 51. Collars Cove bs  |
| 22. Advocate Mines Ltd. ash  | 52. Briggs sh  |
| 23. Terra Nova Mine Cu, Zn   | 53. Dosco Industries Ltd., Wabana Mines Fe                         |
| 24. Consolidated Ramblers Mines Ltd., Cu, Au                       | 54. Newfoundland Minerals Ltd., Manuels sph                        |
| 25. First Maritime Mining Corp., Till Cove Cu, Au                  | 55. Sundew Peak Moss, Cochrane Pond post                           |
| 26. Betts Cove Mine Cu, Zn   | 56. Signal Hill bs   |
| 27. Old English Mine Cu  | 57. Southside bs   |
| 28. McNeely Mine Cu  | 58. Colchester Mine Cu   |
| 29. British Newfoundland Exploration Ltd., Whakaback Mine Cu       | 59. Silver Cliff Mine Pb, Zn, Ag                                   |
| 30. Atlantic Coast Copper Corp., Little Bay Cu, Au                 | 60. Newfoundland Fluorspar Ltd. fl                                 |

INDEX TO PRINCIPAL MINES AND INDUSTRIAL MINERAL OPERATIONS.



MAP 1231A  
GEOLOGY  
ISLAND OF NEWFOUNDLAND  
NEWFOUNDLAND  
Scale 1:1,000,000  
1 inch = 15.78 miles

Printed by the Surveys and Mapping Branch  
Copies of this map may be obtained from the  
Director, Geological Survey of Canada, Ottawa