A Water Demand Study Design

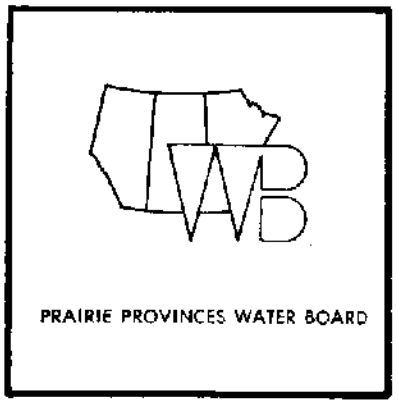
for the

Saskatchewan – Nelson Basin

Part 1, Current & Historical Uses

May 1976

PPWB REPORT #49



FOREWORD

The Board, at its November 1975 meeting, established a Committee on Water Demand and directed it to aid in the development of a study design, to be prepared by a seconded individual from the Socio-Economics Division of Environment Canada's Inland Water Directorate. The following report contains a detailed Water Demand Study design resulting from many hours of search, study, analysis, and writing by Mr. Don Tate, the seconded individual, and four meetings by the Committee to examine, comment, modify and discuss this material.

There have been two previous study outlines done on a Water Demand Study. The first, completed by a Task Force in January 1972, examined the need for and Terms of Reference of a water demand study to establish historic trends and forecast future uses throughout the Prairie Region. At a meeting of the SNBB Committee of Ministers in the following December, the Ministers agreed that a water demand study should be undertaken but the study should not be as extensive as outlined in the Task Force Report. They suggested that the work be done in two parts, the first to consist of historical and existing uses, and the second to consist of forecasting water demands.

Following this meeting, the Board recalled the Task Force and had them revise their study outline and estimate in accordance with the Minister's instructions. The Task Force completed this assignment and reported to the Board at its March 1973 meeting. The Board forwarded the modified study proposal to the Ministers for their review, concurrence, and approval. During fiscal 1973-74, the Ministers of the three Provincial Departments of the Environment replied in the affirmative, but the Minister of Environment Canada could not commit financial support at that time even though agreement of the study in principle was indicated.

Early in 1975, the Minister of Environment Canada wrote to the Provincial Ministers to inform them that funds for the study were now available and asked for confirmation of the agreement to proceed. At that time, the Manitoba Government agreed to participate in the study provided that Manitoba was able to review results at the end of the first phase (study design) and decide at that time whether or not it was prepared to continue with the study. Following this request, the Board established the Committee on Water Demand and seconded Mr. Don Tate to produce this detailed study design.

To avoid duplication of the large amount of pertinent material contained in the earlier Task Force Report and Letter Report, the Committee intends that the study office and working groups refer to all three documents during the course of the proposed study.

Some change will be apparent between the sector studies of this outline and those of the earlier reports. The Fish and Wildlife Sector and the Pollution Abatement Sector have been combined under a newly named Environmental Enhancement Sector.

The Committee is aware that this is Part One of a two-part study and that all the historical and current data collected would form the data base for the forecasting of Part Two. Because of this, there have been discussions on the forecasting methods available so that suitable data are collected and stored in a useful format. Unless these forecasting methods are known and understood, more and different data could be required for Part Two. The Committee believes that data omissions can be prevented in Part One by spending time in studying the forecasting methods.

This Water Demand Study is to be a companion to the Saskatchewan-Nelson Basin Study. Thus, river basin regions are of fundamental importance, and are viewed as the most appropriate type of area for collecting, organizing, and analyzing data. However, socio-economic data is collected on the basis of census division and political regions which do not correspond to basin boundaries. This difficulty can be overcome by modifying river basin boundaries to correspond with census areas. The Committee recommends the use of this system throughout the study.

The budget estimates for the proposed sector studies have been reduced over the earlier two proposals because many of the data sets required for the study are now available, either federally or provincially. In addition, the Fish and Wildlife Sector and the Pollution Abatement Sector have been combined and reduced. It is now estimated that the study will cost $714,000 (May 1976) and be carried out over a four year period.

The Committee recommends, as did the earlier reports on this study, that the Study Office Staff be small, with the Study Director's function through the early years to be mainly the co-ordinator of each sector technical sub-group. Each sector technical sub-group would consist of technical personnel from each participating agency and the study director. Their role would be to refine the details of their sector as to collection and analysis that would be compatible basin by basin, to ensure their agency did the collection and analysis on schedule and within budget, and to assist the Study Director in the preparation of a report on their particular Sector Study.

The Committee is aware of the time and effort of Mr. Don Tate towards this project, and appreciative of his patience and co-operation.

The following three pages present; a comparison of the cost of this study proposal versus the earlier two, a proposed schedule with annual budget requirements, and a map showing the basins proposed for socio-economic data collection. The body of the report contains more details on the proposed study.

Committee on Water Demand

E. CALIGIURI CANADA DREE-PFRA

V.M. AUSTFORD PROVINCE OF MANITOBA

R.L. KELLOW PROVINCE OF SASKATCHEWAN

G.D. LEWIS ENVIRONMENT CANADA EMS

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D.J. BERRY PRAIRIE PROVINCES WATER BOARD

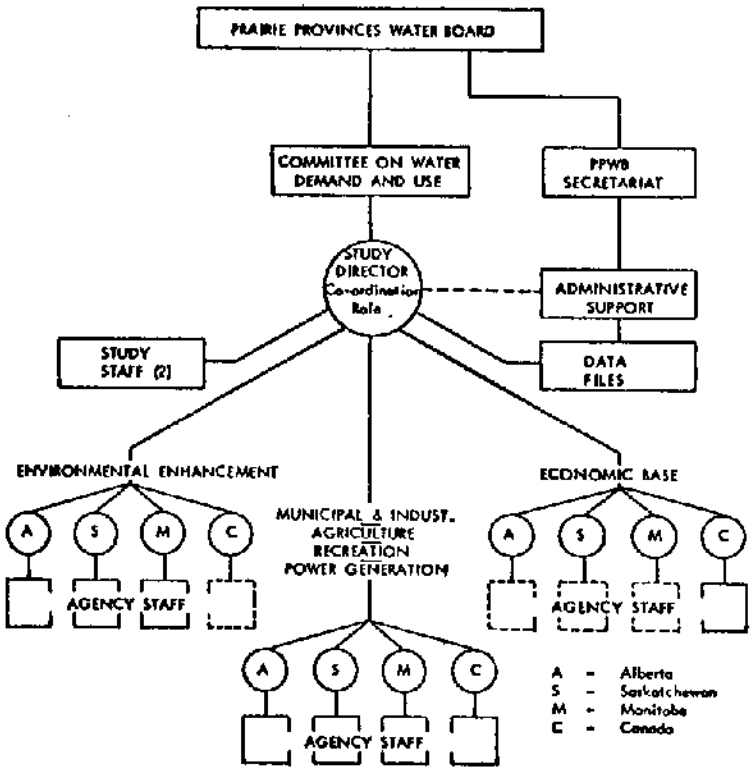
Cost Comparison of Study Reports

	1972 * January Report	1973 Letter Report	1976 Committee Report
Regional Economic	125,000	60,000	45,400
Municipal & Industrial	70,000	75,000	70,800
Agriculture	430,000	270,000	137,100
Recreation	145,000	145,000	92,700
Power	100,000	35,000	41,100
Fish & Wildlife	85,000	40,000	(a)
Pollution Abatement	60,000	25,000	(a)
Environmental Enhancement	(b)	(b)	30,600
Data File Construction	(c)	(c)	5,300
Study Office	235,000	150,000	226,000
Printing	(c)	(c)	65,000
	$1,250,000	$800,000	$714,000
	(1972 dollars)	(1973 dollars)	(1976 dollars)

(a) - these sectors have been incorporated into Environmental Enhancement.
(b) - this sector is newly proposed.
(c) - costs not separable in earlier reports.

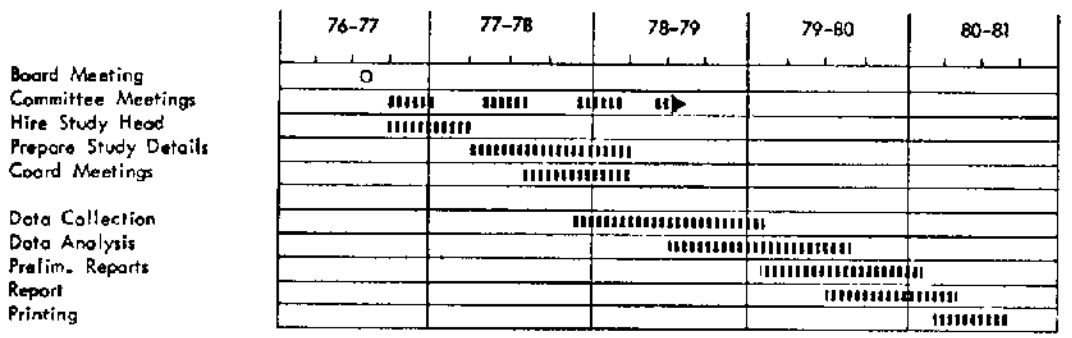
* includes forecasting

ADMINISTRATIVE FLOW CHART

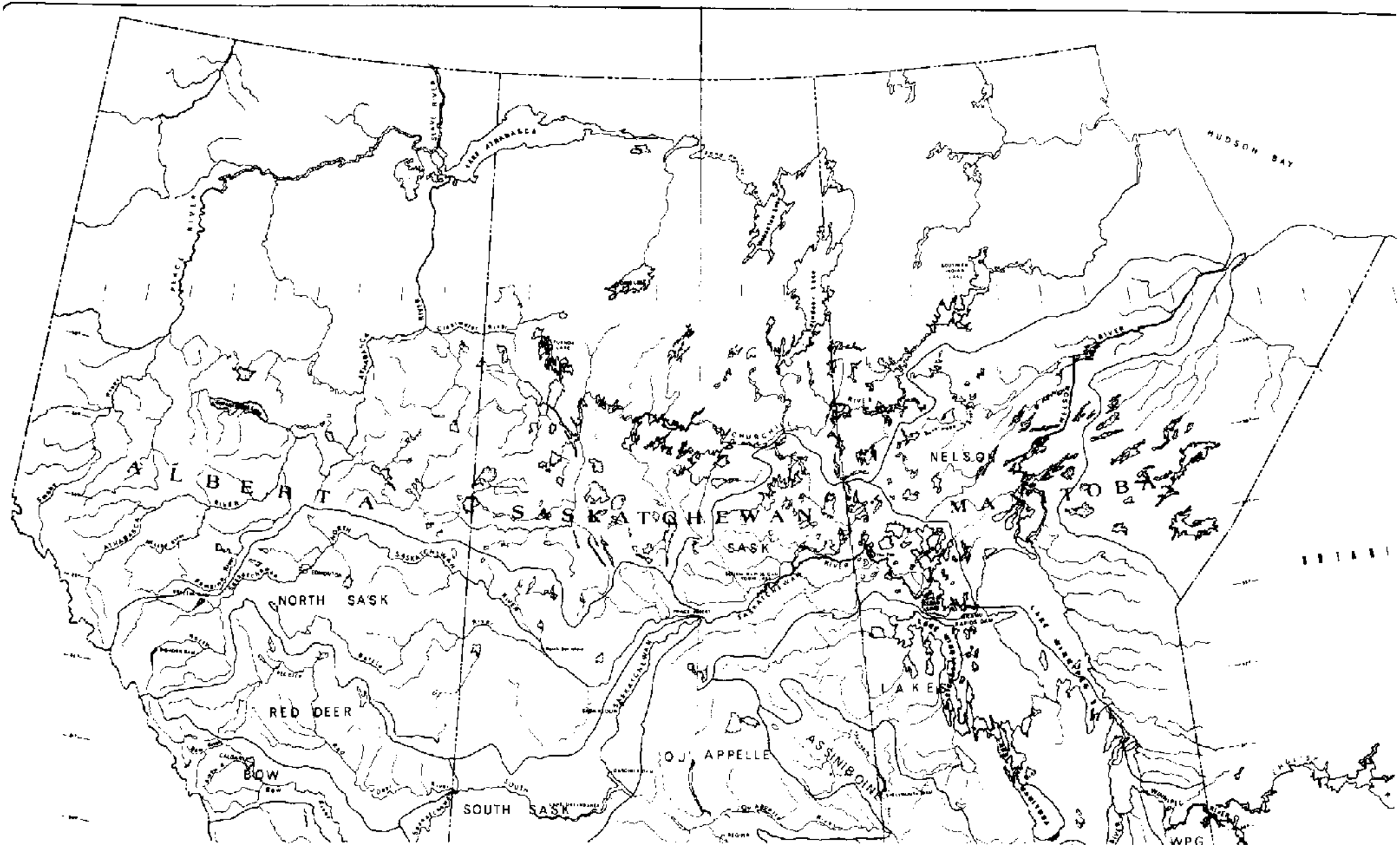


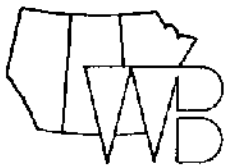
SCHEDULE AND BUDGET

PPWB WATER DEMAND STUDY - PART ONE



Fed. Collection			38,850	10,250			49,100
Fed. Analysis			15,850	23,650			39,500
Prov. Collection (one)			43,950	11,650		(×3)	166,800
Prov. Analysis (one)			21,950	32,150		(×3)	162,300
Total Collection			170,700	45,200			215,900
Total Analysis			81,700	120,100			201,800
Study Staff (3)		33,000	57,000	57,000	39,000		186,000
Study Office		8,000	11,500	11,500	9,000		40,000
Report Printing					65,000		65,000
Data Files Storage			100	1,200	4,000		5,300
Total Cost (May 1976)	0	41,000	321,000	235,000	117,000		714,000
Total Cost (Inflated $) - (based on inflation estimates of 10-8-6-6%)		45,100	381,348	295,931	156,176		878,555
						rounded =	880,000


HUDSON BAY
ALBERTA
SASKATCHEWAN
MANITOBA
NELSON
CHURCHILL
SASK
NORTH SASK
RED DEER
BOW
SOUTH SASK
OU APPELLE
ASSINIBOINE
LAKE
WPG



PRAIRIE PROVINCES WATER BOARD

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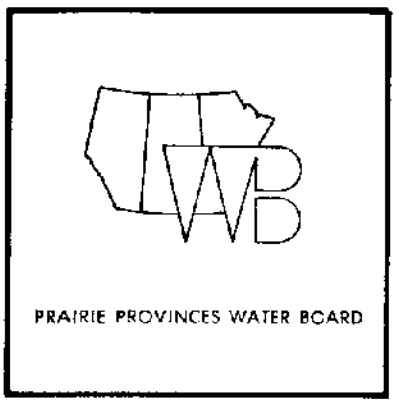


INTRODUCTION

1. Background

In 1970, the Prairie Provinces Water Board (PPWB) established a need to study water demands in the Saskatchewan-Nelson River basin to complement a water supply study, which was then nearing completion. The Task Force established by the Board to outline such a water demand study reported in early 1972, by means of a very detailed report. Subsequent provincial action led to the division of the proposed study into two Parts - Part I on current and historical water uses and Part II on forecasting water demands to 1985 and 2000. It was agreed that the Task Force would re-formulate the study outline to conform to the needs of Part I, while Part II would follow at a later date and would be the primary responsibility of the provinces. Budgetary difficulties intervened and Part I was postponed. A Committee was formed to review the proposed Part I study outline and to amend it in light of new data collected since 1972 and new methodologies for undertaking the individual study components.

This paper presents an outline for a re-formulated Part I study. It reviews the 1972 detailed report and the subsequent "letter report" of March, 1973 in light of new methodologies and data which have been developed since 1972. It modifies the study outline presented in the "letter report" in view of these developments, and determines the data required to carry out the modified study. Finally, it re-formulates the budget required for the study to reflect the modifications made.

2. Objectives and Terms of Reference for Part 1

As proposed by the PPWB, Part 1 will have the following three objectives: (a) to inventory and evaluate available data on water requirements and usage;

(b) to determine current water demands and use, and analyse the build-up of uses and how they occured;

(c) to identify weaknesses and inadequacies in existing demand information, collection and retrieval systems, and to recommend improvements.

These objectives were translated into the following draft Terms of Reference for Part 1: - to compile current and historical statistics related to water use in the Saskatchewan-Nelson River Basin. Major uses to be included are defined as follows:

Municipal - residential, commercial, institutional.

Industrial - primary and secondary manufacturing mineral and fuel extraction.

Agricultural - irrigation, stockwatering and rural domestic.

Power generation - hydro-electric and thermal.

Recreation - all forms of recreation wherein water plays an important role. This would include the activities of sport fishing, hunting in wetlands areas and passive activities such as aesthetic appreciation.

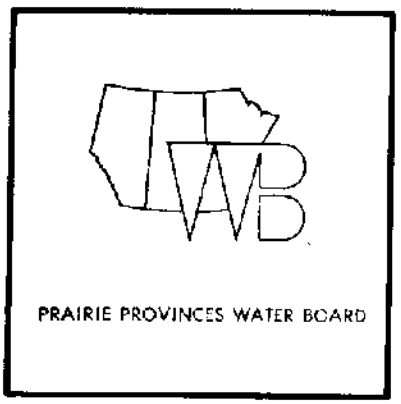
Environmental Enhancement - water for maintenance of fish and wildlife habitat and low flow augmentation.

- to carry out statistical analysis of historical and current water uses in order to determine factors affecting water use in each of the above categories.
- to identify weaknesses and inadequacies in existing demand information, collection and retrieval systems and recommend improvements.
- to outline input data needs for Part II forecasting procedures and provide a plan for filling in input data gaps.

In contrast, the recreation component investigates a non-withdrawal use. The study will focus on determining levels of participation in water-based activities at specific sites and the adequacy of these sites to meet existing demands.

The power generation component involves the determination of water requirements for the production of thermal and hydroelectric power and the variables controlling current water usage.

The last component, environmental enhancement, is a new one which will deal with the identification of significant fish and wildlife breeding areas where water can be used to increase productivity, alleviate deficiencies and increase the carrying capacity of the area for commercial or native use. This sector will also document water releases specifically used for water quality and quantity improvements.



REGIONAL ECONOMIC BASE

1. Background

Water uses arise primarily because of the social and economic activities which are carried on in any society. Water uses in the context of fish and wildlife, which rely upon water in correct quantities and qualities for survival are important, principally because of the broad range of activities which they engender. The role of water in industries, municipalities, agriculture and power generation is such that many of these activities would be impossible without it. Therefore, it seems clear that an accounting of current and past water use and subsequent analyses should begin with an examination of the social and economic structure of the region. This social and economic analysis will provide the context for subsequent studies of particular water uses, in addition to furnishing much basic data for those studies.

2. Study Objectives

a. To determine the nature of the current economic base of the region, and to trace its historical development from 1950;

b. to provide analysis of this economic base suitable for use in subsequent studies of Part I; and

c. to formulate a system of sub-regions which will be useful in storing, manipulating and analyzing the data.

The following paragraphs discuss the concepts introduced in these statements of objectives:

a. The nature of a regional economic base: An economic base of a region refers to its population size, location and density; and the economic activities which support this population. In the Prairie region, this involves determining the composition, and output of major industrial groups, the most important of which is agriculture. Characteristics of industry examined explicitly will include output volume and value, growth patterns since 1950, employment characteristics (size, growth, etc.), regional income, and the size and location of natural resources.

b. Types of analyses anticipated: The basic data in this section will consist of time series statistics on the regional economy. The first type of analysis is the calculation of growth rates for the various data series compiled. Two major analyses follow which probe the factors underlying the development as reflected in the data. The first is formulation of basic-non-basic ratios for each sub-region. Well-established theory shows that regional growth depends upon a region's "basic" industries, or the industries which produce for export outside the region. Industries producing solely or primarily for the internal regional market are referred to as "non-basic" or "service" industries. An obvious example of a basic industry in the Prairies is agriculture, while a non-basic industry would be, say, medical or accounting services. The basic-non-basic ratio is a concise summary description of a region's economic base, which is useful in determining future growth. The second type of analysis is shift-share analysis. This method probes the causes of growth in a more detailed manner than the basic-non-basic analysis outlined above. It enables the analyst to determine why a given area has grown. Knowing the causes of growth allows more accurate forecasting of future growth. Basic-non-basic analysis and shift-share analysis can be synthesized to form a reliable regional economic growth model.

c. Dissaggregating the region into sub-regions: Regions may be thought of as units of area which have relatively homogeneous physical, social and economic characteristics. For example, an urban, or city-centered area may form one type of region, while an agricultural area would form another type. Examples of both types of sub-region can be readily thought of for the Prairie Region as a whole. An analysis suitable for an urban-centered sub-region will, of necessity, consider different characteristics than one carried out for an agricultural sub-region. Thus, in carrying out a compilation and analysis of current and historical water uses, the study area must be split into appropriate sub-regions.

Since water resources are the focus of this study, water-based regions are of fundamental importance. In water resource studies, the river basin is generally viewed as the most appropriate type of region for collecting, organizing and analyzing data, and this is the case for this study. However, as noted above, water uses are responses to social and economic activities, and thus water use studies must rely upon large quantities of socio-economic data. Such data are collected on the basis of census division and political regions, the boundaries of which rarely correspond to watershed boundaries. For this reason, considerable adjustment is necessary in designing regions which conform generally to river basins, and yet which are feasible from the standpoint of socio-economic data collection. Appendix 1 suggests such a set of sub-regions, and supplies the method by which their boundaries have been determined.

3. Major Study Components

a. Compilation of data on the current economic base of the region and the historical development of this base.

b. Establishment of a system of sub-regions, which are based on both the major river basins of the region and the practicalities of collecting and organizing social and economic statistics. The statistics collected in Component (a) above will be organized to fit this system of sub-regions.

c. Analysis of the data using growth rates, basic-non-basic ratios and shift-share analysis.

4. Major Data Sets Required *

NOTE: All socio-economic data, except where specified, will be collected by Census Division for 1951, 1961, 1966, and 1971. Data for 1976 will be added if available. Principal data sets required for this component are:
- population by age, sex, income level and education level;
- labour force and unemployment (provincial and economic region only) for the following occupational categories: managerial, teaching, medical, technical, clerical, sales, service, agriculture, other primary industries, construction, transport, and other; and

* All data sets required for all sectors are summarized in Appendix 2.

- production and related workers employment data for 20 two-digit SIC (Standard Industrial Classification) groups.[1] (NOTE: Some SIC groups may be eliminated if they contain very small numbers; the eliminated groups will be put into a residual category)
- for all labour force groups and the two-digit SIC groups, data on physical output (where applicable), salaries and wages, and value added.
- farm size and number, major farm products.

5. Progress since 1972 and its Impact on the Budget

A comprehensive plan completed for the Qu'Appelle River basin contains limited data on the economic base of that area. Alberta has completed a study of the Red Deer River Basin, and has others underway concerning the western portion of the Saskatchewan-Nelson Basin. These studies will provide some information on the economic base of the basin. However, these data are of limited usefulness as they are not in the required format for the analysis to be undertaken in this project. New data, available methods and a reduced scope* will decrease the budget for this study from the $60,000 outlined in the March 1, 1973 amendment to the Task Force report to $45,400 (May 1976), as outlined on Page 9.

* Reduced scope refers to limited area and a more precise definition of methods to be employed.

[1] These groups are: food and beverage, tobacco products, rubber and plastic products; leather, textiles, knitting mills, clothing, wood, furniture and fixtures, paper and allied, printing, publishing and allied, primary metal, metal fabricating, machinery, electrical products, non-metallic mineral products, petroleum and coal products, chemicals and chemical products, and miscellaneous manufacturing industries. Agriculture will be treated in the same manner as these industrial groups.

6. Budget for Regional Economic Study [1]

1. Data Collection, Transcription, and Collation

	Time (Man-months)	Cost (1976)
Professional	5	$ 9,000
Technical	9	10,800
Clerical	5	4,500
		$24,300

2. Data Analysis and Manipulation

Professional	4	7,200
Technical	7	8,400
Clerical	5	4,500
		$20,100
Travel		1,000

3. Total for Study $45,400

This total cost is apportioned among the major study components as follows:

i	Economic base	13,000
ii	Watershed and economic sub-region	3,000
iii	Analysis	28,400
	Travel	1,000

[1] Throughout the cost analyses, the following rates are used to estimate Professional man-month = $1,800. Technical man-month = $1,200, and Clerical man-month = $900.

PRAIRIE PROVINCES WATER BOARD

MUNICIPAL AND INDUSTRIAL

1. Background

Municipal and industrial water use is relatively small in the Prairies when compared to the quantities of water used in agriculture. However, the municipalities, are centres of population and industry, and current trends indicate that they will become even more important with respect to population and industry in the future. Thus water demands in municipalities are very important and are certain to increase in magnitude. Water has been called industries' most important raw material. Without adequate water supplies, industry could not function. With increasing emphasis on processing raw material prior to export from the region, water use for industry is certain to become more important in the future. Uses included under both the municipal and the industrial categories were defined in the draft Terms of References for Part One which are included in this study outline (page 2).

2. Study Objectives

a. To determine current and historical water use patterns in the Saskatchewan-Nelson River Basin as a whole and in each of the sub-regions identified in the regional economic study, with particular emphasis on the larger urban centres (i.e. population over 1,000) and the large water-using industries.

b. To organize those data into an appropriate analytical framework.

c. To analyze the municipal and industrial water use in a manner suitable to determining the major variables affecting the levels of use.

3. Major Variables Affecting Water Use and Principal Analyses

a. Municipal: Detailed analyses of water use will be done for municipalities of greater than 1,000 persons. Residential, commercial, institutional and public uses will be examined for these communities. Residential water use, according to recent studies, is determined by several interrelated variables, including population size, rainfall amounts and distribution, potential evapo-transpiration, value of the housing stock, and pricing (i.e. metered or flat rate) arrangements in the municipalities. For residential use, a multiple regression analysis is quite feasible, and the precedents for such an analysis are well established. Some survey work will be necessary to compile the data for this sector. In addition, from data on current residential water use, the calculation of water use coefficients per capita will be feasible. For commercial, institutional and public uses, water use coefficients per unit of area or other parameters (e.g. hospital beds) can be derived from secondary sources. As water use for the three latter uses is a direct function of area or other parameter, it is readily quantifiable using these co-efficients. For communities under 1,000 in population, only gross water pumpage and water source will be examined.

b. Industrial: Industrial water use is a function of several variables such as activity level, as measured by parameters such as output or employment, process-product mix, recirculation level, water source, and the nature of charges on water use. Data on industrial water use are available for 1972, but are exceedingly difficult to obtain on a consistent basis for any other year. Data on water charges and the cost of plant water are not always available. Thus, industrial water use will be analyzed using a simulation-type framework into which the correct structural relationships, at least, can be incorporated. This simulation model will provide a useful framework for considering the variables affecting this use. The model of industrial water use will link the major determinants of use such as production level, recirculation, technology level, industrial growth and others. Linkages with the municipal sector will be through the industrial growth rate and through withdrawals from the public supply system.

4. Major Data Sets Required

a. Principal data sets required for the municipal water use study are as follows:
   - population size and historical growth rates (from the regional economic base study) and population served by water supply system.

- average family size and income.
- monthly water use patterns by the communities as a whole and for the various major user groups.
- number of water connections within each user group.
- methods of pricing (e.g. flat rate or metered) and metering schedules (where applicable), and average cost of water per 1,000 gallons.
- source of water supply.
- restrictions on water use for any period within the time of study.
- quantity of water sold to industry, and other communities or establishment outside the municipality.
- adequacy of current water supply.
- value of housing stock.
- rainfall patterns and potential evapotranspiration.
- leakages from the water supply system.
- water use coefficients for commercial, institutional and public users.

b. Data required for the industrial water demand study are as follows:

- economic activity levels in the base year and past growth rates from the economic base study, for each industrial group and for each sub-basin.
- water use data from the survey of industrial water use.
- industrial water rates.
- data on technological trends in gross water use, recirculation, and process changes.
- effluent standards and their impact on water use.

5. Major Advances since 1972 and its Impact on the Budget

Municipal water use data have been collected for 1974 by a Federal-Provincial survey of waterworks and waste treatment facilities. Much of the required data can be derived from this source. The rest is normally available from municipal offices. Industrial water use data have also been collected for 1972 by a federal survey for Manitoba and Saskatchewan and by an Alberta Environment survey for that province. This data base will fulfill many of the data requirements of this study. Also a fairly sound forecasting methodology has been developed for these sectors. These developments will reduce the required budget from $75,000 as proposed in March 1973 to $70,800 (May 1976) as detailed below.

6. Budget for the Municipal and Industrial Water Demand Study

a. Data Collection, Transcription and Collation

	Time (Man-months)	Cost (1976)
Professional	7	$ 12,600
Technical	13	15,600
Clerical	11	9,900
		$ 38,100

b. Data Analysis and Manipulation

Professional	7	$ 12,600
Technical	9	10,800
Clerical	7	6,300
		$ 29,700

c. Travel $ 3,000

d. Total cost for study $ 70,800

e. The total cost is apportioned among the major study components as follows:

i	Municipal Water Use	40,000
ii	Industrial Water Use	27,800
iii	Travel	3,000
		$ 70,800

PRAIRIE PROVINCES WATER BOARD

AGRICULTURAL

1. Background

Agriculture accounts for the largest water use in the Prairie region in quantitative terms. In view of the pre-eminence of agriculture in the Prairie economy, this water use is probably the most important one in the region. Irrigation accounts for the largest proportion of water used in the agricultural sector, with stockwatering and rural domestic uses assuming less important roles. Over 70% of Canada's irrigated agricultural land is located in the region, and most of this proportion is in the Saskatchewan-Nelson Basin. From 1910 to 1970, the amount of water used for irrigation increased by about 200,000 acre-feet per decade. In the study of water use in agriculture, therefore, irrigation uses will receive the most emphasis.

2. Study Objectives

a. to compile current and historical statistics on water use in the agricultural sector in the Saskatchewan-Nelson River basin and for each of the sub-regions delineated in the regional economic base study.

b. to organize these data into an appropriate analytical framework.

c. to analyze the factors, both physical and economic, which influence the amount of water used in the agricultural sector.

3. Major Variables Affecting Water Use and Principal Analyses

For stockwatering and rural domestic uses, which are relatively minor, the amount of water used depends principally on "activity level". For stockwatering this level is the number of livestock of different types existing in the area. For rural domestic, the level is the number of people living in the rural areas. The analysis here is simply to determine a water use coefficient per capita (for all types of livestock and for humans) and to multiply this coefficient by the "activity level".

For irrigation water use, the number of independent variables is larger and consequently the analysis is more complex. Irrigation water use is determined by the amount of irrigated acreage, the rainfall and potential evapotranspiration of the growing season, the technology of irrigation, and losses from the conveyance system. Of these, irrigated acreage is probably most important, and is determined by soil type, product price, market area population, capital cost of developing the irrigation system, increment to crop value as a result of irrigation, and presence or absence in the irrigation area of a processing plant for the product. Data on all of these variables are available, and consequently multiple regression techniques will be useful for the principal analysis of this use. This analysis will be developed for each sub-region. Before carrying out this analysis, the data can be used to calculate water use coefficients for the agricultural uses in each sub-basin.

4. Major Data Sets Required

- rural population (from regional economic base study)
- livestock counts
- coefficients of water use per capita for rural domestic and stockwatering uses
- irrigated acreage by census division, aggregated to sub-basin, current and historical
- water diverted at source, water delivered to farms, return flows, imputed farm losses
- rainfall and potential evapotranspiration rates by sub-basin
- product prices for crops produced on irrigated land, current and historical
- location of principal product markets and their current and historical populations
- incremental value of producing crops by irrigation methods vis a vis dry land methods, for each crop type
- capital costs of developing irrigated acreage
- location, size, and construction dates of food processing plants

- type of irrigation technology in practice for each irrigation district
- estimates of loss of water for conveyance system in each sub-basin

5. Progress since 1972 and its Impact on the Budget

No substantial progress has been made since the original study proposal was submitted. However, the elimination of studies of scientific and technological developments, market analysis and forecasts, and a study of government policies will reduce the budget from $270,000 as proposed in March 1973 to $137,100 as shown below.

6. Budget for the Agricultural Water Demand Study

a. Data Collection, Transcription and Collation

	Time (Man-months)	Cost (1976)
Professional	17	$ 30,600
Technical	35	42,000
Clerical	11	9,900
		$ 82,500

b. Data Analysis and Manipulation

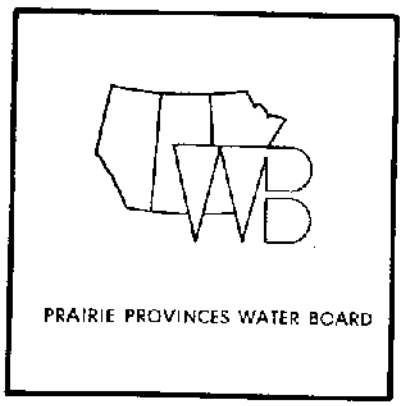
Professional	9	$ 16,200
Technical	25	30,000
Clerical	6	5,400
		$ 51,600

c. Travel $ 3,000

d. Total cost for study $137,100

e. The total cost is apportioned among the major study components as follows:

i	Stockwatering and rural domestic	10,000
ii	Irrigation	124,100
iii	Travel	3,000
		$137,100



RECREATIONAL

1. Background

The water uses dealt with in the previous sections have all been "withdrawal" uses, or uses which require water to be withdrawn from the water course for use (and subsequent discharge) in a separate circulation system. Recreation is the first of the non-withdrawal uses of water which will be dealt with in this study. For the most part, non-withdrawal uses of water are based upon characteristics of the resource (e.g. quantity, quality or flow) as it occurs naturally. In many cases water is such an integral part of the activity (e.g. swimming, boating) that quantification of amounts required is of secondary importance. For recreation, the integration of water with the characteristics of demand, the nature of the surrounding land resources and supply characteristics at major recreational sites is much more important than quantifying water use in gallons per day or acre feet required to sustain a certain level of activity.

Since the study of water demands for recreation is relatively new, there are no well-established methodologies of conducting this type of investigation. Many of the components of recreational water demand studies are, as yet, imperfectly understood. For example, more than in any other major use, in recreation, the supply of new areas creates its own demand. The provision of swimming facilities, for example, at a hitherto undeveloped location will attract participants more or less automatically. A real problem exists in building this supply component into an analysis of recreational water demands. Another methodological issue is that of determining participation rates, and the numbers of persons taking part in specific activities. These,

and other problems, are challenges to the type of study which is being contemplated in this study.

2. Study Objectives

a. To compile an inventory of current water-based recreation sites for the region and each sub-region; this inventory will include size, degree of development, facilities, estimates of quality, degree of use, and other factors;

b. to determine the numbers of persons participating in each water-based recreation activity according to age, sex, and income level;

c. to organize these data into a framework suitable for the analyses required for Part I and later for Part II of the Demand Study.

3. Major Variables Affecting Water Use and Principal Analyses

There are three types of questions which must be addressed in this study; the characteristics of supply of water-based recreational opportunities; the characteristics of demand by the region's population, and a method of allocating the demand to available sites. The latter question relates to the provision of a framework for organizing, storing and analyzing the data for this demand sector.

The supply of water-based recreational opportunities concerns the number of sites, the site size (e.g. total acreage, acreage or footage of beach, etc.), site development (e.g. number of campsites, miles of walking of hiking trails, etc.) and, site accessibility from major population centres. Most of these statistics are obtainable from park records. All federal and provincial parks, plus major municipal and private sites in the region will be included.

The demand portion of the recreation study attempts to quantify the number of persons who participate in individual activities, or, better still, "packages" of related recreational activities (e.g. swimming, boating and canoeing). Participation is associated with many factors, including income level, sex, age, educational level, personal preferences, etc. While personal preferences are difficult to collect data on, other variables are more empirical; thus, in studies such as the Canadian Outdoor Recreational Demand Study (CORDS) participation rates are given in terms of parameters such as income, age, and sex. Normally, participation rates are obtained by surveying the characteristics

of households. In this study, a household survey is possible along the lines specified in the 1972 report. Alternatively, it is suggested that the provincial participation rates obtained by the CORDS study could be used as adequate proxies for participation rates in the major centres considered in this study. The budget estimate given below was made assuming that a household survey would not be necessary.

The method for linking the supply and demand components of recreation, thus allocating potential demand to the various sites, will provide the framework for storing and analyzing water use in this sector. Methods for achieving these links are still the subject of experimentation and no one method is accepted as being the correct procedure. Most methods developed to date, are based upon the gravity model, a well-established technique of social science research. A variety of alternative procedures under this general method are available, and the one finally selected will be left to those involved in the study, along with advice from experts in this field. Appendix 3 explores the techniques of analyzing recreational water demand in more detail.

4. Major Data Sets Required

The data requirements for the recreational water demand study are as follows:

- total basin population
- population distribution by age group, income and sex
- participation rates for activities and annual rates of change in participation
- participation rates for age groups, income, and sex categories
- rates of change in participation for age groups, income, and sex categories (based on changes in distribution and analysis of trends)
- number of national and provincial parks
- area of recreation sites; both land and water
- attendance at parks and other recreation sites
- investment in recreation facilities
- accessibility of resources
- carrying capacity of existing sites
- water quality requirements for fish and wildlife.

5. Progress since 1972 and its Impact on the Budget

A supply study for Southern Alberta is underway and results will probably be available for the demand study. A study has also been completed on the use of reservoirs in Alberta. The planning studies discussed above contain

recreational material of as yet indeterminant value. Progress in recreational demand forecasting in this area since 1972 has not been substantial.

6. Budget for the Recreational Water Use Study

a. Data Collection, Transcription and Collation

	Time (Man-months)	Cost (1976)
Professional	8	$ 14,400
Technical	9	10,800
Clerical	5	4,500
		$ 29,700

b. Data Analysis and Manipulation

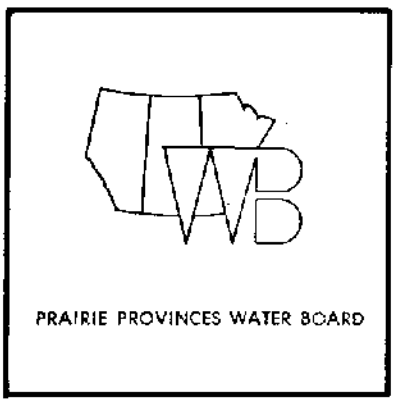
Professional	17	$ 30,600
Technical	14	16,800
Clerical	14	12,600
		$ 60,000

c. Travel $ 3,000

d. Total cost for study $ 92,700

The total cost is apportioned among the major study components as follows:

i	Supply Assessment	$ 18,000
ii	Demand Study	71,700
iii	Travel	3,000
		$ 92,700



POWER GENERATION

1. Background

Between 1972, when the original Task Force reported, and the present, energy matters have assumed a greater importance, both in the public eye, and for the economy as a whole. Predicted energy shortages and the rise in fossil fuel prices which accompany these shortages mean that alternative energy sources, such as hydro and thermal power generation have become even more important than they were in the total energy picture. For example, increased oil prices imply a long term shift to electric heating for homes. In all means of producing electricity, water is of central importance. For hydro, the energy of falling water is used to drive turbine generators to produce power. In thermal power production, water is used, firstly, to produce steam which drives the generators, and secondly, for cooling purposes. In both hydro and thermal generation, water is an absolute requirement, without which the activity would be infeasible. For the study area, both types of generating types are found, hydro generally in the northern areas and in the Rock Mountains, and thermal in the vicinity of major urban centres.

2. Study Objectives

a. to compile current and historical statistics on power generation and water use for this purpose in the Prairie Region.

b. to analyze these statistics in order to determine the variables underlying the water requirements of the industry.

c. to develop a framework suitable for storing and manipulating data on this water use for subsequent use in Part II of this study.

3. Major Variables Affecting Water Use and Principle Analyses

As the characteristics of water use are quite different for the two types of power generation, analysis must be split into two distinct segments - hydro and thermal. The simplest method of analyzing the historical and current data in both segments is to develop growth rates for each type of generation and thereby derive a simplistic explanation of the growth in water use. However, such an analysis would be of marginal value, assuming that Part II will eventually be done. Thus, more analysis than mere growth rates is required.

For thermal generation, it is suggested that regression analysis would be the most useful tool for analyzing water use. Water use is determined by several variables, including plant capacity and load factor, power production pattern, thermal efficiency of the plant (which governs the waste heat which must be removed by the water) the recirculation rate of the plant, and the allowable temperature differential between the intake and discharge water. This analysis is a suggested one only as no work of this kind has been done in Canada. For example, more variables may be included in the analysis.

For hydro generation, the primary focus should be upon minimum river flows to support various levels of power production. This involves analysis of the daily, monthly and yearly patterns (including peaks) of power production at each plant and comparison with the streamflow patterns of the streams on which the plants are located.

4. Major Data Sets Required

The data requirements for development of the proposed power generation water demand model are as follows:

- amounts of electric power production by basin of origin and power grid for current and past years
- breakdowns of these data by type of production, hydro and thermal
- capacity, load factor and thermal efficiency of thermal plants
- water use patterns of thermal plants
- adequacies of water supplies, by region and site if possible
- river flow data where relevant
- types of cooling systems employed and their costs
- data relating cooling water temperature rise to water use for cooling and water consumption

5. Progress since 1972 and its Impact on the Budget

Surveys of thermal and hydro generation plants by the federal government and by Alberta will provide base data on current water use at most sites throughout the region.

6. Budget for Power Generation Water Demand Study

a. Data Collection, Transcription and Collation

	Time (Man-months)	Cost (1976)
Professional	4	$ 7,200
Technical	5	6,000
Clerical	4	3,600
		$ 16,800

b. Data Analysis and Manipulation

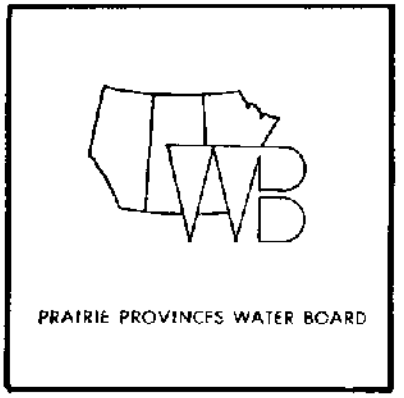
Professional	4	$ 7,200
Technical	8	9,600
Clerical	5	4,500
		$ 21,300

c. Travel $ 3,000

d. Total cost for this study $ 41,100

e. The total cost is apportioned among the major study components as follows:

i	Hydro water demand	$ 15,000
ii	Thermal water demand	23,100
iii	Travel	3,000
		$ 41,100



ENVIRONMENTAL ENHANCEMENT

1. Background

In addition to the water uses which can be separated into clear categories, as done in the previous sections above, there are uses which are so integral to the whole water environment that they must be dealt with very broadly, considering diverse environmental elements. Fish and wildlife is one of these uses in which water is only one element of the total environment which is important in sustaining the resource base. Water releases for pollution abatement and low flow augmentation are other uses which will be considered here. The thrust of this study will be to document significant areas for fish and wildlife propagation to determine the degree of economic dependence on fish and wildlife, and to identify the degree to which pollution abatement in the area depends upon releases of water at certain periods of the year.

To a certain degree, this study is similar to the recreation portion of Part I. There, it will be recalled, water use had to be considered in conjunction with a total environment. Also, the methodology for the recreation study involved some experimentation to find a correct procedure. So too, in the environmental enhancement study, the selection of a procedure will involve some innovation.

2. Study Objectives

a. to compile an inventory of areas in the Saskatchewan-Nelson basin which are important for the propagation of fish and wildlife, and to identify any water related problems associated with these areas.

b. to determine the level of economic activity associated with fish and wildlife resources.

c. to document the frequency, extent and quantitative nature of water storage and release for pollution abatement, low flow augmentation and habitat maintenance.

3. Major Variables to be Considered and Principal Analyses

This study is concerned mainly with compiling an inventory of data which can be used to ensure the protection of fish and wildlife habitats should water-related developments be initiated in the study area. Thus, it is concerned with the identification of significant areas for fish and wildlife and an adequate description of these areas in terms of their productivity and water-related characteristics. Variables which are important in this type of descriptive analysis are size of area, types and numbers of principal species, the quantitative and qualitative water requirement for maintaining the viability of these areas as fish and wildlife habitats, and the socio-economic characteristics such as production, employment and income, associated with commercial activities in these areas. As noted above, this analysis will be mainly descriptive, with no advanced quantitative techniques required.

The inventory of water releases for the above purposes will be compiled by interviewing government officials responsible for these operations. The aim here is solely to document water released specifically for pollution abatement purposes, and not to become involved with the very expensive process of water quality modelling. Thus, again the analysis required will be descriptive in nature.

4. Major Data Sets Required

- inventory of sites which are important for fish and wildlife
- acreage, principal fish and wildlife species, carrying capacities, and water quality and quantity characteristics of sites
- historical water levels and the documented impact of water level fluctuations on the fish and wildlife species of the site
- economic characteristics associated with each site
- documented releases of water for habitat maintenance
- documented releases of water for pollution abatement purposes

5. Advances Since 1972

The environmental enhancement study proposed here is essentially a combination of the fish and wildlife and the pollution abatement study contained in the 1972 study proposal. Some work of the nature proposed has been conducted by Alberta in the Red Deer and Oldman River Basins. Some water quality modelling has been done in the Manitoba portion of the Souris River Basin. Both of these pieces of work will prove useful, but there is still much work to be completed, especially in compiling the inventories required in this study.

6. Budget Requirements for the Environmental Enhancement Study

a. Data Collection, Transcription and Collection

	Time (Man-months)	Cost (1976)
Professional	6	$ 10,800
Technical	3	3,600
Clerical	3	2,700
		$ 17,100

b. Data Analysis and Manipulation

Professional	3	$ 5,400
Technical	3	3,600
Clerical	3	2,700
		$ 11,700

c. Travel — 1,800

d. Total Cost for Study — $ 30,600

e. The total cost is apportioned among the major study components as follows:

i	Fish and Wildlife	$ 23,000
ii	Water Releases	5,800
iii	Travel	1,800
		$ 30,600

PRAIRIE PROVINCES WATER BOARD

ADMINISTRATIVE ARRANGEMENTS

1. Organization

The type of organization conceived for the Part I study is somewhat different than suggested by the original 1972-73 Task Force and is depicted in Figure 1. The same basic criteria for executing the study as set forth in the 1972-73 report were followed. To review briefly, the organizational structure proposed in that report, proposed that the study be done by a study team working under a study director located in the Regina office of the PPWB. The study team would report to a PPWB Committee on the Water Demand Study, composed of federal and provincial personnel. Technical advice and assistance would be provided by a Technical Advisory Committee, composed also of federal and provincial personnel expert in the study area.

The modified proposal retains overall responsibility and general direction for the study for the PPWB Committee on Water Demand. A Study Director would be appointed by and report to this Committee. The Study Director and his staff, composed of a technical assistant and a clerk-typist, and located administratively within the PPWB Secretariat, would coordinate the study, working closely with the federal and provincial personnel involved in carrying out the work program. For all sector studies except the regional economic base study, which will be dealt with below, a sub-committee would be established. These sub-committees would be composed of one provincial representative from each of the three provinces, one representative from the federal government, and the Study Director. These sub-committees would be responsible for carrying out the data collection and analyses as specified in the terms of reference for each study. The provincial representatives would be responsible for data collection within their respective provinces and for assuring

input of the provincial point of view in the analyses done for each study. The federal representative would collect and provide data held by federal agencies (e.g. Statistics Canada, Environment Canada, PFRA, etc.) and would seek any specialized assistance which might be contributed by federal personnel. The study director would coordinate the study and would assure the production of a final report which would fulfill the requirements of the term of references set forth for the individual studies. With this type of administrative arrangement, it will be possible to assure adequate provincial input to the analyses, to tap the best possible expertise of both the federal and provincial governments, and to carry out the studies in an efficient manner.

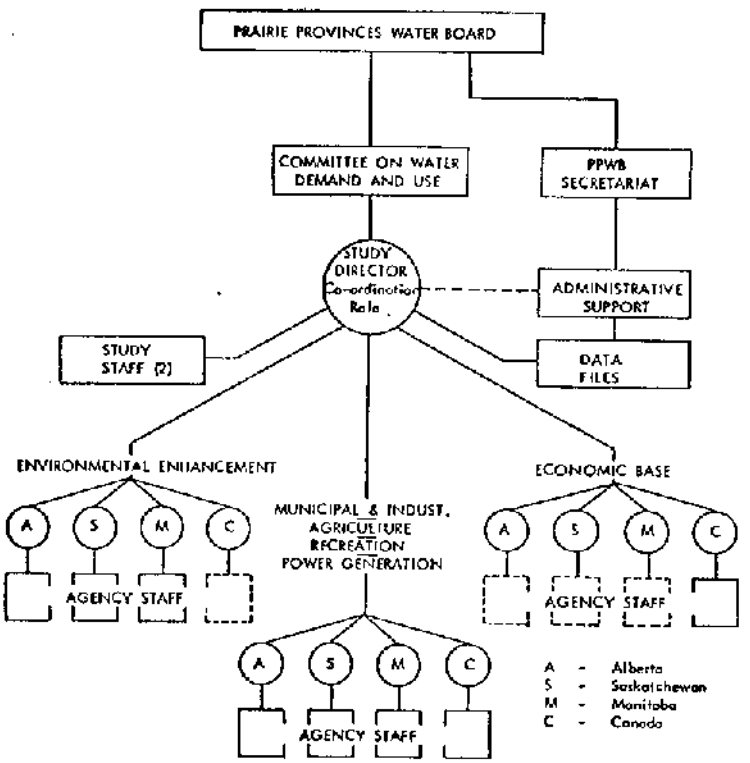


Figure One - Administrative Flow Chart

The exception to this administrative arrangement, it is suggested, should be for the regional economic base study. Here, a great deal of data is required from Statistics Canada and from other parts of the federal government. Thus, it is proposed that Environment Canada take the lead for this particular study, as it has close contact with the agencies which will supply the data, as

well as an established procedure for collecting and collating this data. Contact with the provinces would be maintained through the Study Director and Committee and required provincial inputs could be made in this manner. This procedure is suggested solely from the viewpoint of efficiency in the use of manpower and data sources. If this study were done in the same manner as the other sectors it is estimated that the cost of the Regional Economic Base Study would be at least 50 per cent more.

2. Administrative Budget

Several items are common to the entire study, costs of which are estimated below. These include the Study Director's and staff salaries, the cost of staff travel, study office supplies and equipment, the cost of developing a computerized data storage and retrieval system, and printing costs for the final report. The costs of these components are set forth as follows:

Data Bank Development	5,300
Study Director and staff (incl. travel)	186,000
Office supplies and equipment	40,000
Printing	65,000
TOTAL	$296,300

3. Total Budget for Part 1

The following tables summarizes the costs of the study. Table 1 presents these costs as they will be incurred over the fiscal years 1976-77 to 1980-81, along with a diagrammatic view of the study's timing. Table 2 gives a breakdown of man months and resources required by each agency, while Table 3 details the cost and timing for the administrative expenditures.

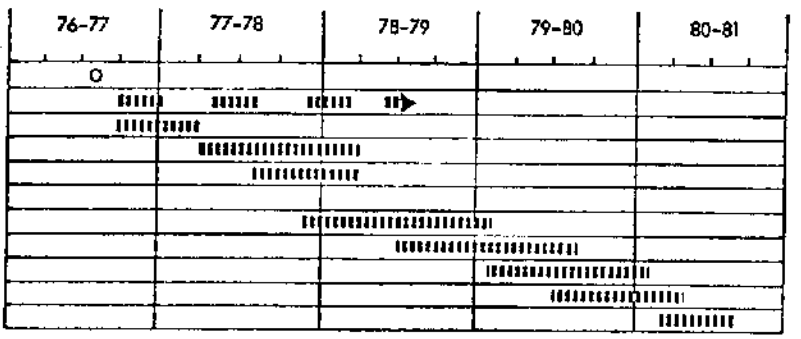
4. Inflation

It should be noted that two total costs are included at the bottom of Table 1. The first is based on constant dollars (May 1976) and the second based on outlays in inflated dollars. The inflation rates adopted are based on guidelines issued by the Anti Inflation Board of 10, 8, 6, and 6 per cent for the years 1976-1980 respectively.

TABLE 1

SCHEDULE AND BUDGET

PPWB WATER DEMAND STUDY - PART ONE



	76-77	77-78	78-79	79-80	80-81		
Fed. Collection			38,850	10,250			49,100
Fed. Analysis			15,850	23,650			39,500
Prov. Collection (one)			43,950	11,650		(x3)	166,800
Prov. Analysis (one)			21,950	32,150		(x3)	162,300
Total Collection			170,700	45,200			215,900
Total Analysis			81,700	120,100			201,800
Study Staff (3)		33,000	57,000	57,000	39,000		186,000
Study Office		8,000	11,500	11,500	9,000		40,000
Report Printing					65,000		65,000
Data Files Storage			100	1,200	4,000		5,300
Total Cost (May 1976)	0	41,000	321,000	235,000	117,000		714,000
Total Cost (inflated $) - (based on inflation estimates of 10-8-6-6%)		45,100	381,348	295,931	156,176		878,555
						rounded =	880,000

TABLE 2

MAN MONTHS

	Collection			Analysis			Total		
	* P	T	C	P	T	C	P	T	C
Regional Economic	5	9	5	4	7	5	9	16	10
Municipal & Industrial	7	13	11	7	9	7	14	22	18
Agriculture	17	35	11	9	25	6	26	60	17
Recreation	8	9	5	17	14	14	25	23	19
Power Generation	4	5	4	4	8	5	8	13	9
Envir. Enhancement	6	3	3	3	3	3	9	6	6
Total									

FEDERAL

	* P	T	C	P	T	C	P	T	C
Regional Economic	5	9	5	4	7	5	9	16	10
Municipal & Industrial	1	1	2	1	0	1	2	1	3
Agriculture	2	2	2	0	1	0	2	3	2
Recreation	2	0	2	2	2	2	4	2	4
Power Generation	1	2	1	1	2	2	2	4	3
Envir. Enhancement	0	0	0	0	0	0	0	0	0

PROVINCIAL (ONE)

Regional Economic	0	0	0	0	0	0	0	0	0
Municipal & Industrial	2	4	3	2	3	2	4	7	5
Agriculture	5	11	3	3	8	2	8	19	5
Recreation	2	3	1	5	4	4	7	7	5
Power Generation	1	1	1	1	2	1	2	3	2
Envir. Enhancement	2	1	1	1	1	1	3	2	2

THREE PROVINCES (X3)
FEDERAL WORK
TOTAL

COST (MAY 1976 DOLLARS)

	Collection			Analysis			Total					Total
	Prof.	Tech.	Clerk	Prof.	Tech.	Clerk	Prof.	Tech.	Clerk	Total	Travel	
Regional Economic	9,000	10,800	4,500	7,200	8,400	4,500	16,200	19,200	9,000	44,400	1,000	45,400
Municipal & Industrial	12,600	15,600	9,900	12,600	10,800	6,300	25,200	26,400	16,200	67,800	3,000	70,800
Agriculture	30,600	42,000	9,900	16,200	30,000	5,400	46,800	72,000	15,300	134,100	3,000	137,100
Recreation	14,400	10,800	4,500	30,600	16,800	12,600	45,000	27,600	17,100	89,700	3,000	92,700
Power Generation	7,200	6,000	3,600	7,200	9,600	4,500	14,400	15,600	8,100	38,100	3,000	41,100
Envir. Enhancement	10,800	3,600	2,700	5,400	3,600	2,700	16,200	7,200	5,400	28,800	1,800	30,600
Total	84,600	88,800	35,100	79,200	79,200	36,000				402,900	14,800	417,700
		208,500			194,400							

FEDERAL

	Prof.	Tech.	Clerk	Prof.	Tech.	Clerk	Prof.	Tech.	Clerk	Total	Travel	Total
Regional Economic	9,000	10,800	4,500	7,200	8,400	4,500	16,200	19,200	9,000	44,400	1,000	45,400
Municipal & Industrial	1,800	1,200	1,800	1,800	0	900	3,600	1,200	2,700	7,500	600	8,100
Agriculture	3,600	2,400	1,800	0	1,200	0	3,600	3,600	1,800	9,000	600	9,600
Recreation	3,600	0	1,800	3,600	2,400	1,800	7,200	2,400	3,600	13,200	600	13,800
Power Generation	1,800	2,400	900	1,800	2,400	1,800	3,600	4,800	2,700	11,100	600	11,700
Envir. Enhancement	0	0	0	0	0	0	0	0	0	0	0	0
	19,800	16,800	10,800	14,400	14,400	9,000				85,200	3,400	88,600
		47,400			37,800							

PROVINCIAL (ONE)

Regional Economic	0	0	0	0	0	0	0	0	0	0	0	0
Municipal & Industrial	3,600	4,800	2,700	3,600	3,600	1,800	7,200	8,400	4,500	20,100	800	20,900
Agriculture	9,000	13,200	2,700	5,400	9,600	1,800	14,400	22,800	4,500	41,700	800	42,500
Recreation	3,600	3,600	900	9,000	4,800	3,600	12,600	8,400	4,500	25,500	800	26,300
Power Generation	1,800	1,200	900	1,800	2,400	900	3,600	3,600	1,800	9,000	800	9,800
Envir. Enhancement	3,600	1,200	900	1,800	1,200	900	5,400	2,400	1,800	9,600	600	10,200
	21,600	24,000	8,100	21,600	21,600	9,000				105,900	3,800	109,700
		53,700			52,200							

THREE PROVINCES (X3)	161,100	156,600	317,700
FEDERAL WORK	47,400	37,800	85,200
TOTAL	208,500	194,400	402,900
			14,800
			417,700

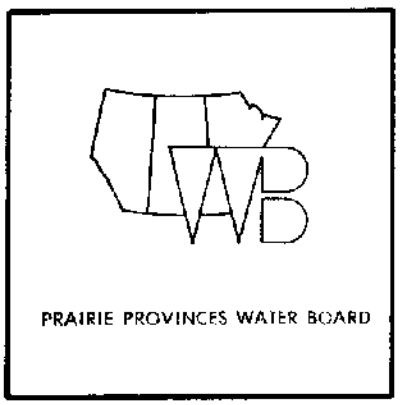
* PROFESSIONAL
* TECHNICAL
* CLERICAL

Prof. @ 1,800/mon.
Tech. @ 1,200/mon.
Clerk @ 900/mon.

Table 3

Administrative Expenditures

		1977-78 8 mos.	1978-79 12 mos.	1979-80 12 mos.	1980-81 8 mos.	
Staff:						
	Director	20,000	30,000	30,000	20,000	100,000
	Assistant	6,000	17,000	17,000	11,000	51,000
	Secretary	7,000	10,000	10,000	8,000	35,000
		33,000	57,000	57,000	39,000	186,000
Office:						
	Rent	5,000	7,000	7,000	5,000	24,000
	Material	1,000	1,500	1,500	2,000	6,000
	Travel	2,000	3,000	3,000	2,000	10,000
		8,000	11,500	11,500	9,000	40,000
Data Files:						
	PPWB		300	1,000	4,000	5,300
Printing:					65,000	65,000
						$296,300

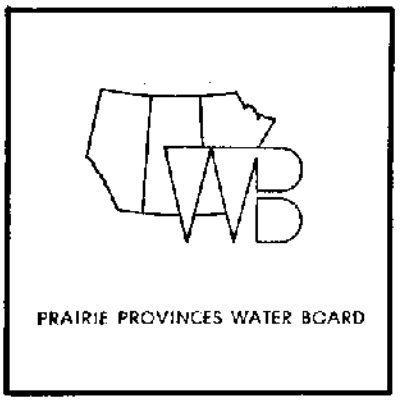


ACKNOWLEDGEMENTS

The Committee on Water Demand would like to acknowledge the work and cooperation of Mr. Don Tate who was seconded by the Board from the Socio-economic Division, Inland Waters Directorate, Environment Canada to prepare this report in conjunction with the Committee.

The Committee also wishes to acknowledge the effort toward the completion of this report from Mr. E.W. Allison, Secretary of the Committee, and the following individuals:

Mr. D. Lacelle, Socio-economic Division, Inland Waters Directorate,
Mr. P. Power, Socio-economic Division, Inland Waters Directorate,
Mr. E.J. Smith, PPWB, Secretariat.
Mrs. J.E. Nelson, PPWB, Secretariat.
Mrs. E. Jackson, PPWB, Secretariat.



APPENDIX

APPENDIX 1 - A Proposed Method for Compiling Socio-economic Data on River Basin Regions

APPENDIX 2 - Data Summary: Regional Economic Base Studies

APPENDIX 3 - Techniques of Analyzing Recreational Water Demands

2. River Basins Used in Part 1

Since the study area itself is a river basin, the Saskatchewan-Nelson, the major units used in this study are actually sub-basins. Thirteen of these have been selected to form the areal basis for Part 1. Each watershed was defined by reference to I.W.D. Hydrometric Reference Maps, Water Survey of Canada, 1972. A brief description of each watershed follows:

1. The Red River, plus one international tributary (Roseau Rivers); all of Metropolitan Winnipeg, and a small southern portion of Lake Winnipeg. The Pembina River was treated as a separate area.

2. The Assiniboine River, excluding the Qu'Appelle and Souris Rivers, up to where the river enters Metropolitan Winnipeg.

3. The Winnipeg River, and drainage into Lake of the Woods, to the mouth of the river on Lake Winnipeg.

4. The Pembina River to where it crosses the International Boundary.

5. A Lakes Area, consisting of drainage from populated areas to Lake Winnipegosis, Lake Manitoba, and Lake Winnipeg. The Eastern portion of Lake Winnipeg (North of the Winnipeg River), and the Northern portion of Lake Winnipeg (North of the Saskatchewan River) were excluded. The Saskatchewan River was treated as a separate area.

6. The Saskatchewan River, from the junction of the North and South Saskatchewan Rivers, to Lake Winnipeg.

7. The Souris River, both East and West portions, plus international tributaries (Antler River, Long Creek), to its junction with the Assiniboine River.

8. The Qu'Appelle River to its junction with the Assiniboine River.

9. The Bow and Oldman Rivers, from their sources, including international tributaries to the Oldman River (Waterton, St. Mary, and Belly Rivers), to their junction at the South Saskatchewan River.

10. The Red Deer River, from its source to its junction with the South Saskatchewan River.

11. The South Saskatchewan River, from the junction of the Bow and Oldman Rivers, excluding the Red Deer River to its junction with the North Saskatchewan River at the Saskatchewan River.

12. The North Saskatchewan River, to its junction with the South Saskatchewan River at the Saskatchewan River.

13. The Nelson River from Lake Manitoba to Hudson Bay.

These natural watersheds are outlined on maps 1 to 3.

3. Approximation of River Basin Populations using Enumeration Areas

As outlined in the Introduction, the enumeration area is the smallest unit of area used to collect census data. It follows that the least amount of error will be encountered if enumeration areas are used to approximate river basins. The thirteen watersheds were plotted using enumeration area boundaries as approximations of the watershed boundaries, and these approximations are shown on maps 4 to 6. For incorporated areas, it is normally clear from a map the river basin into which the enumeration areas containing the settlement falls. In cases where an incorporated place could fall into two river basins, the criteria of "receiving water for sewage" was used to allocate the settlement to one basin. This information was obtained from Environment Canada's Municipal Water and Wastewater Treatment Survey, 1974, and eliminates the problem of municipal water withdrawals from wells, which sometimes cannot be clearly pinpointed into watersheds. The populations for the incorporated settlements were derived from Statistics Canada 1971 Census material and summed to give the incorporated population of the thirteen river basins to be used in the study.

Rural enumeration areas were placed into their respective watersheds by inspection in unambiguous cases. Where a rural enumeration area fell into two river basins, its population was allocated using estimated population densities, or, in the case of a relatively homogeneous area, by estimates of land area. These rural enumeration data were added to the data on incorporated settlements to give estimates of the total population of each of the thirteen river basins.

Table 1 Total Basin Populations

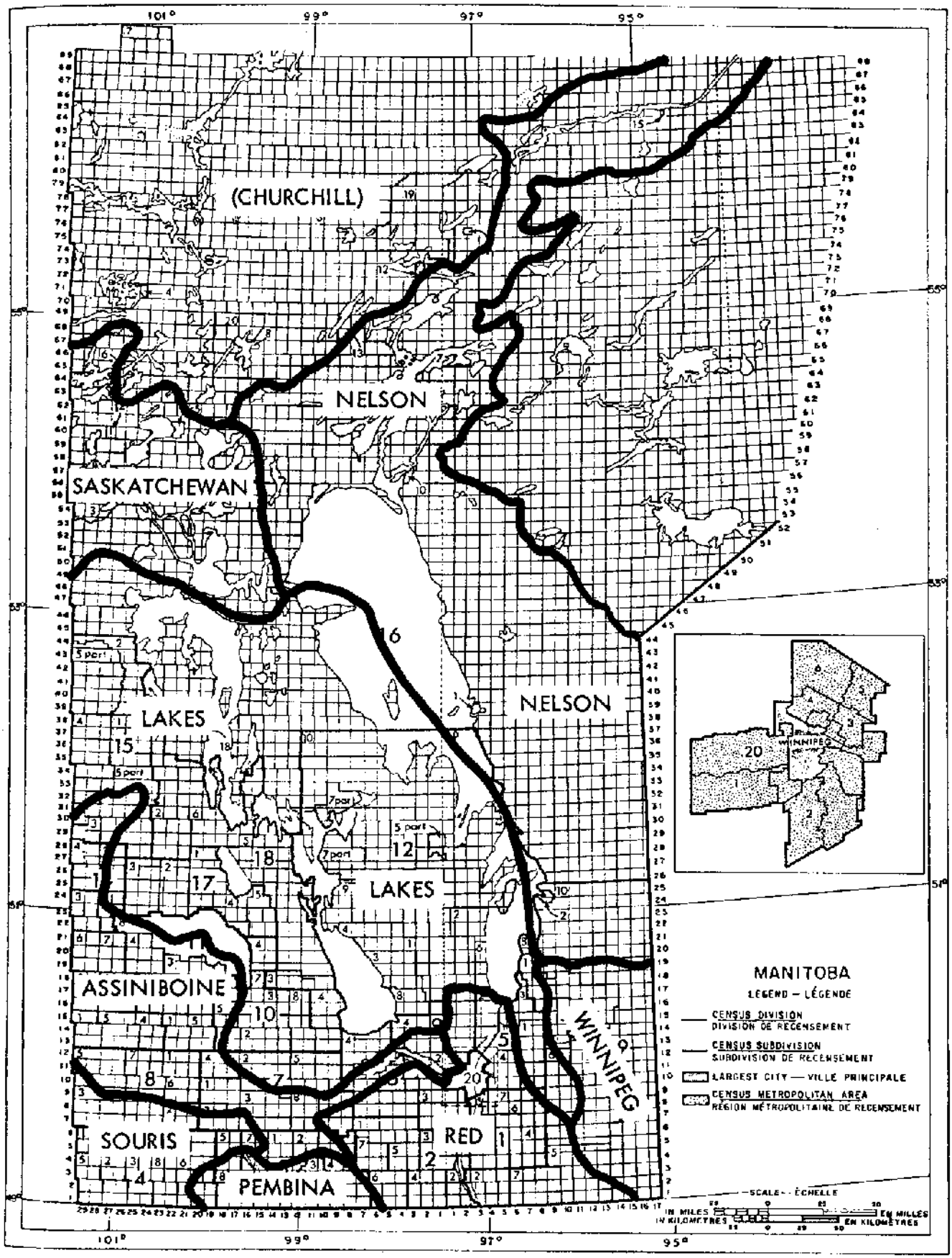
Red	653,877	Qu'Appelle	299,705
Pembina	16,167	Bow-Oldman	565,738
Assiniboine	193,494	Red Deer	123,431
Winnipeg	13,497	South Saskatchewan	254,609
Lakes	130,049	North Saskatchewan	841,029
Souris	84,235	Saskatchewan	72,965
		Nelson	91,988

The problem now remaining is that only limited data are available at the enumeration area level. Most census material is available at the census division level, and therefore a method was required to disaggregate census division data into river basins. An attempt was made to delineate the river basins of maps 1 to 3 solely on the basis of census divisions. The results of this attempt are shown on maps 7 to 9. It is clear, both visually and from analysis, that an unacceptable degree of error would be introduced were this method used to delineate river basins. The disaggregation of census division data can be done using the results obtained from the allocation into river basins of enumeration areas. Since enumeration areas are subdivisions of census division areas, it is possible on the basis of the former to calculate the proportion of the latter falling into each river basin. This is done in Table 1 for population. For example, consider Census Division 7 in Manitoba. Of the total census division population, 4.1% resides in the Red River Basin, 81% in the Assiniboine, 12.2% in the Lakes Area and 2.6% in the Souris River Basin. Therefore, Table 1 can be used in a computer to "weight" population-related data required in the study.

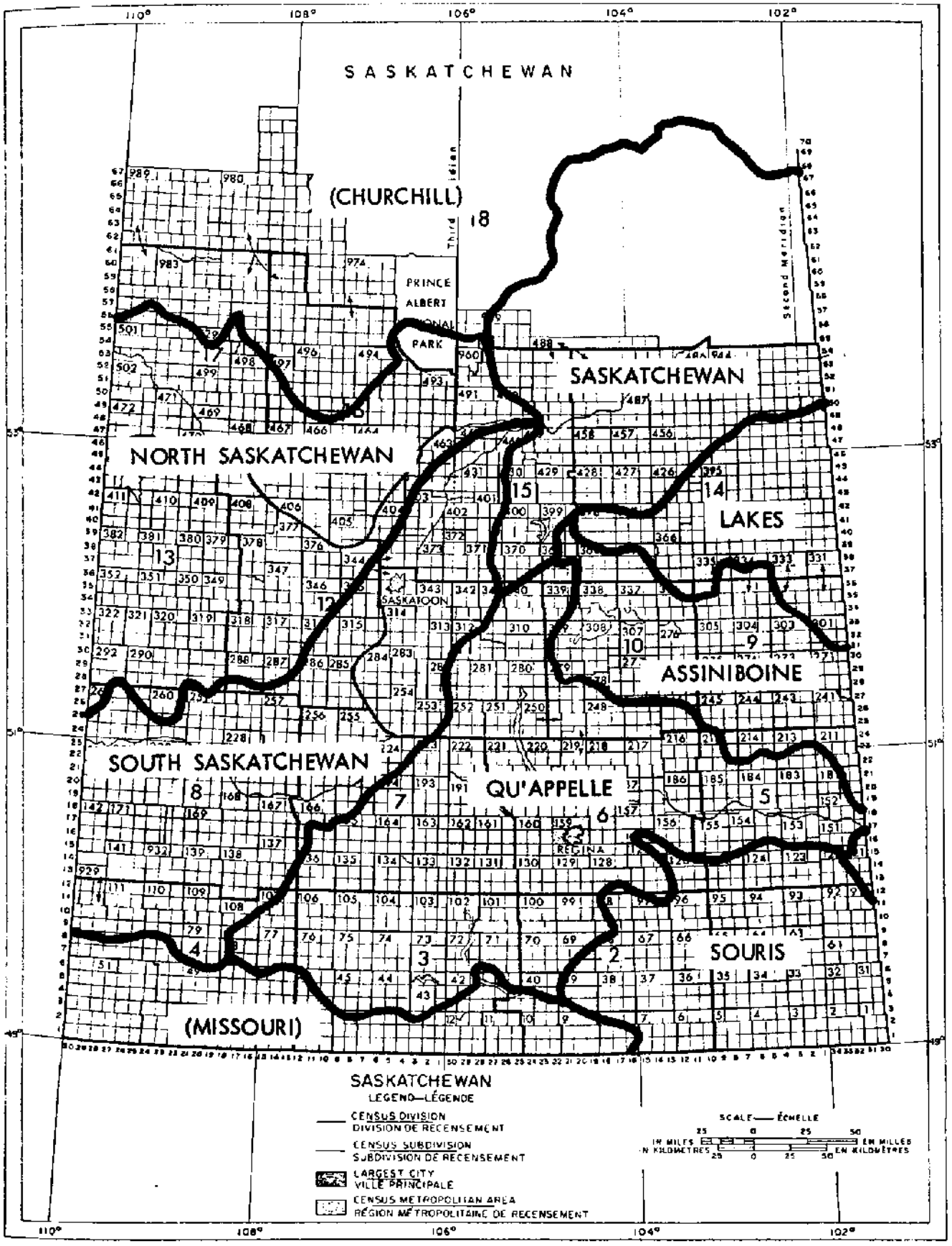
It was noted above that some of the economic analyses, especially those in the regional economic base study, must be conducted on the basis of economic regions. Camu, Weeks and Sametz, in their Economic Geography of Canada, formulated a widely accepted system of economic regions, which are described in Table 2, and are shown on Maps 10 to 12. It is possible using the methodology developed above to allocate the population of an economic region or sub-region among the various river basins. This is done in Table 3, which can be read in the same manner as Table 1. Thus, it will be possible to disaggregate the results of studies based upon economic regions into the appropriate river basin areas.

Using a similar methodology, tables are being developed to allocate industrial production data and agricultural data, all of which are available by census division, into the areal framework of river basins.

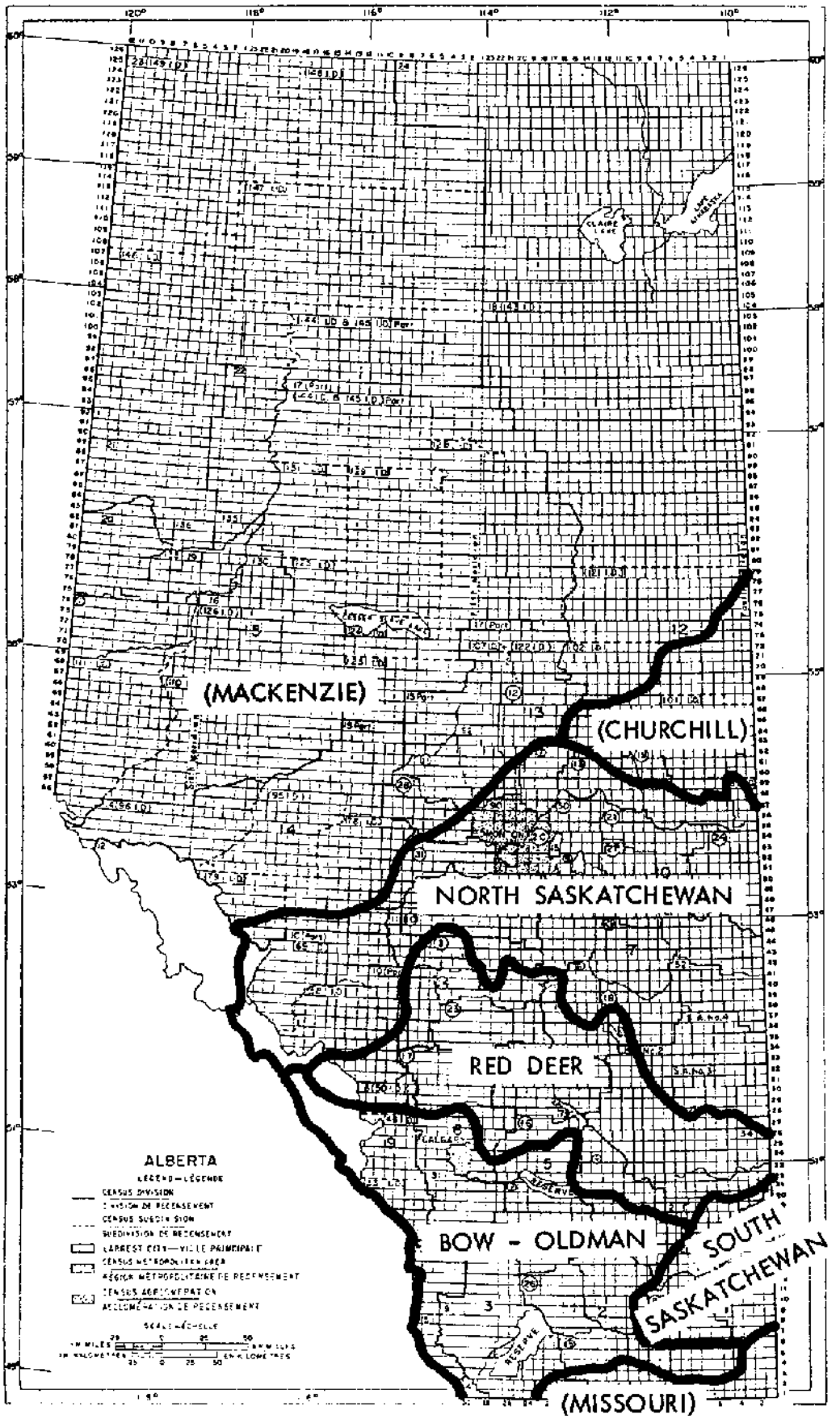
In conclusion, river basins should be used as the primary method for breaking the Saksatchewan-Nelson Basin into sub-regions. The problem of adapting Socio-economic data to the river basin sub-regions can be overcome using the method outlined above, by refering specifically to Tables 2 and 3, and by developing similar tables for industry and agriculture.



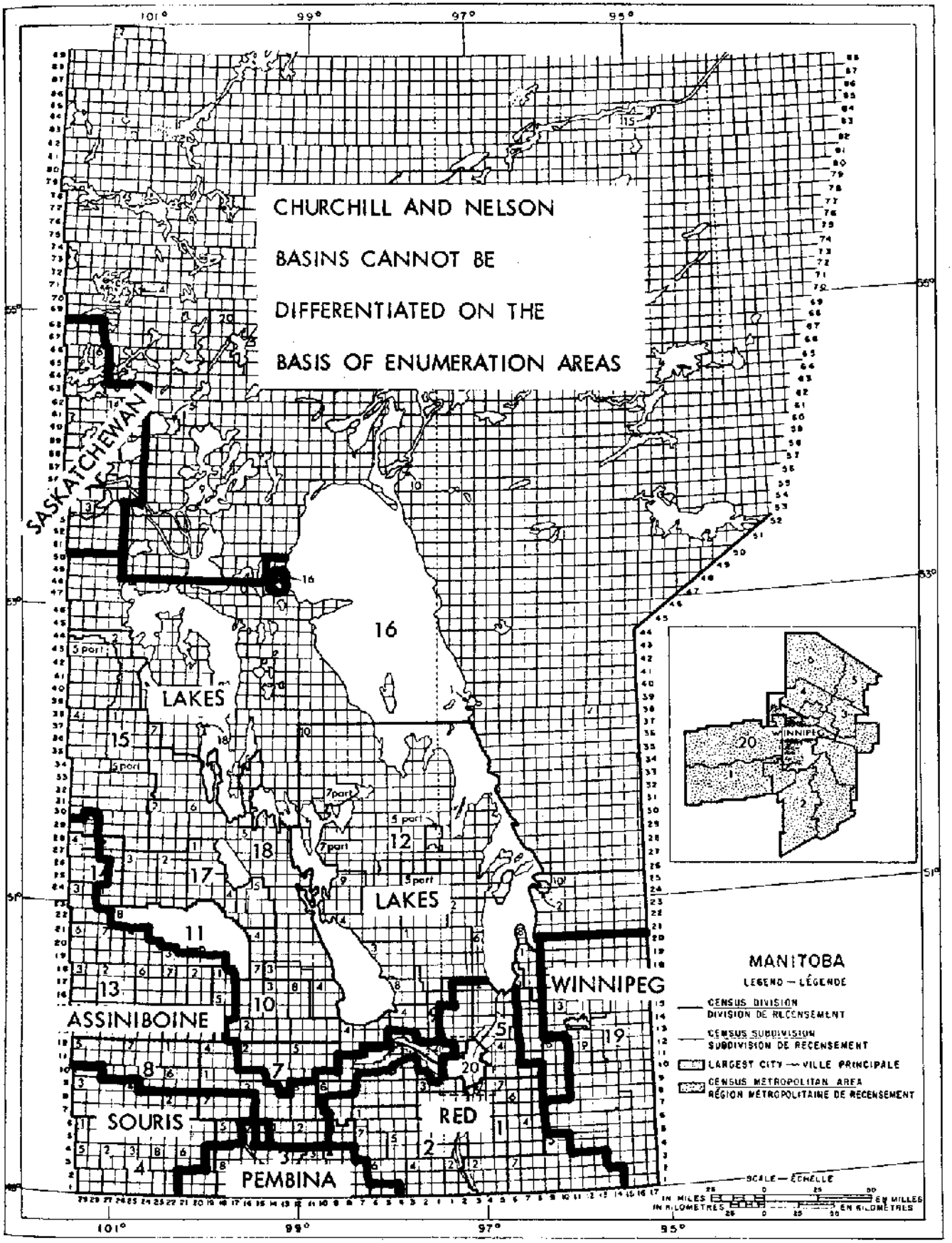
Map 1. Natural Watersheds of Manitoba



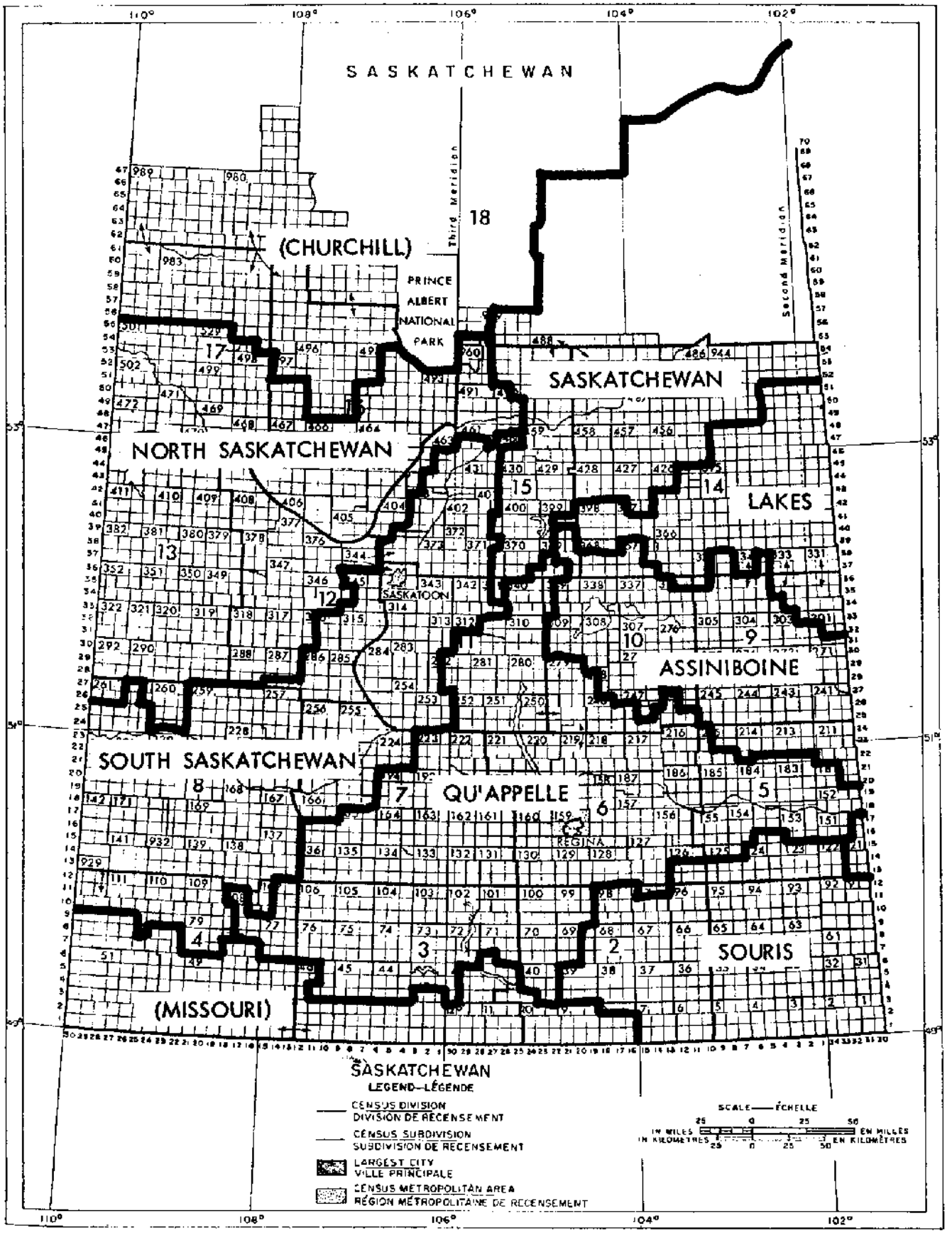
Map 2. Natural Watersheds of Saskatchewan



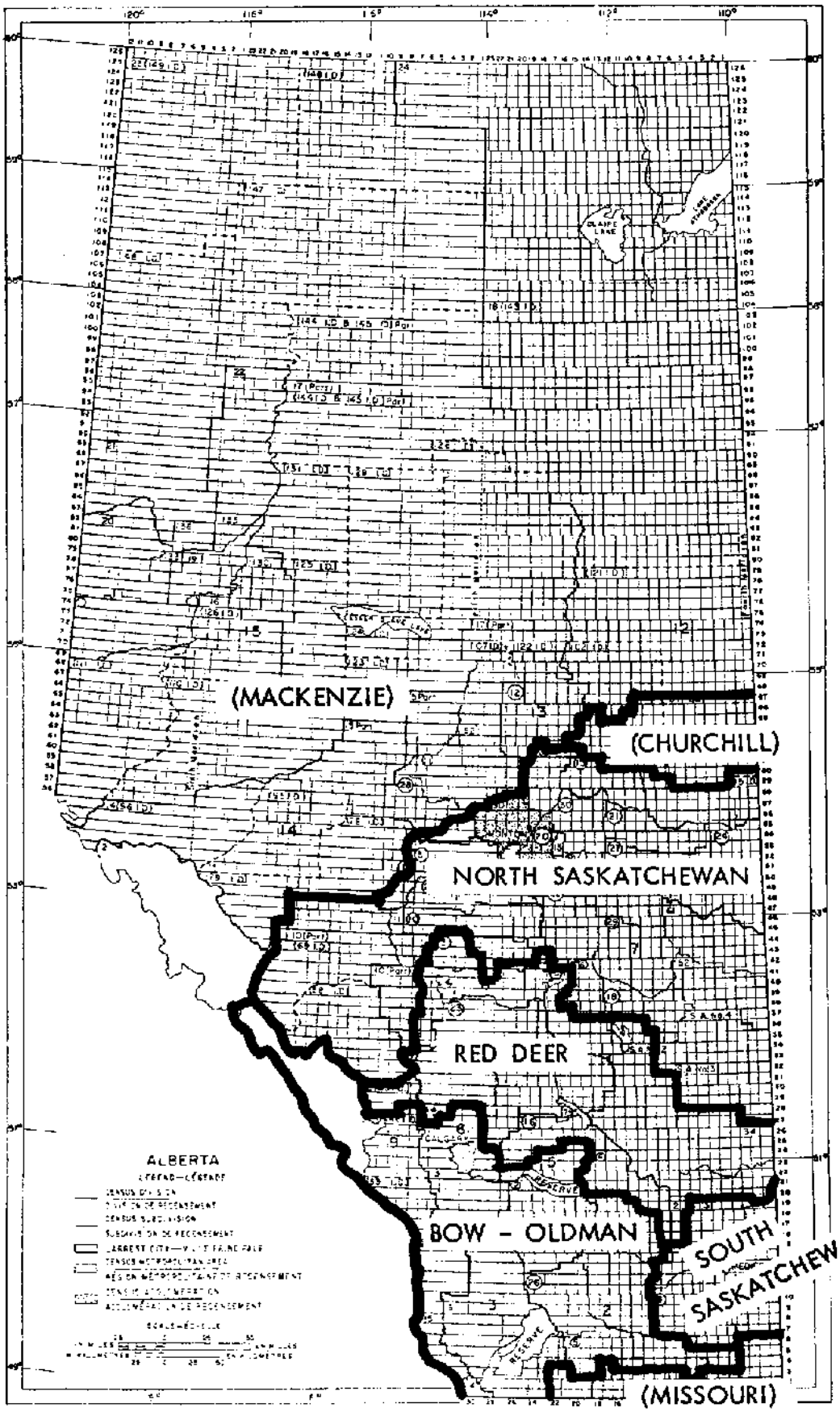
Map 3. Natural Watersheds of Alberta



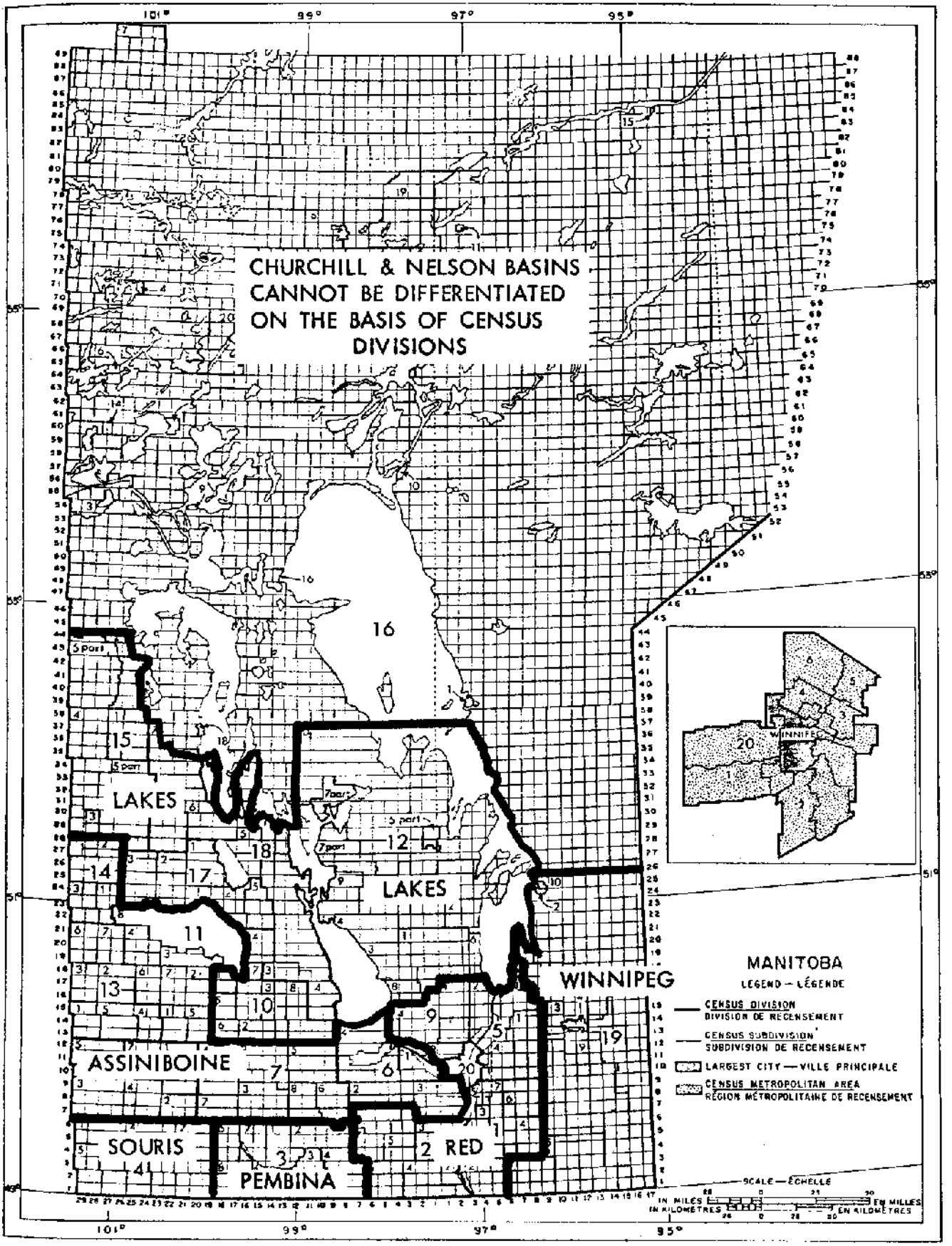
Map 4. Watersheds of Manitoba as approximated by Enumeration Areas



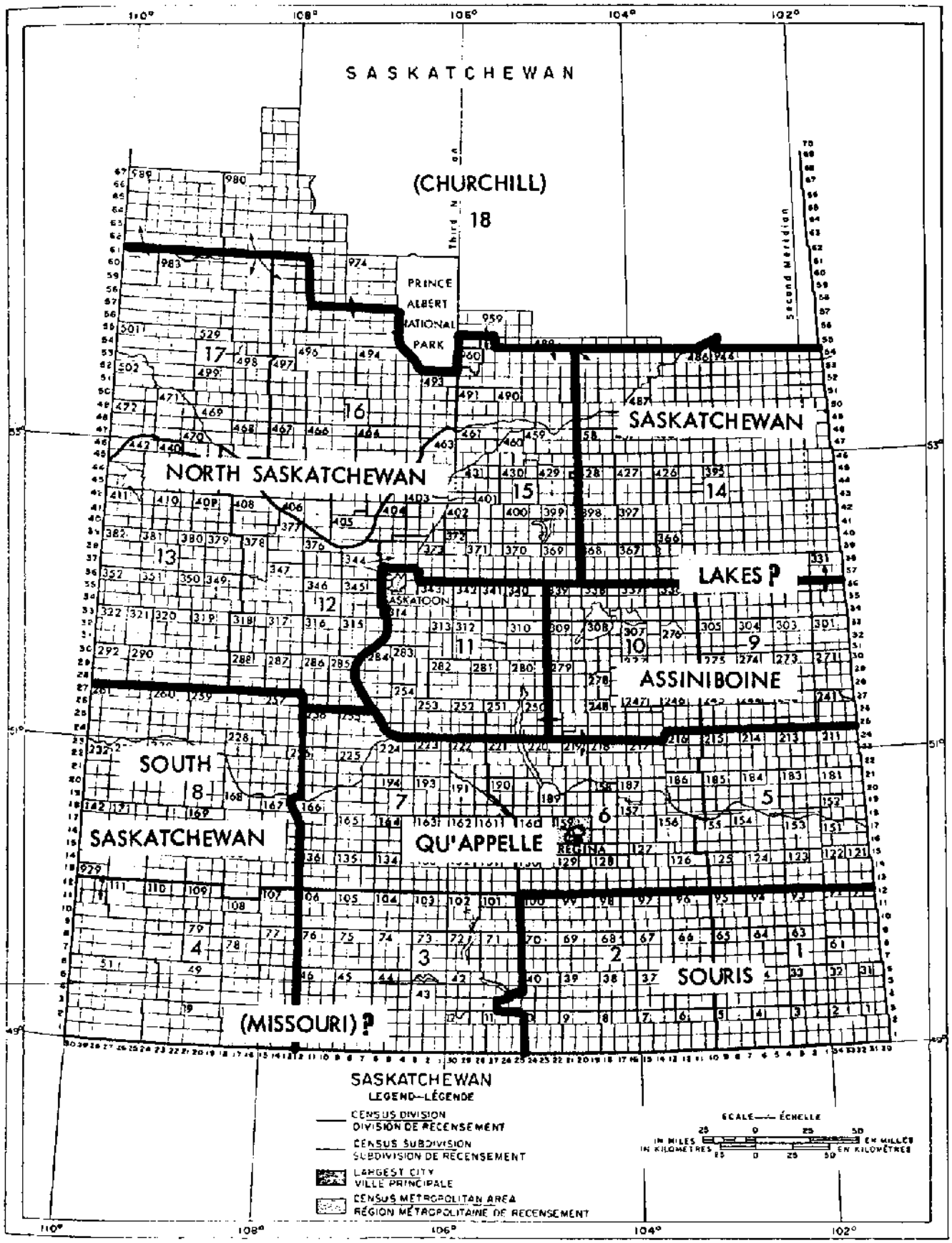
Map 5. Watersheds of Saskatchewan as approximated by Enumeration Areas



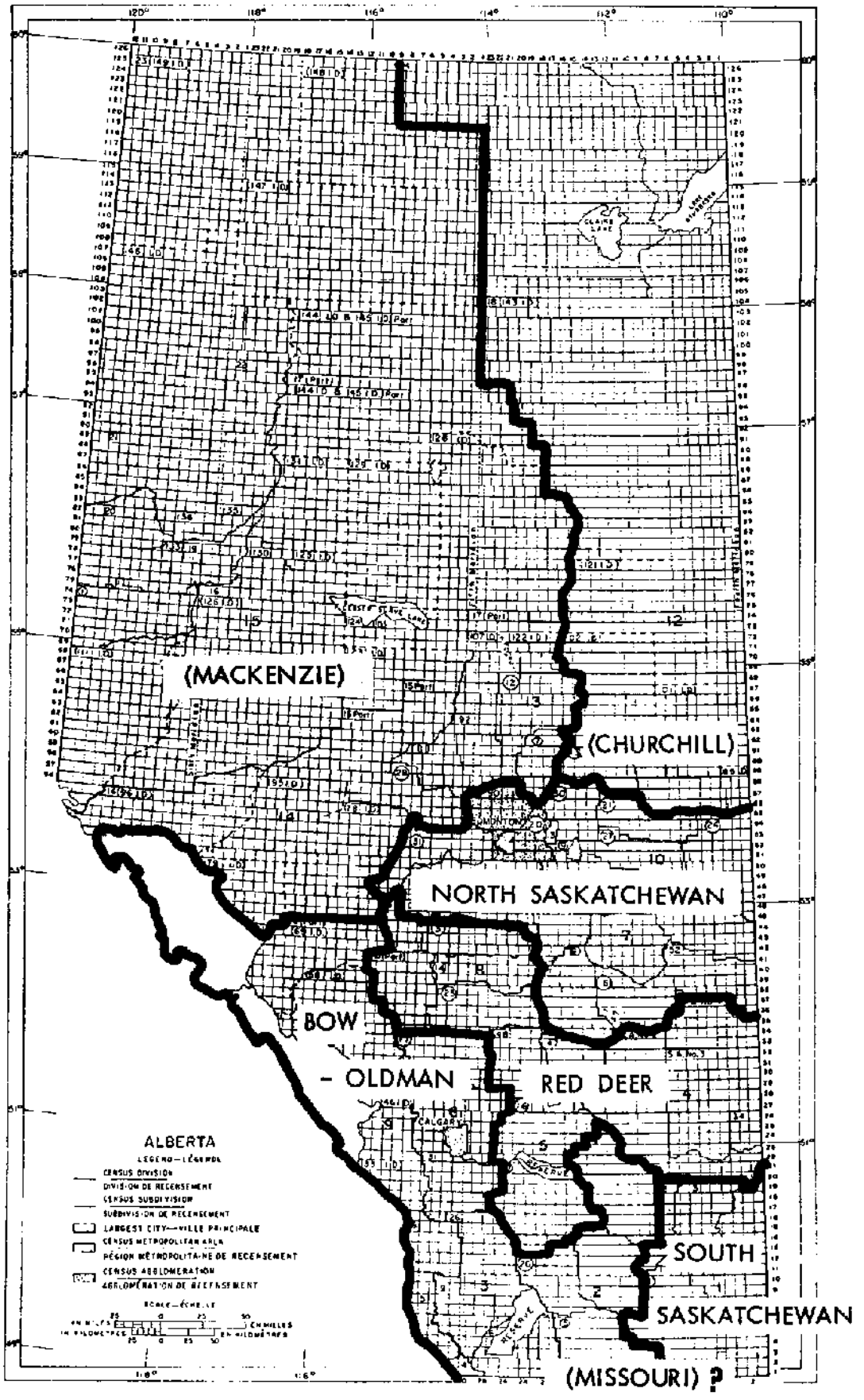
Map 6. Watersheds of Alberta as approximated by Enumeration Areas



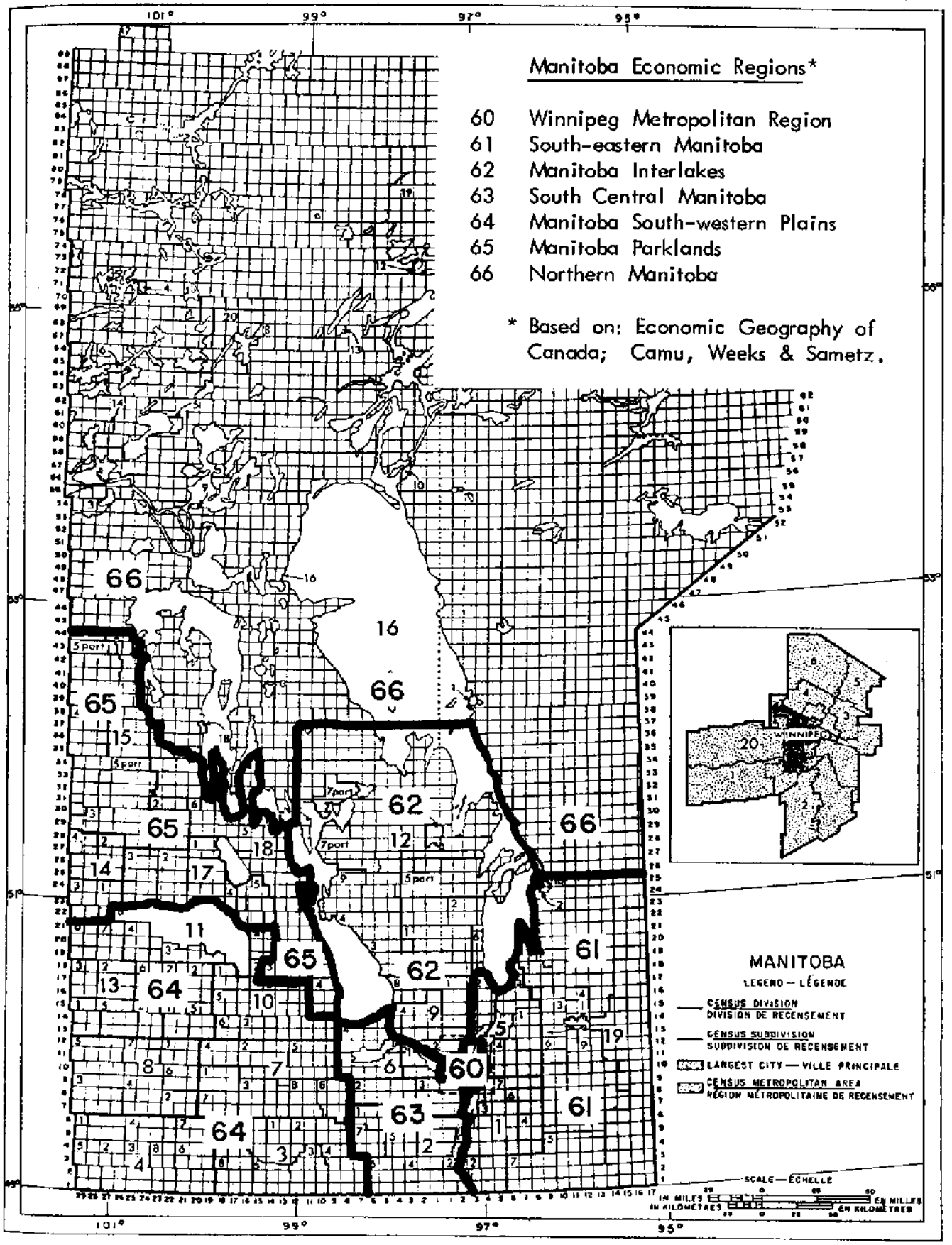
Map 7. Watersheds of Manitoba as approximated by Census Divisions



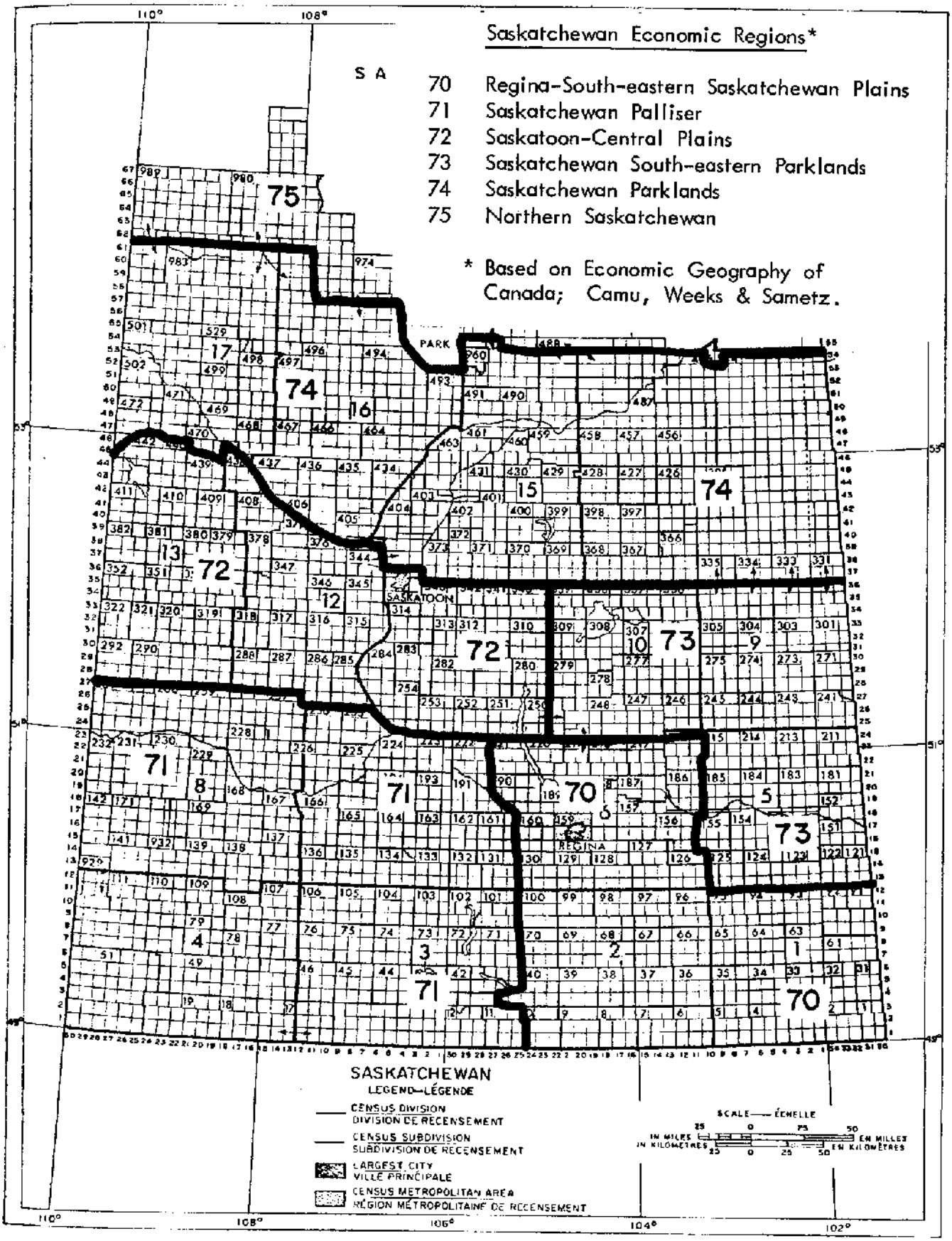
Map 8. Watersheds of Saskatchewan as approximated by Census Divisions



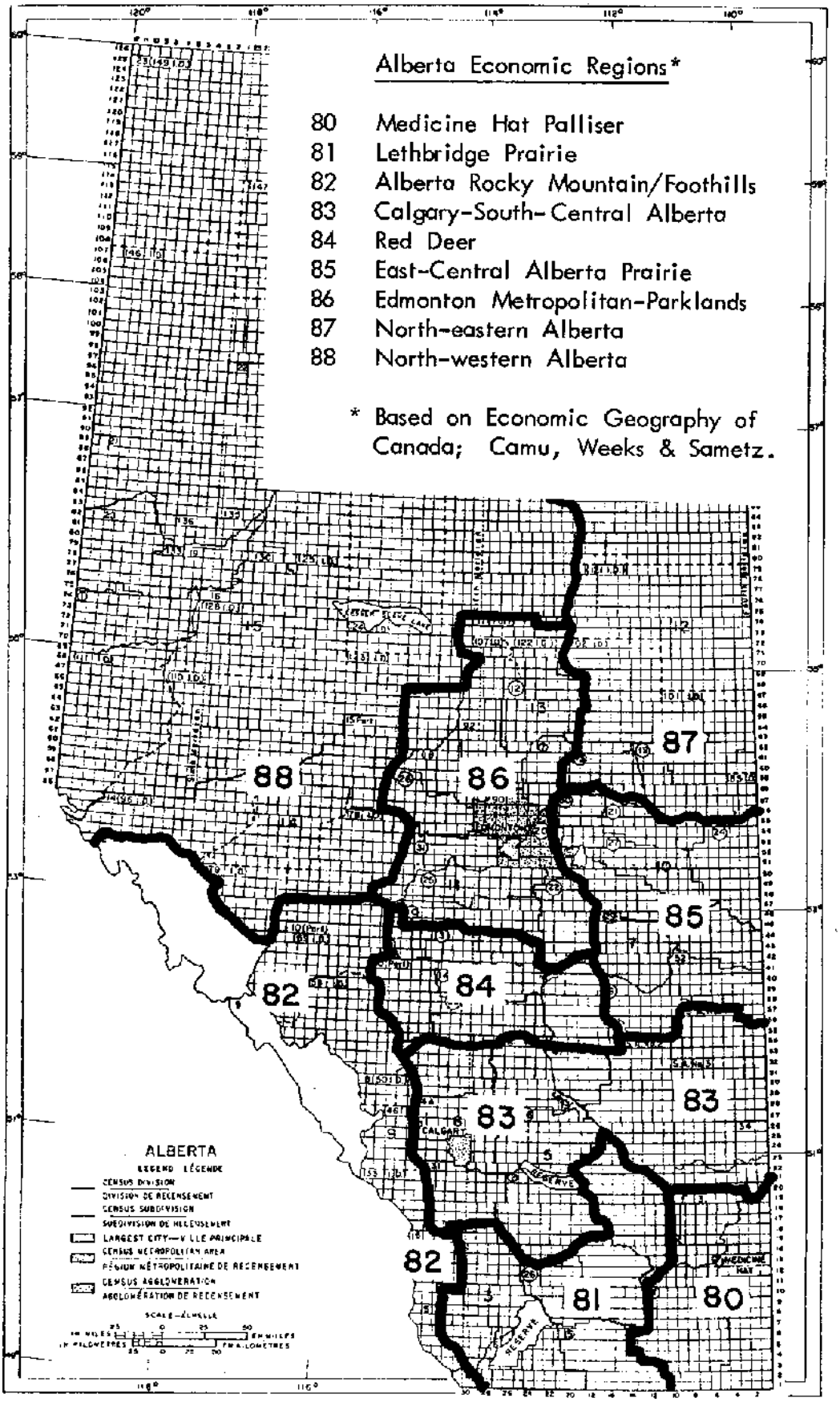
Map 9. Watersheds of Alberta as approximated by Census Divisions



Map 10. Economic Regions of Manitoba



Map II. Economic Regions of Saskatchewan



Map 12. Economic Regions of Alberta

Table 2. Percentage of Census Division, Population in Specified Watersheds.1

Census Division	Red.	Pembina	Assiniboine	Winnipeg	Lakes	Souris	Qu'Appelle	Bow-Oldman	Red Deer	S. Sask.	N. Sask.	Sask.	Nelson-Churchill	(Missouri)	(Mackenzie)
Man.															
1	100.0														
2	98.2	2.0													
3	7.9	69.7	17.6			4.7									
4		28.2				71.8									
5	79.4				20.6										
6	33.7		60.8		5.5										
7	4.1		81.1		12.1	2.6									
8			64.7			35.3									
9	65.4		15.2		19.4										
10			27.3		72.7										
11			99.0		1.0										
12					100.0										
13			100.0												
14			80.6		19.4										
15			5.0		95.0										
16					5.2							32.9	61.9		
17					100.0										
18					100.0										
19	16.7			69.6	5.8								7.9		
20	100.0														

Table 2 (Continued)

Census Division	Red.	Pembina	Assiniboine	Winnipeg	Lakes	Souris	Qu'Appelle	Bow-Oldman	Red Deer	S. Sask.	N. Sask.	Sask.	Nelson-Churchill	(Missouri)	(Mackenzie)
Sask.															
1						100.0									
2						70.8	22.6							6.6	
3							77.9							22.1	
4							25.1			37.7				37.2	
5			37.1			12.3	50.6								
6						.8	99.2								
7							90.4			9.6					
8										95.6	4.4				
9			90.0		10.0										
10			73.1		1.6		25.3								
11							8.4			91.5		.1			
12										24.4	75.6				
13											100.0				
14			5.7		33.0							61.3			
15			1.7		.3		6.5			26.3	46.4	18.8			
16											83.7		16.3		
17											71.3		28.7		
18												22.6	41.7		35.7

Table 2 (Continued)

Census Division	Red.	Assiniboine	Winnipeg	Lakes	Souris	Qu'Appelle	Bow-Oldman	Red Deer	S. Sask.	N. Sask.	Sask.	Nelson-Churchill	(Missouri)	(Mackenzie)
Alta.														
1							2.8	.4	94.5				2.3	
2							91.8	4.4	.6				3.2	
3							98.1						1.9	
4								63.0		37.0				
5							36.8	63.2						
6							95.7	4.3						
7								8.6		91.4				
8								76.7		23.3				
9							73.3	.3		10.9				15.5
10								2.0		98.0				
11										99.8		.2		.2
12										26.8		43.2		30.0
13										10.6				89.4
14										1.1				98.9
15														100.0

[1] Watershed populations determined separately for each Census Division.

Table 3. Percentage of Economic Sub-zone[1] Population in Specified Watersheds[2]

Economic Sub-zone[3]	Red.	Pembina	Assiniboine	Winnipeg	Lakes	Souris	Qu'Appelle	Bow-Oldman	Red Deer	S. Sask.	N. Sask.	Sask.	Nelson-Churchill	(Missouri)	(Mackenzie)
Man.															
600	100.0														
610A	79.4				20.6										
610B	100.0														
612	16.7			69.6	5.8								7.9		
620	65.4		15.2		19.4										
621					100.0										
630	10.0		82.0		8.0										
631A	98.0	2.0													
631B	86.4		13.6												
640A			90.3		6.7	3.0									
640B		80.3	9.9			9.8									
640C		28.2				71.8									
640D			64.7			35.3									
640E			100.0												
640F			99.0		1.0										
640G			91.2		8.8										
647A					100.0										
647B	27.3		29.9		42.8										
648	15.4	59.6	25.0												
650A					100.0										
650B			80.6		19.4										
650C			5.0		95.0										
650D					100.0										
653					100.0										
660													99.6	.4	
661													64.0	36.0	
662														100.0	
663					.4								6.1	93.4	
664					100.0										

Table 3 (Continued)

Economic Sub-zone 3	Red.	Pembina	Assiniboine	Winnipeg	Lakes	Souris	Qu'Appelle	Bow-Oldman	Red Deer	S. Sask.	N. Sask.	Sask.	Nelson-Churchill	(Missouri)	(Mackenzie)
Sask.															
700A							100.0								
700B						3.8	96.2								
701						70.8	22.6								6.6
702A						100.0									
702B						100.0									
710A							98.4			1.6					
710B										100.0					
710C							82.4			17.6					
710D							75.9							24.1	
710E							91.0							9.0	
712A										100.0					
712B										79.2	20.8				
712C							25.1			37.7				37.2	
720A										100.0					
720B							37.1			61.6		1.3			
720C							66.4			33.6					
720D										31.7	68.3				
722											100.0				
723A											100.0				
723B											100.0				
730A			90.0		10.0										
730B			68.9		2.5		28.6								
730C			79.9				20.1								
730D			49.9				50.1								
733			19.9			20.9	51.2								
740A			3.5		11.8							84.7			
740B			10.5		81.1							8.4			
741										11.9	71.8	16.3			
742			4.2		.7		16.4			48.4	7.7	22.6			

Table 3 (Continued)

Economic Sub-zone	Red.	Pembina	Assiniboine	Winnipeg	Lakes	Souris	Qu'Appelle	Bow-Oldman	Red Deer	S. Sask.	N. Sask.	Sask.	Nelson-Churchill	(Missouri)	(Mackenzie)
743A											84.9		15.1		
743B											81.0		19.0		
743C											44.9		55.1		
744											100.0				
750A												38.9	61.1		18.2
750B													67.7		32.6
751												85.4	14.6		
752															100.0
Alta.															
800							2.8		.2	94.7				1.2	
810A							95.1			.6				4.3	
810B							98.1							1.9	
812							66.2	33.8							
820							100.0								
821							99.5	.5							
822								.7			99.3				
823															100.0
830A							100.0								
830B							100.0								
830C							51.2	48.8							
830D								100.0							
831							100.0								
832A							17.7	82.3							
832B								60.6			39.4				
832C								100.0							
840								76.8			23.2				
850								31.4			68.6				
851								.8			99.2				
852											100.0				
853								2.6			97.4				

Table 3 (Continued)

Economic Sub-zone[3]	Red.	Pembina	Assiniboine	Winnipeg	Lakes	Souris	Qu'Appelle	Bow-Oldman	Red Deer	S. Sask.	N. Sask.	Sask.	Nelson–Churchill	(Missouri)	(Mackenzie)
860A											100.0				
860B											98.9				1.1
861											10.6				89.4
870											32.1		51.9		
871															100.0
880											1.1				98.9
881A															100.0
881B															100.0
882															100.0

1. 1961 and 1971 Economic Sub-zones may vary slightly due to boundary changes.
2. Watershed populations determined separately for each Economic Sub-zone.
3. The economic sub-zone numbers refer to the regions as outlined by Canu, Weeks & Sametz in Economic Geography Canada.

APPENDIX 2

DATA SUMMARY: REGIONAL ECONOMIC BASE STUDIES

MAJOR DATA SETS	SOURCES	SIGNIFICANT ADVANCES	WORK REQUIRED
- criteria to define and delimit economic Areas and sub-areas	- maps - "Camu, Weeks and Sametz" - System of 68 Econ. Regions.	- anticipated that this task will be completed, Spring 1976.	- relating economic units to census divisions.
- census divisions and their integration with watershed areas.	Statistics Canada Maps	- task completed. Internal paper by D. Lacelle provides this framework.	
- physical inventory of resources - land forms - resource base - man-made structures (i.e. transport)	- Maps - Census Data - previously prepared descriptions.	- Qu'Appelle Basin Study - Alberta; Red Deer River Basin Study. - Souris Basin Study (underway) - Available Garrison Div. Studies - Boundary Water Report Series.	
- population; by age, education sex, income distribution and density.	Census Publications		
- labour force: labour force participation rates, unemployment rates for major occupational categories. - employment: for all 2 digit sic groups.	Census Publications		- labour force by detailed industry not available for census divisions. Unemployment rates by Province and economic region only.
- 2 digit sic groups and major labour force groups: -data on physical output -value added -salaries and wages.	Census Publications		- physical output - not available. Output/employee ratios may be necessary. - value added available for 2 digit sic groups but D scarce for major labour force groups.
- farm size land use and major products.	Census Publications.		
- geographic distribution of industry - Industrial Mix.	Census Publications	Statistics Canada Publication "Geographical Distribution of Industries".	
- regional economic policies	Provincial Governments DREE PFRA		
- regional economic performance	Statistics Canada DREE Provincial Agencies		
- data on planning constraints, and commodity markets.	Similar to above and marketing boards, industrial associations		
- data on - personnel income - household income levels - off-farm labour			- Note: All data will be collected by Census Division for 1961, 1966 and 1971. Data for 1976 may become available.

DATA SUMMARY: AGRICULTURAL WATER USE

MAJOR DATA SETS	SOURCES	SIGNIFICANT ADVANCES	WORK REQUIRED
- Rural population and farm sizes (acreage)	Economic Base Study		
- Livestock populations	Census Publications		
- Coefficients of water use per capita for rural domestic use and per head for stock-watering	- various		
- Irrigated acreages by census division (sub-basin aggregates) - current and historical.	Census Publications		
- water requirements of crops.	- various		
- water diverted at source, water delivery to farm, return flows and imputed farm losses.	- PFRA and Irrigation District Records.		
- rainfall and potential evapotranspiration for sub-basins.	- climatic maps.		
- product prices for crops produced on irrigated land. Incremental value of producing crops by irrigation methods vis à vis dry-land agric.	- Census Publication; (comparison of farm incomes) - Agriculture Dept. reports - Product Marketing Boards.		- development of trends in irrigation as opposed to dry-land operations.
- Location of principal product markets and their populations (all above current and historical)			
- Capital cost of irrigation Equipment; present investment in developing irrigated acreage.	- Census Publications		
- type of irrigation technology in use for irrigation districts, - any water saving policies or technologies in use.	- PFRA and Irrigation District Reports.		
- system losses or technologies in operations.	- Potential evap.		- difficult to detect, will be estimates.
- location, size, and construction dates of food processing plants.	- various - Provincial Departments.		

DATA SUMMARY: MUNICIPAL AND INDUSTRIAL WATER USE

MAJOR DATA SETS	SOURCES	SIGNIFICANT ADVANCES	WORK REQUIRED
A. MUNICIPAL			
- population of municipalities and past growth rates.	Census Publications	National Inventory Municipal Waterworks and Wastewater Systems.	
- population served by water supply systems.			
- monthly patterns of water use by communities and major user groups. (i.e. gross water use, discharge, gross water use per capita)	Municipal Records, or possibly Statistics Canada		- identification of peak demand periods.
- Number of water connections within user group.	- Surveyed data; (see National Inventory)		
- Methods of pricing; flat rate or metering, metering schedules, and average cost of water per 1000 gallons.	- Municipal Records and Survey data from National Inventory		- Consideration of their effects on water demands.
- Source of water supply	- Census Publications - Survey data from National Inventory.		
- Restrictions on water use for any period within time of study.			- Investigation of constraints in study area.
- quantity of water sold to industry and other communities outside municipality	- National Inventory	Also available from recently completed Industrial Water Use Survey.	
- adequacy of water supply to meet demands.	- National Inventory		- relationships between demands and supplies.
- value of housing stocks	- Census Publications		
- Average household size and related household income data.	- Census Publications		- Modelling components of residential water use.
- Inventory of water using household appliances.	- Census Publications		
- lawn sizes	- Land use, and zoning maps - Municipalities		
- rainfall patterns and potential evapotranspiration (sprinkling requirements)	- Climatic records and municipal records of summer water use.		
- System leakages and inefficiencies	National Inventory (difficult to identify)		- not completely reported in National Inventory. Pricing policies to be identified may also contribute to excessive demands.
- water use coefficients for commercial, institutional and public users.			- development of coefficients from National Inventory data, (and) established coefficients currently in use.

- number of commercial institutions, fire protection provisions.			
- floor area and (or) number of employees for above.			
B. INDUSTRIAL			
- Supply source - public or private		Industrial Water use Survey	
- Economic activity levels and growth rates for 2 digit sic groups for each sub-basin (census division components)	Economic Base Study		
- current water use data	Industrial Water Use Survey		
- number of employees in industry group and (or) plant	Economic Base Study		
- production information (volume of output)			- may be unavailable requiring estimation of output per employee.
- technological trends in gross water use, recirculation and process changes.			- examination of literature. (trends from Industrial Water Use Survey).
- projections of likely effluent standards	Consultation with responsible officials		- investigation of their likely impact on industrial water use (processes, recirculation etc.)
- cost of supplying water (components of costs).			- detailed investigation of plants and records.

DATA SUMMARY: RECREATIONAL WATER USE

MAJOR DATA SETS	SOURCES	SIGNIFICANT ADVANCES	WORK REQUIRED
- total basin (sub-basin) population.	- Census Publications		
- population distributions by age group, sex, income and other socio-economic strata.	- Census Publications		
- participation rates for activities (water-based and complementary). -participation rates for age groups, sex and income groups. -all above: current and historical (if available)	- CORD Study and any other available recreation studies.		- provincial rates only. Need to be adjusted to basin and sub-basin.
- Number of national and provincial parks -attendance or visitation at sites -area of recreation sites -available facilities -use of reservoirs	- Provincial Dept's of Tourism.	Statistics Canada: travel, tourism and outdoor recreation: A Statistical Digest. Alberta Environment term Report 12 "Use of Our Lakes and Lakeshore lands". paper by R. Benfield (Alberta Reservoirs)	
- Accessibility of sites.	- Maps		- travel cost estimates.
- carrying capacity of existing sites - acreage of high class recreation lands.	- C.L.I. Maps		- study of interrelationship between supplies and demands at sites.
- Investment in recreation facilities -purchases of equipment and licences.	- Various Provincial agencies - Statistics Canada Publication referred to above.		
- water quality at sites	- Water quality monitoring reports.		
- enumeration of major wildlife breeding areas -estimates of current stocks.	- C.L.I. information and other sources. - CWS, FMS, and Provincial agencies - Previously completed studies (i.e. Lake Winnipeg, Churchill and Nelson Study)		
- water quality and quantity requirements for fish and wildlife	- investigation of literature - consultation with FMS, CWS and other officials.		

DATA SUMMARY: POWER GENERATION

MAJOR DATA SETS	SOURCES	SIGNIFICANT ADVANCES	WORK REQUIRED
- amounts of electric power production by basin of origin and power grid; current and historical.	- reports from provincial/ regional utilities - Statscan		- power statistics, available for provinces only and specific generating sites. May need disaggregation to basin.
- breakdown of above data by type of production (i.e. hydro and thermal)			- factors contributing to "split" in type of production used. (Avail. of fossil fuels; economic changes which could effect comparature costs, etc.)
- potential hydro generation sites and capabilities.	- Economic Base Study - provincial/regional utilities		
- Capacity, load factor and thermal efficiency of thermal plants.	- Statistics Canada	- Survey of Water Use for Power Generation	- thermal efficiency requires investigation.
- Water use patterns of thermal plants			
- adequacies of water supplies, by region and site if possible.	- economic base study - other water use Studies. - examination of plant requirements (from above)		
- types of cooling systems employed and their costs.	- various reports		- may effect cost of system and total water requirements.
- cooling water temperature use due to thermal discharges	- available water quality reports - various reports.		- investigation of effects on offer uses such as recreation and fish and wildlife. (Multi-purpose use of reservoirs).

APPENDIX 3

Techniques of Analyzing Recreational Water Demands

The scientific study of recreation is still in its infancy. Unlike many of the water uses dealt with in this paper, the methodology for analyzing recreational water uses is not an established one, and consequently several alternatives are available. The purpose of this Appendix is to describe (a) some of the problems involved in analyzing this water use, and (b) a few of the methodologies which could be used in Part 1. The size of the recreational budget (i.e. $92,000) is such that most of these methodologies are possible, either alone or in combination with each other. It is stressed here that the methodologies outlined here have already been developed. In other words, no great deal of "pure" research is required.

A. Water Use in a Recreational Context

Recreational use of water, except in a few instances, such as withdrawals for swimming pools, is an *in situ* or on-site use of the resource. It follows that water must be considered in the context of a total recreational environment, and, for the most part, the quantification of water use for recreation is not as important as in municipal, industrial or agricultural uses. In other words, while the flow of water required to maintain a recreational area at a given level is part of the overall study, it is a relatively minor consideration. It is more important to examine the characteristics of demand for recreational activities, the nature of the supply of water-based recreational opportunities, and the way in which supply and demand are linked. If the recreation sector study done in Part 1 is to be useful, it must consider all three of these things.

The problem faced in this study can be stated rather simply as follows. The water based recreational opportunities of the Saskatchewan-Nelson basin are located at a number of sites throughout the basin. The population generating the demand for recreation is also located, principally in the urban areas, throughout the basin. The problem is to link the population to the different sites - to generate a demand for water-based recreation.

B. The Nature of Recreation Demand

Recreational demand is a complex function of individual tastes and preferences, income level, age, sex, and other variables. The investigation of individual tastes and preferences is not well developed and will be ignored in

this study. The other parameters mentioned above, age, sex and income have been studied with regard to their influence on participation rates for various activities. The Canadian Outdoor Recreation Demand Study (CORDS) has published participation rates for various recreational activities on the basis of these three parameters. These data are published on a provincial basis, and available for 1972. It is suggested that, since the base year for Part 1 is likely to be 1974, these participation rates can be used, thereby saving the cost of an expensive household survey. In fact similar participation rates are available through CORDS for 1967 and 1969, so that the 1972 rates can be adjusted to 1974 on the basis of time trends. Manipulation of the participation rates in conjunction with the population data supplied from the regional economic base study will provide approximations of the number of persons participating in the various recreational activities.

C. The Nature of the Supply of Recreational Opportunities

Recreational supply refers to the characteristics quality and quantity of the various sites where recreation occurs. It includes such variables as site size, the acreage of Class I and II recreational land, length of bathing beaches, water quality, number of showers, number of boat ramps, piers, and boats for rent, numbers of horses for rent, number and length of hiking trails, number of picnic tables, and number of golf courses. It is possible to combine these characteristics into an index of site attractiveness (Cheung, 1972).

D. Interaction of Supply and Demand

The population demanding recreational opportunities and the sites of supply interact over a distance. In general the closer a site is to a population center, the more people will attend that site from that center. The concept of alternative opportunities is important here also. The presence of one or a number of alternative sites between a center and the site under consideration will tend to decrease the attendance at the latter site.

E. Methods of Analysis

As indicated above, the recreation field is highly experimental at present. Thus, a number of methodologies have been suggested to deal with the problem of relating supply, demand and distance. It is suggested that a number of different methods be attempted in Part 1, and that the final report be based upon the best outcomes. The following material outlines several different methods which should be tried.

Site Growth Rates: The simplest method of analysis is the development of growth rates on the basis of time trends in attendance at each individual site. Any work done on future water demands for recreation (i.e. in Part 2) would merely extrapolate these trends to the target year in the future. The advantages of this method are its minimal cost, the relative ease of data handling, and, given the state of the art in recreational analysis, the method's possible accuracy. The disadvantages are several. The method assumes that socio-economic characteristics, the motivating factors in water-based recreation, will remain the same in the future as they are in the past. The mere fact that living standards will probably rise in the future, accompanied by an increase in per capita leisure time, are sufficient to destroy the "constancy" assumption. The method treats each recreation site independently and fails to account explicitly for the interaction between many sites and many population centers. Thus it does not meet one of the principal aims of the recreation study. Thirdly the method fails to analyze any of the factors responsible for recreational participation. Thus, the analyst and the policy-maker are little further ahead when the analysis is complete. Despite these disadvantages, the analytical part of the recreational water use study can start with this method.

Multiple Linear Regression Analysis: This type of analysis attempts to explain the level of a dependent variable, in this case recreation site attendance, by a number of independent variables, such as site attractiveness, alternative sites, population of the service area, etc. Cheung developed a Day Use Park Visitation Model (Journal of Leisure Research, 1972), which gave quite a high level of explanation (i.e. 91% of total variance) using the independent variables population of the service area, the availability of alternative sites, an index of site attractiveness, and distance from the population centers to the site. The advantages of this approach are the relatively straight forward methodology, the availability of most required information, the degree of apparent analysis, and the high explanatory power of the model. The disadvantages are that Cheung seems to have committed some errors in his methodological approach to defining his index of site attractiveness, some errors which are not uncommon amongst most recreational models of this type, and that sites are again considered individually.

A variation of a regression approach would be one which uses as independant variables a set of individual site attributes, such as site acreage, area of beach, number of campsites and other facilities, number of amenities, water quality, and a factor relating population of the service area to distance from site instead of Cheung's site attractiveness index. The advantages here are similar to those outlined above for the Cheung model, except that, instead of developing an index of site attraction, this method would use numbers of different facilities as factors of attraction thereby avoiding Cheung's methodology

problem. The disadvantages are in the treatment of the numbers of facilities and the way in which they are combined. It is assumed, for example, that a site with 14 campsites would have twice the "weight" as a site with 7 campsites. This assumption is very suspect at the present time. In other words, we do not know whether a linear regression framework will fit this problem.

The Development of an Opportunity Quotient: The material outlined so far has made clear that the supply of recreational sites and the demand for recreational opportunity are interrelated. It has proven very difficult indeed to develop measures which effectively combine both factors so that the ratios developed for different places really do reflect differing opportunity levels. Cheung attempted to do this with his index of site attractiveness, but in such a way that his technique is open to question. The second regression model outlined above will attempt to do this also, but again, some of the basic assumptions are questionable.

Ross (1976) has recently suggested the development of an opportunity quotient as an index of recreational opportunity at various points throughout an area. This measure takes into account the interplay of supply and demand factors interacting over distances between the population centers and the sites. This technique is quite complex and will not be outlined in detail here. However, it is a workable technique, and appears to be applicable for the Prairies. The result of Ross' analysis is an index of opportunity for each site in a region; it is then possible to map these indicies to form a surface, much in the same way that a topographic map will depict a physical land surface. The utility of this "opportunity surface" is in its application to identifying areas deficient in recreational opportunities, its use in analyzing the effect of new sites in the area, and in its possible use as an independent variable in explaining site participation. The advantages of the Ross approach lies in its ability to tie supply and demand factors together for all sites and in its solid basis in theory. A possible disadvantage is the technique's limited application to date and some theoretical problems which remain to be resolved. However, it is thought that these problems are relatively minor, and that this approach offers a great deal of promise.

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