Industrial Water Use and Structural Change in Canada and Its Regions: 1966-1976

by

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ABSTRACT

Growth (either positive or negative) in industrial water use can be explained as a process of adjustment to the forces underlying structural change in the economy. Industrial structure, as defined in this thesis, refers to the types of industrial groups represented in a study area. It is measured by a variable such as the proportion of total employment or output in particular categories of industry. Structural change is defined here as the change which occurs in these proportions over time. Four principal factors underlie the process of structural change: variations in supply conditions, variations in demand conditions, productivity changes and technological changes.

The thesis designs and tests empirically a framework with which to analyze industrial water use in the context of structural change. The literature on both structural change and industrial water use suggests that input-output analysis is an effective technique for integrating these two subjects. Accordingly, it is used as the basis of the conceptual framework. Supply and demand forces underlying structural change are viewed as those which determine the level and types of output in an economy, and are combined for measurement purposes into the final demand component of an input-output framework. These two factors

combined are referred to as the "final demand" factor. Productivity and technological conditions are viewed as those which determine how goods and services are produced and are measured by the coefficients of a Leontieff inverse matrix of input-output analysis. The productivity and technological factors, once combined, are referred to as the "production technology" factor. Industrial water use considerations are measured by means of water use coefficients, and are referred to as the "water use coefficient" factor.

The industry-by-industry form of input-output analysis is used throughout the thesis, despite the more common Canadian practice, which is theoretically well-founded, of using the commodity-by- industry form. The industry-by-industry format is adopted because data on industrial water use are available on an industry basis, and are not separable into commodity groupings without introducing questionnable assumptions.

The framework adopted consists of augmenting an input-output model to include a set of water use coefficients. This augmented framework includes three principal components: an input-output inverse matrix, a vector of final demands and a set of water use coefficients. These components are calculated for a series of time periods. By varying each of these three framework components systematically and in sequence, changes in industrial water use due to "pure" changes in final demand, production technology and water use coefficients can be measured.

The empirical portion of the research focusses on compiling, from primary and original sources, data on industrial water use, and from secondary sources, input-output-related data. Patterns of industrial water use are described in detail. The major empirical task, once the data are assembled, is to measure the effects on inter-period industrial water uses of the three structural change components, final demand, production technology and water use coefficients. This was done for Canada as a whole for the time periods 1966 -1972, 1972-1976 and 1966-1976; it was done for the five Canadian economic regions for the time period 1966-1974.

It was found that interperiod changes in industrial water use are a complex adjustment to the three structurally-related factors. The final demand factor is positive and large in its impact on water use. The effect of this factor is partially offset in most cases by the negative effects of the production technology and the water use factor. The water use factor, although often substantial in its impact on changing water use, is somewhat more variable than the other two factors in its direction of influence on industrial water use changes during the study period.

Implications of the research and the findings for both water management and geographical research are discussed in the final chapter.

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NOTATION

Throughout the thesis, upper case letters have been used in the equations to symbolize matrices, lower case letters to symbolize vectors or scalars. (This listing has also been placed in the endpapers of the thesis.)

MATRICES

A = an n * n matrix of direct input coefficients based on an industry-by industry input-output table.

B = a m * n matrix of direct commodity input coefficients based upon a commodity-by-industry input-output table.

D = an n * m matrix of direct industrial input coefficients based upon a a commodity-by-industry input-output table.

F = an abbreviated notation for the Leontieff inverse $(I - A)^{-1}$ used in the industry-by-industry version of input-output analysis.

I = an n * n identity matrix.

M = a matrix of water use coefficients formed with the coefficients comprising the principal diagonal, with all of the off-diagonal elements equal to zero.

U = a matrix of the values of commodity inputs by industry group.

V = a matrix of the values of industrial outputs by commodity group.

VECTORS AND SCALARS

a_{ij} = the value of the direct input requirements for industry i's prod-product per unit of output in industry j.

b_{ij} = the value of the input of commodity i required to produce a unit of output by industry j.

d_{ji} = the jth industry's market share of the production of the ith commodity.

g_j = the value of industry j's commodity outputs.

g = the vector of the values of commodity outputs by industry.

k^{z-t} = a difference vector quantifying the "pure" effects on changes in output of changes in final demand between an initial time period, z, and a final time period, t.

m^{z-t} = a difference vector quantifying the "pure" effects on changes in output of changes in production technology over the period z-t.

n^{z-t} = a difference vector quantifying the changes in total water use over the period z-t.

p^{z-t} = a difference vector denoting changes in total water use for any water use parameter over the period z-t due to "pure" changes in water use coefficients.

q_i = the value of the domestic output of commodity i.

q = the vector of the values of the output of commodities.

r^{z-t} = a difference vector denoting changes in total water use for any water use parameter over the period z-t due to "pure" changes in final demand.

s^{z-t} = a difference vector denoting changes in total water use for any water use parameter over the period z-t due to "pure" changes in production technology.

t = the final year of any time period.

v_{ji} = the value of the jth industry's output of commodity i.

x_i = the value of the ith industry's industial output.

y_i = the sum of final demands for the products of industry i.

y = the vector of the sums of final demands for industrial products.

z = the initial year of any time period.

$z-t$ = the period between year z and year t.

CHAPTER I

PURPOSES AND SCOPE OF THE RESEARCH

One important function of water resources in any economy lies in supporting the economy's industrial base. In water management, considerations of industrial water use are therefore of central importance. For this reason, one aim of research in the water resources field is to expand the knowledge of industrial water use.

The level of industrial water use is a response to a large number of interacting variables. Among the more important of these variables are the level of production by the industry in question, the nature of the technology in use, the product mix, the degree of recirculation, the opportunities for by-product recovery and the cost of water. This list is indicative rather than exhaustive, and a more comprehensive treatment of the variables influencing industrial water use was compiled by Bower (1968, p. 89). Several variables, such as the level of technology, the level of productivity of industrial operations and the factors governing output levels, are associated with industrial structure, and the forces which lead to structural change. Thus, there is an overlap between the variables influencing industrial water use and those governing the nature of structural change.

In view of this commonality of underlying variables, this thesis examines the influences of factors underlying structural change on changes in the levels of industrial water use. Specifically, a framework will be established to quantify these influences. A case study will be conducted to test the analytical effectiveness of the proposed framework. Conclusions will then be drawn as to the quantitative role played by each of the structural change factors in determining changes in industrial water use over time.

1.1 STUDY OUTLINE

The remainder of this chapter discusses the scope of the work and the relevance of the thesis to geography and to water management. Chapter two is concerned with the definition and measurement of industrial structure and structural change. For reasons to be given in this chapter, an input-output analytical framework has been selected for measuring some of the principal factors involved in the changing industrial structure of a nation or region. Thus, Chapter two will include a discussion of input-output analysis. Chapter three discusses the field of industrial water use, focussing upon previous approaches to analyzing this subject. On the basis of these literature reviews, Chapter four develops in detail a framework to analyze industrial water use within the context of structural change.

The empirical part of the research (Chapters five and six) begins with a detailed outline of industrial water use in Canada, based on the results of surveys conducted by the author since 1973. In addition, Chapter five outlines the derivation of water use data for 1966, and presents time series of water use data for the period 1966-1976.

Results of analyzing these data using the framework developed in Chapter four are presented in Chapter six. The conclusions derived from this empirical study and the implications of the findings for water management, geography and future research are outlined in the final chapter

1.2 SCOPE OF THE STUDY

In discussions of water use, a distinction is commonly drawn between withdrawal and nonwithdrawal uses. Withdrawal uses refer to activities, such as the provision of municipal or industrial water supplies, which take water from some ambient water source into a distinct and separate circulation system, use it as required, and return some or all of it to the ambient source. Nonwithdrawal uses employ characteristics of the water resource as it occurs in its natural state. Common examples of the latter type of usage are hydroelectric power generation and water-based recreation. The distinction between the two types of water use is important here, because this research pertains only to the former type of use. Many of the concepts employed here would be inappropriate for a study of nonwithdrawal water usage.

There are two principal types of withdrawal water use, those which are related to the support of the population and those which pertain primarily to the support of industry. The former includes municipal and rural domestic uses; the latter includes water used for manufacturing, mineral extraction, thermal power production and agriculture (livestock support and irrigation). In Canada, the most recently available statistics on water use (Canada, 1983c, p. 34) indicate that about 89% of national water withdrawals is comprised of industrial use as defined here. White (1960, p.414) showed that industrial uses accounted for some 93% of total withdrawals in the U. S. in 1955. In view of the overwhelming importance of the industrial component of national water withdrawals, the present research excludes analysis of municipal and rural domestic uses.

The principal emphasis was placed upon defining suitable measures of changes in industrial structure, and combining these with measures of industrial water use into an analytical framework. Although the factors behind structural change were discussed in some detail, the thesis was not aimed at an extensive discussion of the processes generating shifts in a region's industrial structure. Rather it examined the implications of such shifts for the use of water resources by industry. The framework established was used to analyze the changes in industrial water use for selected areas and time periods. The use of an input-output accounting framework implicitly reflects the industrial structure of the area in question. Changes in the input-output description of an economy over time provide a measure of structural change. The incorporation of water use considerations into the input-output framework permits analysis of the effects of structural change on industrial water use. It is clear that the case study results (Chapter six) are indicative of conditions occurring over the period of study. However, the analytical process developed is a general one, which can be applied to any area, given the availability of suitable data.

The empirical portion of this research was undertaken at a broad level of spatial and industrial aggregation. Spatially, the study deals with Canada and its five economic regions: Atlantic Region, Quebec Region, Ontario Region, Prairie Region and British Columbia Region. These five economic regions represent one common way in which Canada has been regionalized for politico-economic and administrative descriptions. This regional scheme was also the spatial basis of Canada's first regional input-output table, which was used in this thesis. The country's two northern territories were omitted from consideration because neither industrial water use nor input-output data were available for these areas.

Industrially, the database used was compiled at the broad 2-digit Standard Industrial Classification level used by Statistics Canada. An outline of the industrial groups used will be given in Chapter five. The spatial and industrial orientation of the work was chosen for two reasons: an interest in the factors underlying industrial water use at the broad national and regional levels, and the availability of suitable input-output tables. The spatial scale selected meant that structural changes and water use at individual plants or in less extensive areas were not examined. Thus observations about specific structural changes as they affect water use were not possible.

The time period covered was from 1966 to 1976. Although primary Canadian industrial water use data were available for the years 1972 and 1976 only, a longer time period was required in order to conduct a proper study of structural changes as they affect this resource use. As mentioned in the previous paragraph, Canada's first regional input-output table was compiled for 1966, making it the clear choice for the beginning year of the analysis. The method for overcoming the water use data deficiencies for 1966 are outlined in Chapter five.

Several related areas of water management research were not examined in this thesis. Economic aspects of industrial water use, although mentioned in Chapter three, were not dealt with substantively. No consideration was given to water supply conditions, nor was any attempt made to address the issues involved in water use:supply imbalances. The complex area of industrial water quality and water pollution were also excluded. Each of these related areas present opportunities for future research.

1.3 GEOGRAPHICAL AND WATER MANAGEMENT RELEVANCE OF THE RESEARCH

The use of water is one of the most fundamental transactions between man and nature. In the case of the establishment and growth of most significant industrial areas, the availability of adequate water supplies is a fundamental, though not determining, consideration. That the study of resource quality and availability is an appropriate area for geographical research there can be little doubt. For many years, geographers have been involved in resource inventory and analysis. The case for geographical study of resource issues has perhaps been most fully developed in the area of land use, where many of the measurement, mapping and analytical methods have been due to the efforts of geographers (Mitchell, 1979, pp. 57-67).

An equally strong case can be made for geographical analyses of water use. Geographers have been active in this field, and have made substantial contributions to it. Sewell (Canada, 1968) was a principal collaborator in a federal government colloqium and subsequent publication concerning methodologies for forecasting water demands. Both Lee (1969) and Grima (1972) made significant contributions to the theoretical understanding of residential water use in developing and developed countries. Mitchell and Leighton (1977) conducted a study to compare methodologies of water use forecasting in new residential communities. Robinson (1979) conducted, and is still actively engaged in conducting, research to promote water conservation in the Regional Municipality of Waterloo, Ontario; a large portion of this research is aimed at understanding the nature of municipal water use. In the area of data collection, the author and his colleagues at Environment Canada (Canada, 1977a, 1983b; Tate and Lacelle, 1978) have established a continuing program of data collection and analysis on both industrial and municipal water use.

Therefore, this thesis is seen, not just as an isolated study, but rather as part of a developing area of geographical research. An effort has been made in the thesis to advance the understanding and analysis of industrial water use. As Mitchell (1979, p. 79) pointed out, the compilation of resource inventories and knowledge of current and future resource use are central to the task of water management, and are tasks which are well within the scope of geography as a discipline.

In the context of Canadian water management, the thesis also has significant relevance. With nationally abundant water supplies, Canada's answer to water problems has traditionally been one of supply manipulation and physical works. The large engineering feats, such as the St. Lawrence Seaway, the James Bay development, the Columbia River project, and many others, are examples of the supply management approach which Canadians have often taken to water resource issues (Tate, 1982, p. 155). No attempt is made here to laud or condemn this supply-oriented approach, but it must be pointed out that this approach has been taken in clear disregard for the alternatives suggested by demand management, which is concerned with influencing water demands so as to curtail the need for large scale (public) capital works. Relatively few efforts have been made to understand the nature of water use and the factors which influence it. The current research project is aimed, therefore, at examining one aspect of industrial water use, namely its interaction with the factors of structural change.

CHAPTER II

THE DEFINITION AND MEASUREMENT OF INDUSTRIAL STRUCTURE AND STRUCTURAL CHANGE

Industrial structure refers to the composition of the industrial base of a nation, region, or urban area. O'Connor's (1974, pp. 113-114) definition of industrial structure is suitable for use in this thesis, namely that industrial structure refers to "... the types of industrial groups represented in a study area, measured by a variable such as (the) proportion of total employment in particular categories of industry." Structural change is simply the change which occurs in these proportions over time.

This chapter is concerned with examining the concept of structural change as it is used in this thesis. The major factors underlying structural change are dealt with in the first section of the chapter. Four major groups of factors are dealt with in this section: supply conditions, demand conditions, conditions which give rise to productivity changes, and those which generate technological changes. The second section of this chapter reviews briefly some of the past eff''rts which have been used to measure and analyze industrial structure, placing emphasis upon the possibility of incorporating into each measure considerations of resource use. To anticipate somewhat the outcome of this discussion, input-output analysis has been found to be the most appropriate method of combining resource use considerations with structural change analysis. The third section of the chapter is devoted to an explanation of this finding and to an overview of the input-output technique.

2.1 FACTORS UNDERLYING STRUCTURAL CHANGE

The development of a nation or region over the long run can be fundamentally described in terms of its shifting economic structure. Works by Perloff et al. (1960), for the U. S. economy, and by Kuznets (1966), for the developed nations are but two of the major works in the past to document economic history in terms of structural change. Although structural change can be quantified quite readily in aggregate terms, as indicated at the beginning of this chapter, explanation of the processes underlying shifts in industrial structure are complex, and have been the subject of considerable research in economics, geography and other disciplines.

This thesis uses the concept of structural change to examine shifts in the pattern of Canadian industrial water use. The relatively brief comments made here, although important for development of the thesis, constitute by no means a comprehensive review of the structural change literature, and draw no conclusions as to the processes underlying structural shifts in an economy's industrial base.

For present purposes, the factors underlying structural change have been discussed under four major groupings, namely: supply forces, demand forces, productivity changes and technological changes. The classification of forces is by no means the only one possible, but is one which will be useful in developing the framework for the current research. Although this classification of forces was useful, it is still somewhat artificial in view of the many interactions between factors. Several examples of these interactions can be given. Supply and demand forces combine and interact to determine the price of goods and services. Prices, of course, are crucial in determing the nature and structure of an industrial base. Shifts in technology may be generated by of may generate changes in productivity or changes in the structure of demand. Shifts in demand due to autonomous price changes, like those occuring as a result of energy shortages may generate conditions favourable to technological change. Several examples of these energy-related technological changes have been described by Howe (1979). The focus of this section is descriptive, rather than definitive and explanatory in its treatment of the four factor groups which underlie structural change.

2.1.1 Supply Factors

For present purposes, supply factors are considered to be those related to the supply of inputs to industrial processes. Economists have traditionally classified these resource inputs as land, labour and capital. The "land" factor relates not just to the land mass occupied by a nation or region, but also to the natural resources contained therein, as well as to the physical capital which has been created. Labour as a productive factor refers to the availability and charactistics of an area's labour force, while capital is used to generalize the availability of financial resources and infrastructure.

Structural change usually involves decreasing production costs, the generation of new products, the use of new processes or the discovery of new ways of using raw materials. Increasing the supply of any productive input will tend to decrease production costs. Supply increases may emanate from a variety of sources, such as the discovery of new raw material sources or of new methods of using previously unused materials. As suggested by Zimmermann, (1953), the concept of natural resources is fundamentally functional in nature, meaning that the "neutral stuff" of nature is not a resource until a function is found for it to satisfy human wants or needs. In general, any conversion of "neutral stuff" into resources is by definition an increase in resource supplies and thus may create conditions for structural change. In economic terms, increases in resource supplies will tend to shift the supply curve downward to the right, thereby tending to lower the cost of the material in question, and thus lower raw material supply costs.

Water has considerable importance as an industrial raw material, and some evidence exists that its availability can influence an area's industrial structure. The significant industrialized areas of Canada, for instance, are all located close to abundant water supplies. The Great Lakes-St. Lawrence and the Lower Fraser River basins are examples of this locational phenomenon. It is not suggested here that water supplies condition absolutely industrial location, for that would be over-simpliying the factors and calculus of industrial location. However, the location of heavily industrialized areas in water-abundant locations demonstrates that water supply has been an influence on industrial location decisions.

2.1.2 Demand Factors

In considering questions of demand influences on structural change, the concept of income elasticity of demand is a key one. Income elasticity of demand is a concept devised to measure the degree of responsiveness of the quantity of a good or service demanded to changes in income levels. In a situation of rising income levels, the demand for a good or service is said to be inelastic if the increase in quantity demanded is less than proportional to the rise in income levels. It is said to be elastic if the rise in the quantity demanded is more than proportional to the rise in income levels. The implication of an income inelastic demand is that, as incomes rise, proportionately less is spent on the good or service in question, leaving proportionately more money available to spend on other goods and services.

Income elasticity of demand is significant in the sector theory of growth (Fisher, 1933 and Clark, 1940), which attempts to explain the apparent shifts from a significant concentration on agriculture to manufacturing and tertiary industries as a country develops. The demand for agricultural products tended to be income inelastic, and, as incomes grew, proportionately less was spent on such products, leaving a residual amount available to generate a demand for manufactured goods and tertiary services. As real incomes became progressively larger, this residual grew, raising demand for the goods and services provided by manufacturing and tertiary sectors. Thomas (1969, pp. 44-45; 1974, p. 41) showed that income elasticity of demand was a significant factor leading to structural change, by raising the demand for secondary and tertiary goods and services, and by creating the demand for new products.

In addition to income elasticity, other demand-related factors are also important in considering the sources of structural change. Clearly, changes in the size, quality and location of the population will change the character of demand. The sheer volume of a nation's or region's population will tend to increase demand, as well as leading to demands for new products. Changes in the quality of a population (e.g. higher average educational attainment) will lead to a shift in demand functions, will generate new product demand, and thus induce structural change.

Demand and supply factors, as noted above, are closely interlinked. Readily available resources, for example, will tend to give rise to relatively low production costs, as compared to other producing areas less well endowed. These lower costs will, assuming the existence of reasonably "pure" competition (i.e. a market situation in which no person or firm has any individual influence on market price), give rise to lower prices, which, in turn, will lead to increased demand for the product.

2.1.3 <u>Productivity Changes</u>

Productivity is measured by a ratio of output per unit of input; for example, output per man-hour measures labour productivity. While labour productivity is perhaps the most well known measure of productivity, other measures are possible. For example, in this thesis, productivity is measured by the value of output per unit value of input to the industrial components of Canada's economy. Improved productivity in the agricultural sector was used in the sector theory of growth, referred to earlier, to complement the effect of income elasticity of demand. Productivity improvements can result from a variety of measures, such as mechanization, improved education, and computerization. The general effect of improved productivity is to lower production costs, leading to increased output and/or structural change.

Productivity increases have also been suggested to play a key role in the "unbalanced" growth theories of Perroux (1955), Hirschman (1958) and Boudeville (1966). These theories of industrial growth and structural change are based upon a lead industry or "growth pole", which gains an initial advantage in a region. The dynamic growth of this lead industry induces growth in related industries through such mechanisms as interindustry linkages, accelerators and multipliers. Thompson (1968, pp. 12-15) described this process of induced growth for a hypothetical urban region. Through the mechanism of input and output linkages, the lead industry attracted both its input suppliers and the users of its products and by-products. As the region grew, more and more services were attracted to it, and a greater proportion of income was retained within the region. Multipliers, which arose through the effect of the respending of earned incomes, reinforce the retention of funds within the region. If the growth process continues unimpeded, not only does the volume of regional economic activity increase, but also the region's industrial structure becomes increasingly diversified.

There are other avenues by which cost reductions can be achieved through productivity improvements. One is through the attainment of economies of scale. As production increases, the opportunities for scale economies are numerous, for example, better and/or more intensive use of machinery, specialization of the work force and bulk ordering of raw materials. A related path of cost reduction is spatial in nature, the so-called spatial economies of scale, such as localization economies, urbanization economies and agglomeration economies. These have been described by Isard (1960, pp. 404-409) and underlie the industrial complex analysis technique of regional science (Isard and Schooler, 1959). Another avenue of cost reduction is technological change.

2.1.4 Technological Change

A major force leading to economic growth and development over the long term is technological change. According to Schmookler (1966, p.2), technology is

> ... the social pool of industrial arts.... The rate at which new technology is produced in any period is the rate of technological progress... When an enterprise produces a new good or service or uses a method or input which is new to it, it makes a technological change...

While Perroux (in McKee et al., 1970, pp. 93-103) and other growth pole theorists alluded to the role of technological change, their analyses focussed on factors which affected growth principally in the short run. Their concern with a single, short term cycle, or "round", of growth and its economic effects did not include factors which give rise to long-term change. Thus, they concentrated on factors such as cost reduction, elasticities, and others which can be conceived of as acting over the short term.

In contrast, technological advance is an important factor in the explanation of long-term economic and structural changes, and has two general effects: increased efficiency and new products. The former generates cost reductions and/or increased productivity. New products engender an increased demand and fresh demands for new products. When combined, the effects of decreased cost and new demands generate growth and structural change.

Schultz (1977, p. 31) stressed indirectly the seminal role of technological change in societal living standards. After pointing out the role of market-like arrangements in stimulating technological change, he stated that:

> Living standards in modern Western societies are, by an order of magnitude, superior to those of the early seventeenth century. Had the triumph of the market meant only a more efficient use of the technologies and resources then available, the gains in living standards would have been miniscule by comparison. What made the difference was the stimulation and harnessing of new technologies and resources.

Technological change has effects on the other three factors underlying shifts in industrial structure. As shown earlier, the previously "neutral stuff" of nature can be transformed into productive resources. Demand patterns can be shifted substantially through the invention of new or improved products. Technological advances can also lead to productivity changes, thereby lowering production costs and leading to structural changes. Different types of technological changes have been described. Some are imposed from outside the industry in question, and are termed exogenous. Such exogenous changes have been felt in the transportation sector, with the long-run shift to smaller automobiles, the demand for which increased substantially as a result of the energy "crises" of the 1970's. Other technological changes can generated from within the industry itself, and are termed endogenous. The endogenous changes are most often the product of industrial research and development efforts.

There is no doubt that technological changes from whatever source can affect industrial water use. In-plant water use patterns have frequently been caused by endogenous shifts in technology. A notable example occured with the conversion to use of the basic oxygen furnace from the open hearth method in steelmaking. Changes of this type ultimately have an effect upon water use (Bower, 1966, 1968), as shown in a study of the Canadian integrated iron and steel industry (Canada, 1971). Similarly, exogenously created shifts in technology, such as decreasing automobile size may affect water use, in this case tending to lower it for a constant level of demand. This thesis examines the results of technological change on water use, not at the causes of that change, and thus makes no attempt to assess the relative importance of the two types of shift.

The process of technological innovation is a continuous one, normally achieved through the adoption of small improvements to production processes, and occasionally through major innovations, such as the current advances occurring in microcomputer technology. The adoption of new technologies has time lags or inertia built into it.

When industrial operations are new, they presumably incorporate the latest advances in technology. Once established, they represent significant investments, which cannot easily or inexpensively be altered, because of amortization and write-off considerations, and also because of interruptions to production. Thus technological change tends to be "step-wise" rather than continuous in nature.

This problem of inertia is a significant one in considering industrial water systems, and aspects such as water recycling and pollution control. It is clear that water system considerations are relatively minor ones in overall plant design. In addition, water system investments, while fundamental to plant operations, are essentially non-productive ones, except possibly for the issue of by-product recovery. Also, water costs are insignificant ones with respect to corporate decision-making and in the total cost of raw material acquisition in most plants. For these reasons, water and other environmental considerations are unlikely to be candidates for efforts to maintain the state-of-the-art in production processes. In other words, substantial inertia exists in altering plant water systems. The implication here is that industrial water systems change only very slowly, and that analysis of issues such as the adoption of water recycling is a long-term undertaking.

2.1.5 Summary of the Factors Leading to Structural Change

To summarize this section, four sets of factors have been put forth in previous research studies to explain structural change. These factors, although discussed separately, are interrelated to some degree. Attention is drawn here to the fact that demand and supply factors interact to establish an equilibrium level of production, and to establish what types of products are produced. On the other hand, productivity change- and technological change-inducing factors interact to determine how goods and services are produced. More will be said later in the chapter about the usefullness of combining the four factors into those which govern the quantity and type of production and those which govern primarily how goods and services are produced. Before doing this, however, it will be useful to examine possible approaches to the measurement of structural change.

2.2 SYSTEMS OF MEASURING STRUCTURAL CHANGE

This section outlines some of the systems which have been developed to measure industrial structure and structural change. The outline is not intended to be exhaustive, but is intended to show some of the research strategies used by geographers and others to examine the structural change dimension of economic growth. The purpose of this review is to examine the degree to which existing techniques of structural change analysis can be augmented to include, simultaneously, considerations of resources utilization.

Economic base studies arose from the effort to determine which were the important variables underlying the processes of national or regional economic growth. The economic base approach drew a distinction between basic and nonbasic economic activities in an economic system under study. Employment was commonly the parameter used in economic base studies, although output and other measures have also been used. Basic activities were considered to be those which produced goods and services for extra-regional markets. Nonbasic, or service, activities consisted of those which served markets internal to the region. Basic activities, according to the economic base hypothesis, are important for regional growth because they attract money and capital flows into the region.

One measurement method commonly used at the regional level was to develop, from data on the nation as a whole, a proportion of total employment which could be "expected" in a region, assuming that the region mirrored exactly the nation's production pattern. Multiplying this set of proportions by the total regional employment gave a set of expected employment levels in the region. Regional employment in each industry in excess of the expected level was considered to be basic employment. The remainder (i.e. that up to the expected level) was considered to be nonbasic employment, or that employment which served intraregional markets.

Alexander (1954, pp. 87-100) reviewed and criticized the economic base approach to structural analysis. It is not intended here to review these criticisms. Rather, the point is to look at the technique as a possible method for structural change analysis, and at the potential for augmenting it to include resource use considerations. Clearly, changes in structure could be measured by observing interperiod changes in the amounts of basic employment in each industrial group. However, while this process might indicate overall changes in industrial structure, the technique is one-dimensional in that only one parameter at a time can be analyzed. In other words, it is not possible to integrate other conditions, such as resource utilization into the calculations. Thus, the technique is unsuitable for the analysis of resource use in conjunction with measuring structural change. Even if water use were to replace employment as the parameter used for measurement, it seems clear that the division of water use into basic and non-basic components would be futile and meaningless. The point should also be made here that the analysis of resource use in conjunction with calculation of basic activity was not an intended application of the economic base technique.

The same type of criticisms can be levelled at a number of other methods for examining industrial structure. Harris' (1943) functional method for classifying cities, Nelson's (1955) service classification, Boivert's (1978) functional method for examining regional structure, and Lloyd's (1979) components of industrial change methodology are all one dimensional in the variables considered and offer little hope for augmentation to consider the resource use impacts of stuctural change.

Perloff et al. (1960) described and analyzed long-term structural change in the industrial base of the United States from 1830 to 1950. Regional structure was measured by calculating the employment levels in each regional industry. Structural change was then described by observing changes in the proportions of regional employment in each industry over time (i.e. share analysis). Analysis of structural change was carried out by partitioning the changes in these proportions into two types of employment shifts: differential shifts and proportional shifts. Differential shifts were hypothesized to be related to the advantages offered by the region to industry. In contrast, proportional shifts were thought to be due to the nature of the region's industrial base. Together these two shift components added up to the region's total shift in employment.

The shift-share technique and the principal criticisms levelled against it have been dealt with extensively by Stevens and Moore (1980; see also Tate, 1981). In terms of analyzing resource use simultaneously with structural change, the technique is open to the same criticisms as levelled against the economic base and related techniques outlined above. However, the shift-share technique does partition the observed changes in economic structure into components related theoretically to the forces behind structural change. This technique of partitioning total changes into theoretically-based components is similar to the one adopted in this thesis to consider the effects of structural change on industrial water use.

Input-output analysis, in contrast to the structural analysis techniques dealt with above, offers a framework which is both based on a description of an economy's industrial structure and sufficiently flexible to accomodate simultaneous consideration of water use. The remainder of the chapter is devoted to an outline of this analytical method.

2.3 INPUT-OUTPUT AND THE ANALYSIS OF STRUCTURAL CHANGE

2.3.1 Historical Antecedents

The roots of input-output analysis are found in the literature of economics, with their origin being generally credited to the French physiocrat Quesnay (1694-1774). Quesnay's description of an economy as an integrated whole, which could be depicted in tabular form was an early version of the modern input-output table. Little development was given to this line of research until Walras (1834-1910) developed a system of equations to demonstrate how prices were determined in an economy, given assumptions about pure competition, individual utility functions, commodity supply and demand functions and production technology. Walras' system provided a theoretical view of an economy, but the amount of information required made his system of little practical value.

Leontieff (1905 -) used the theoretical system of Walras, but simplified the information requirements by "collapsing" the number of industries to a manageable number, forty-five in his pioneering work an by dispensing with the Walrasian demand functions (Leontieff, 1936). The attractiveness of such "input-output" analysis is its general equilibrium view of the economy, one of the few economic models to incorporate such a view in a workable manner.

2.3.2 The Accounting Framework

Input-output analysis is based upon an input-output table, which systematically accounts for the sources of inputs used in an economy and the points of disposition of the economy's outputs. Richardson (1972, p.14) drew a distinction between input-output as an accounting technique and as an analytical model. It is useful at the outset to describe briefly the nature of input-output accounts.

In the established Keynesian economic framework, national income (Y) is equal to the sum of consumption (C), investment (I), government expenditure (G) and the nation's net trade flow, exports(E) minus imports (M). The accounting system based upon the Keynesian conceptualization of the economy, is commonly referred to as the system of national income accounts. In this accounting framework, the production of individual industries and the flows between them are not specified. In contrast, the input-output accounting system views the economy in a substantially more detailed manner. Richardson stated (1972, pp.14-15):

> The major difference between input-output accounts and income accounts is that input-output accounts break down the business sector into a large number of individual industries or sectors and record the transactions that flow between each sector; these intersectoral flows are shown as an interindustry transactions matrix in the account. Apart from this, the input-output account contains more or less the same kind of information found in national (or regional) accounts, though occasionally in a slightly different form...
>
> Although input-output accounts can be made consistent with income accounts, their emphasis is different. The dominant concern of income accounts is the composition of final demand, while input-output accounts focus more on the interindustry transactions that lie behind changes in final demand.

An overview of the input-output system of accounting is shown in the form of an input-output table (Figure 2.1) for a hypothetical economy. This table is set up to show how input-output and national income accounts are related. The intermediate sector of the table, labelled producing and purchasing sectors, contains rows and columns for each of the 'n' industries in the economy. Each row of this part of the table shows the distribution of sales from one industry to each

Figure 2.1 **A Simplified Input-Output Transactions Table**

To		Purchasing Sectors	Final Demand Sectors				
From		1.......i.......n	Households	Private Investment	Government	Exports	Total Gross Outlays
Producing Sectors	1	X_{11}.....X_{1i}.....X_{1n}	C_1	I_1	G_1	E_1	X_1
	.	. . .	.	.	.	.	.
	.	. . .	.	.	.	.	.
	.	. . .	.	.	.	.	.
	i	X_{i1}.....X_{ij}.....X_{in}	C_i	I_i	G_i	E_i	X_i
	.	. . .	.	.	.	.	.
	.	. . .	.	.	.	.	.
	.	. . .	.	.	.	.	.
	n	X_{n1}.....X_{nj}.....X_{nn}	C_n	I_n	G_n	E_n	X_n
Labour		L_1......L_j......L_n	L_C	L_I	L_G	L_E	L
Other Value Added		V_1......V_j......V_n	V_C	V_I	V_G	V_E	V
Total Gross Outlay		X_1......X_j......X_n	C	I	G	E	X

Source: Richardson (1972, p. 19).

of the other industries in the economy. Each column shows the sources of one industry's purchases. The final demand sector records how much of each industry's sales are purchased by the various categories of final demand, such as households, private investments, exports, and government. Below the producing sector of the table are recorded the various categories of primary input, including imports. The right-hand column records the total gross outputs for each producing sector and the total amount of primary inputs, while the bottom rows shows the total gross outlays for each of the purchasing and final demand sectors.

The table shows that national income accounts can be computed from the input-output accounts, using the data recorded in the final demand and import portions of the table. Final demand consists of household consumption, private investment, sales to government and exports. As shown in the table, the input-output accounting stance also contains a detailed description of interindustry flows.

With this accounting framework established, it is now possible to describe input-output as an analytical model. The following outline commences with a description of national input-output models, and then proceeds to discuss briefly the interregional form of the models.

2.2.3 National or Single Region Input-Output Models

Input-output analysis was initially developed in the national or single region context. In the initial phase, data requirements and computer capacity constraints limited the development to the single spatial unit, and single unit models are still in use. The following review covers two types of single unit models: the industry-by-industry model and the commodity-by-industry model. The former is reviewed because it forms the basis for the research carried out in this project; the latter because it is the framework for Canadian input-output work and, accordingly, was the source used in obtaining much of the data to be used in this research.

<u>The Industry-by-Industry Format</u>: In the industry-by-industry format, the set of purchasing sectors is identical to the set of producing sectors. The relationships between inputs and outputs for any industry can be stated in the following identity:

$$x_i = \sum_{j=1}^{n} x_{ij} + y_i \qquad \text{(Eq. 2.1)}$$

where: x_{ij} = the sum of sales from industry i to industry j;

x_i = total value of sales of industry i;

y_i = the sum of the final demands for the products of industry i.

Assuming that industry j's purchases from industry i are stable in terms of industry i's output, equation 2.1 may be rewritten as:

$$x_i - a_{i1}x_1 - a_{i2}x_2 - a_{i3}x_3 - \ldots - a_{in}x_n = y_i \qquad \text{(Eq. 2.2)}$$

where: a_{ij} = the direct input requirements for industry i's product per unit of output in industry j.

In equation 2.2, the a_{ij}'s are termed direct input coefficients since they denote how much of industry i's input must be purchased by each industry per unit of output.

The objective of the input-output analysis is to estimate total outputs in each industry, given the level of final demand for each industry's products. This task involves tracing not only the direct first round outputs required to meet these final demands, but also the outputs required in second and subsequent rounds of production. The methodology for accomplishing this was developed by Leontieff and is now a standard procedure in economic and regional analysis. In terms of matrix algebra:

$$x - Ax = y \qquad \text{(Eq. 2.3)}$$

where: x = a column vector of gross output;

y = a column vector of final demands;

A = an $(n \times n)$ matrix of direct input coefficients.

Using an identity matrix, equation 2.3 can be rewritten:

$$(I - A)x = y \qquad \text{(Eq. 2.4)}$$

where: I = an $(n \times n)$ identity matrix.

Since the level of gross output in each industry is the variable being solved for, the system is rewritten as:

$$x = (I - A)^{-1} \; y \qquad \text{(Eq. 2.5)}$$

where: $(I - A)^{-1}$ = the Leontieff inverse matrix.

The elements of the inverse matrix quantify the direct plus indirect requirements of industry i per unit of final demand for the output of industry j. With the relationship quantified between final demand and total output, this model can be used to simulate the effects of changes in final demand on each of the producing industries.

Two assumptions are of central importance in using this methodology. First, the system allows the production of no joint products, that is, each commodity produced is associated with one industry only. Second, the technical coefficients are assumed to be constant, requiring constant returns to scale and no import substitution. The "one industry : one product" assumption is especially important in this thesis, since industry-by-industry input-output tables were used here. This choice was made in spite of conventional practice in Canada to use commodity-by-industry tables. The assumption, and its principal alternative are discussed here, followed by an explanation of why the industry-by-industry approach was selected.

Holtzman (1953) discussed methods, criteria and problems of aggregation. The theoretical criteria for aggregating industrial operations developed in this work were (1) similarity of input structures and (2) complementarity of output. Davis (1968, pp.22-23) summarized the two criteria as follows:

> (With regard to) similarity of input structures ... if two sectors utilize their inputs in identical proportions, nothing is lost with regard to analytical results from their aggregation into a single sector. More specifically, the inverse of the aggregated table under such circumstances is identical

> to the aggregated inverse of the original table ... (With regard to) complementarity of output....if the outputs of two sectors are produced in fixed proportions, these sectors may also be combined without undesirable effects upon the analytical results....A classic example is the consolidation of the textile activities of spinning, bobbing, weaving, etc.

Considerations of practicality must enter into the aggregation process. Clearly, if an analyst is examining a particular problem, industrial sectors which have little bearing on the problem can be aggregated with little loss to the analysis. For example, in preparing the model outlined in Chapter five, many of the industries in the Canadian input-output system will be aggregated because they are minor water users. A second issue of practicality is the concern for data availability. There must be a trade-off between theoretical precision and data availability constraints. The latter consideration was the principal one involved in the decision to use the industry-by-industry approach.

The "one industry : one product" assumption has been strongly criticized by many analysts (e.g. Rosenbluth, 1968, p. 260; Victor, 1972, p. 20). In fact, criticism of this assumption has motivated some countries, including Canada, to adopt a commodity-by-industry approach to building input-output tables, in place of the Leontieff industry-by- industry approach. Victor (1972, p. 20) summarized this point as follows:

> Until recently, input-output analysis and inter-industry analysis have been synonyms for each other. In order to study inter-industry relations it was practice to aggregate the various commodity outputs of each industry into one 'average', 'typical' or 'primary' product. As a result of this aggregative process, inter-industry models have the characteris-

> tic that industry outputs can always be structured so that any final demand can be produced exactly, without shortage or surplus. Referring to this as a 'sleight of hand of the inter-industry system', Professor Gideon Rosenbluth has argued that "if the economic system is indeed well-described by rigid industrial input coefficients....and if we recognize that industries have multiple outputs, then it is unreasonable to suppose that there is no such thing as joint production ....and hence it is unreasonable to assume that any bill of goods one cares to specify should be produceable exactly without shortage or surplus." For this and other reasons, Rosenbluth advocates "the abolition of industry-by-industry analysis and its replacement by ....commodity-by-industry analysis." In this variety of input-output analysis, commodities and industries both enter explicitly, and the need to aggregate the multi-commodity output of each industry into one composite commodity is avoided. Full recognition can thus be given to the fact that industry uses and produces many commodities, and that some commodities are produced by more than one industry.... As a result of the interest of Canadian economists in this particular type of input -output analysis, and their contributions in its development, Canadian input-output data are published in commodity-by- industry accounts.

In spite of these criticisms of the "one industry : one commodity" assumption and the theoretical improvements offered by the commodity-by-industry approach, which is dealt with below, the decision was made to use the industry-by-industry approach. This decision was taken because of the availability of data on industrial water use. These data were collected and compiled on an industry basis, and the surveys used for the data collection have not asked for information on water used to produce individual commodities. While commodity-specific water use estimates could have been made in a manner similar to that used by Victor (1972, p. 172), such an estimation exercise was rejected because of the possible error which would thereby be introduced.

For example, in a paper mill operation, it would be very difficult to allocate water use amongst major products because of the integrated nature of operations. Such an allocation process would require the making of a number of quite arbitrary assumptions, thereby introducing sources of error.

The second assumption, that of constant technical coefficients, was not an essential part of the methodology used in the current research, as distinct input-output inverses were used for each successive year in the analysis. In fact, the analysis hinges in part upon the changes in the coefficients of the inverse. In view of the methodology used, no further comment is made here on the coefficient constancy assumption.

The Commodity-by-Industry Format: The development of the commodity-by-industry approach to input-output modelling was based upon the reasoning given by Victor, cited at length earlier. Statistics Canada has been a pioneer in the development of national and interregional models of this type (see Canada, 1969, 1979). The following brief outline is based upon the work of that agency. The outline is given because the industry-by-industry tables used in this research were derived from the commodity-by-industry tables of Statistics Canada.

The major matrices and vectors involved in commodity-by- industry tables are shown in Figure 2.2. In place of the n x n processing sector of industry-by-industry analysis, two commodity-by-industry matrices form the basis of the approach. The V matrix, often called the "make" matrix shows the values of the industrial outputs of the system,

Figure 2.2 The Accounting Framework of Canadian Input-Output Tables

	Commodities	Industries	Final Demand[1]	Total
Commodities		U	F	q
Industries	V			g
Primary Inputs[2]		YI	YF	n
Total	q'	g'	e'	

1. Final demand categories include: personal expenditures on goods and services, fixed capital formation (business and government), value of physical change in inventories (both withdrawals and additions), gross government current expenditure on goods and services, domestic exports of goods and services, re-exports of goods and services, imports of goods and services, and government revenue from sale of goods and services.
2. Primary inputs include: commodity indirect taxes, other indirect taxes, less subsidies, wages and salaries, supplementary labour income, net income of unincorporated business, and other operating suplus.

Notation:

V = a matrix of the values of industrial outputs;
U = a matrix of the values of intermediate inputs;
F = a matrix of the values of commodity inputs of final demand categories;
YI = a matrix of the values of primary inputs of industries;
YF = a matrix of the values of primary inputs of final demand categories;
q = a vector of the values of total commodity outputs;
g = a vector of the values of total industrial outputs;
e = a vector of the values of total inputs (commodity plus primary) of final demand categories;
n = a vector of the values of total primary inputs (industries plus final demand categories).

Source: adapted from Canada, 1982b, p. 8.

classified by commodity. The U, or "use", matrix contains the values of the intermediate commodity inputs to industries. The other matrices and vectors are as described in the figure.

Two sets of assumptions tie these matrices together into an input-output model. The first set concerns the allocation of commodity production amongst industries. The second set establishes industrial production functions, which are in turn used to determine the industrial requirements for commodities. A basic accounting identity establishes a balance between the supply and demand for commodities in the system. When the commodity allocation and industrial production assumptions are combined with the accounting identity, an input-ouput model is defined, which determines outputs as a function of final demand, in a manner similar to the interindustry model.

The commodity allocation assumption states that, regardless of the level of production, industries will maintain their share of domestic commodity output. In other words, the total domestic output of each commodity is produced by industries in fixed proportions. In mathematical terms:

$$d_{ji} = v_{ji}/q_i \qquad \text{(Eq. 2.6)}$$

where: d_{ji} = the jth industry's market share of the production of the ith commodity;

v_{ji} = the output of the ith commodity by industry j;

q_i = the total domestic output of the ith commodity.

The total value of the output of each industry equals the sum of the output value of each commodity produced by the industry; that is:

$$g_j = \sum_{i=1}^{m} v_{ji} \qquad \text{(Eq. 2.7)}$$

where: g = the m x 1 vector of industry j's outputs.

By combining equations 2.6 and 2.7, the total industry output can be expressed in terms of market share coefficients:

$$g_j = \sum_{j=1}^{n} d_{ji} \cdot q_i \qquad \text{(Eq. 2.8)}$$

This equation can be restated in matrix form as:

$$g = D.q \qquad \text{(Eq. 2.9)}$$

where D = a matrix of the elements d_{ji}, referred to by Statistics Canada as the Domestic Market Share Matrix;

g and q = the vectors defined in Figure 2.2.

The industrial production assumption states that the values of the inputs used in each industry are fixed in terms of the industry's total output value. This assumption is the familiar industry technology assumption discussed earlier, and can be derived as follows:

$$b_{ij} = u_{ij}/g_j \qquad \text{(Eq. 2.10)}$$

where: b_{ij} = the input coefficient, that is, the value of the input of commodity i required to produce a unit of output by industry j;

u_{ij} = the input of the ith commodity to the jth industry.

Equation 2.10 can be rearranged to produce a relationship between industry output and commodity input:

$$u_{ij} = b_{ij}.g_j \qquad \text{(Eq. 2.11)}$$

In matrix terms, this can be restated as:

$$Ul = B.g \qquad \text{(Eq. 2.12)}$$

where: U = the matrix of commodity inputs;

l = an n x 1 vector whose elements are 1's;

B = the matrix of input coefficients, termed by Statistics Canada the Industry Technology Matrix.

Given the composition of matrix B, any vector of inputs determines exactly the required commodity outputs by using the accounting identity, which states that total domestic commodity production must equal the sum of intermediate outputs and final demand. This can be written in matrix form as:

$$q = Ul + fl \qquad \text{(Eq. 2.13)}$$

where: f = an n x f matrix whose elements, f_{ij}, denotes the final demand for the ith commodity by the jth category of final demand.

From equation 2.12, Ul = Bg, and thus:

$$q = Bg + fl$$

Also, from equation 2.9, g = Dq, and thus:

$$gD^{-1} = Bg + fl$$

This can be manipulated to:

$$g = (I - DB)^{-1}.Df \qquad \text{(Eq. 2.14)}$$

This equation defines the linear transformation of final demand categories into industry outputs. The expression DB in Equation 2.14 is equivalent to matrix A in Equation 2.5, thus providing a means of transforming a commodity-by-industry input-output formulation into an industry-by-industry format. This type of transformation was used in preparing the input-output tables for the current research.

2.2.4 Interregional Input-Output Analysis

Input-output analysis at the national or single region level, while fruitful in terms of aggregate analysis such as the provision of overall impact multipliers, is of limited usefulness at the regional level. For example, because of the nature of interregional impacts, an expansion of steel production, say, in Ontario, will require increased agricultural output. Since Western Canada is the country's major agricultural area, some of this required increase in agricultural output as a result of expanding steel production will originate in Western Canada. Such interregional impacts cannot be addressed effectively using national level analysis.

These types of considerations led to the development of an interprovincial input-output table by Statistics Canada. This table, compiled on the basis of 1974 data, was done on a commodity-by-industry basis, with provinces being interlinked by an interprovincial trade flow matrix. Its structure has been described by Hoffman and Kent (Canada, 1976a) and in the Statistics Canada Users' Guide (Canada, 1981, Chapter 7).

The subject of interprovincial trade flows and their impacts on industrial water use (Davis, 1968) is beyond the scope of this thesis. The focus here is on the industrial structure and structural change in each region by itself, and not on the interregional system as a whole. In other words, each region was treated separately, and, accordingly, the interregional input-output work is not described here. However, the interprovincial table did provide the source of input-output data and inverse matrices for each of the five regions comprising the regional portion of the work. Industry-by-industry tables were provided for each region by Statistics Canada, calculated by removing the effects of imports from each regional table. In other words, the regional tables used here account for intraregional production only. These tables, once calculated can be considered as single region tables and treated in the same manner as outlined earlier for the national tables.

2.2.5 The Concept of Multipliers

In neo-classical economics, the multiplier concept is a common one. In terms of the national income approach to quantifying the level of productive activity in an economy, an increase in any of the underlying variables, (consumption, investment, government export, or net exports) will tend to increase national income. When expenditures are increased in any of these national income sectors, part of the increase is re-spent by its recipient. For example, purchase of an automobile requires that the auto industry increase its purchases of raw materials. The recipients of these increased auto industry expenditures, likewise, will increase their purchases. Thus, the initial increased consumer demand will have an effect on national income greater than its initial level, due to the input linkage process, assuming that the product demanded is not imported from outside the economy. The ratio of total (i.e. direct plus indirect) expenditures to the original direct expenditure is one form of economic multipler.

In input-output terms, changes in the final demand for industrial products have direct plus indirect effects on other industries; thereby, the effect of final demand increases are spread through the entire economy. For example, income increases resulting from increased final demand can be traced through the economic system, and their total income generating effects can be compared, in the form of multipliers, with the initial direct effect. Similarly, employment multipliers can be generated to show the total effect on industrial employment of an increase in final demand. The methods of calculating income and employment multipliers have been dealt with by Richardson (1972, pp. 32-43), and will not be outlined here, since they do not play an integral role in the development of the thesis.

The concept of water use multipliers, however, is of more direct interest. Lofting and McGauhey (1963, p. 23) referred to a water use interactions matrix, formed by post-multiplying the inverse matrix by a diagonalized vector of water use coefficients. (This study will be described in more detail in Chapter three.) Each entry in the water use interactions matrix shows the amount of water required in any industry to meet a unitary change in final demand in any other industry. If the rows of this matrix are totalied , the resulting set of figures will show aggregate water requirements on an interindustry basis for the delivery of output to final consumers. These totals, when divided by the direct water use coefficients, form a set of water use multipliers, which can be interpreted as indices of the extent to which industrial inter-dependencies affect total industrial water use.

Let it be assumed that the water use multiplier is relatively high. For example, Lofting and McGauhey (1972, p. 23) showed that the direct freshwater withdrawal coefficient for the chemical products industry was some 30 acre-feet per million dollars of output, while the direct plus indirect freshwater requirements were 1681 acre-feet, making the water use multiplier in excess of 56. These figures show that, even if water use in the chemical industry were reduced through recycling, or by other means, to almost zero, "....this would only reduce by about one-fiftieth the amount of water needed on an interindustry basis to supply chemical products to final demand." Thus, the total picture of freshwater use could be distorted substantially if water uses were projected using constant (direct) water use coefficients. Also this example shows that, for the California economy, the very high water use multipliers were for industries with strong linkages to some segment of the agriculture, mining, and to a lesser extent, to electric power industries. Thus, the authors concluded that:

> ...the really striking shifts in water use technology may not come ...from recycling or reclaiming methods...The largest potential shifts in technology appear to lie in the greater use of inorganic materials or through controlled photosynthesis which would free some industries from their ties with the organic products of the traditional forms of agriculture. (Lofting and McGauhey, 1963, p. 23)

2.2.6 Input-output in the Analysis of Structural Change

Earlier in the chapter, it was shown that the supply and demand factors underlying structural change combined to determine both the equilibrium level of production and the types of products made in an economy. In terms of the input-output framework, these two factors are closely related to final demand. The factors leading to productivity and technological changes, on the other hand, are related to the technological coefficients of the input-output framework.

This type of combining procedure has been used in past applications of input-output analysis to the study of structural and technological change. The model outlined below is based upon a paper by Syed (Canada, 1978), who examined intertemporal structural changes in the Canadian economy between 1961 and 1971.

Earlier, Equation 2.5 was stated as:

$$x = (I - A)^{-1}.y$$

For convenience, let $F = (I - A)^{-1}$ and thus $x = F.y$. To incorporate time into this equation, let

$$x^t = F^t.y^t \qquad \text{(Eq. 2.15)}$$

where: x^t = the vector of gross outputs in time t;

F^t = the inverse matrix in time t;

y^t = the final demand vector in time t.

To analyze changes in gross output resulting from "pure" changes in final demand, technology, as reflected by the coefficients of the inverse, is held constant, and the actual output experience in year t compared to a hypothetical output pattern calculated using the final demand of an earlier time period. Thus:

$$k^{z-t} = F^t.y^t - F^t.y^z \qquad \text{(Eq. 2.16)}$$

where: k^{z-t} = a difference vector quantifying the "pure" effects of final demand between the initial time period, z, and the final period, t. (This length of time is noted here as z-t.)

Similarly, to quantify the changes in output resulting from "pure" technology changes:

$$m^{z-t} = F^{t}.y^{z} - F^{z}.y^{z} \qquad \text{(Eq. 2.17)}$$

where: m^{z-t} = a difference vector quantifying the "pure" effects of technology change between periods z and t.

The combined effects can be written as:

$$x^{z-t} = F^{t}.y^{t} - F^{z}.y^{z} = k^{z-t} + m^{z-t} \qquad \text{(Eq. 2.18)}$$

This type of methodology will be used as the basis of the framework to analyze industrial water use in the context of structural change, as will be outlined in Chapter 5. Before this framework is outlined, however, it is first necessary to examine the major approaches which have been taken in analyzing of industrial water use.

CHAPTER III

A REVIEW OF INDUSTRIAL WATER USE STUDIES

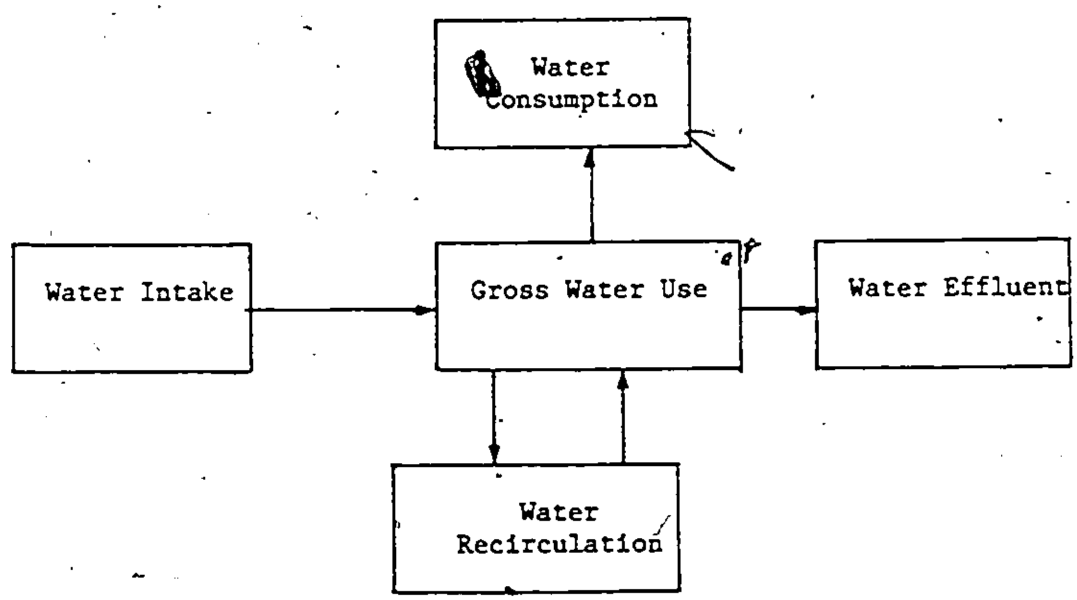
In conducting this study, several approaches were possible for analyzing the industrial water use component. These different approaches are reviewed in this chapter to assess their usefulness for the present research. Specifically addressed are (1) the ways in which the issue of industrial structure is dealt with in the various approaches reviewed, (2) the application of each approach to the national and regional scales of study, and (3) the ways in which input-output techniques have been used in industrial water use analyses. The chapter begins with a discussion of the basic industrial water use concepts used in the thesis

3.1 BASIC CONCEPTS OF INDUSTRIAL WATER USE

In examining the use of water by industry, a distinction is commonly drawn between the terms "water use" and "water demand". "Water demand" is a term used in situations in which a relationship has been drawn between the quantity of water used and the price paid to supply this use. "Water use", on the other hand, is a more general term, used in situations where there is no price implication on the use of water. Because this research concentrates on issues other than water pricing and supply:demand equilibria the more general term "water use" is used throughout most of this thesis. Nevertheless, in the interests of completeness, literature on both water use and water demand will be reviewed.

In collecting data and conducting research on industrial water use, the following concepts have been used, based upon Bower's (1966, 1968) description of a typical plant water circulation system. A simplified industrial water system is shown in Figure 3.1. Water is taken

Figure 3.1 A Generalized Diagram of an Industrial Plant Water Use System



Source: Canada (1971). p. 25.

into the plant by way of some type of intake system composed of pipes, pumps and intake treatment. The amount of water taken in for first time use is termed "water intake", or simply "intake." To produce the product, some total amount of water is used; this amount is referred to as "gross water use". The arithmetic difference between water intake and gross water use is made up by "water recirculation". All plants in their use of water are considered as having water intake and gross water use components; not all recirculate water. Many relatively small users or large users located adjacent to large water bodies may employ "once through" water systems, in which water is taken into the plant, used and discharged, with no recirculation at all.

The ratio of gross water use to water intake is called the "use rate" and is an index of water recirculation in the plant. The minimum value of the use rate is 1.0 (for the once through systems); the ratio increases as more and more water is recirculated, and may reach values of 15 or higher. To quantify the amount of water recirculated, industrial firms were asked to estimate the amount of water which would have been required in their operations had there been no recirculating system; this amount is the gross water used at the plant. From this amount is deducted the amount of water intake, the residual being taken as the amount of recirculation.

On the discharge side of a typical plant water circulation system three components are apparent. "Water discharge" is the amount of water put back into receiving waters after use, and, in many cases, subsequent to some form of waste treatment. The arithmetic difference between water intake and water discharge is termed "water consumption".

The third discharge component of the system is composed of water recirculation, discussed in the previous paragraph. The ratio of water consumed:water intake is called the "consumption rate" and varies in value between 0 and 1.

In making comparisons of water use with available water supplies, both intake (Canada, 1972) and consumption (Wolman and Bonem, 1971) have been used. Neither measure is completely satisfactory. Water intake denotes the total instantaneous withdrawal from an ambient water source by a given set of industries. Most or all of this water is returned to the watercourse from which it was withdrawn, and therefore does not constitute a "loss" to the regional water supply. Other types of environmental "losses" which may occur as the result of industrial use, such as water quality degradations, are acknowledged but not addressed in this thesis.

Water consumption, in contrast, is a measure of water apparently lost during a plant's operation, consisting of components such as evaporative losses, water incorporated into products, wastes removed from the plant site to landfill sites, and other such losses. The concept of water consumption thus measures the water loss at a particular location. But this concept does not necessarily indicate losses to the water resource system as a whole, even in the local area. Evaporative losses may fall locally as precipitation; products which incorporate part of plant water intake may be used in the local area, with the water re-entering the watercourse near the plant; water in wastes deposited in local landfill sites will eventually re-enter the local water system. Thus, water consumption may not be a true indicator of water loss to the local or regional water supplies. As used here, the concept of water consumption is relative to the industrial operation itself and not to the concept of the hydrologic cycle.

3.2 APPROACHES TO THE STUDY OF INDUSTRIAL WATER USE

3.2.1 The Coefficients Approach

The coefficients approach to industrial water use analysis is based upon selection of a variable which is closely associated with the use of water; examples of such variables used in the past are physical output, output value, value added and employment. The amount of water used (i.e. intake, recirculation, etc.) per unit of the selected variable forms the water use coefficient. The variable is then forecasted independently. Finally, the water use coefficient is multiplied by the forecast of the associated variable to produce the forecast of water use.

There have been many variations on this simplest form of the coefficients approach. One variation uses time as the explanatory variable. This form of forecasting is simply an extrapolation into the future of past trends. A second variation recognizes that, within a given industry, water use will vary depending upon product mix. The plant output is divided into types of output, and separate coefficients are calculated for each output type. Then the output mix is projected; the forecasted levels of each type of output are multiplied by the corresponding water use coefficient, and finally the resulting levels of output are summed to give the forecasted level of water use for the

7

plant as a whole. A third variation associates water use coefficients with different types of production technology. For example, within an iron and mill, crude steel can be produced in open hearth, basic oxygen or electric arc furnaces. The amount of water used to produce steel varies substantially, depending upon the type of technology in use (Canada, 1971). Coefficient-based forecasts using this variation develop coefficients of water use for each particular technology, and then use a procedure similar to the second variation outlined above. Additional variations are clearly possible using combinations of the methods outlined above.

The advantages of this group of approaches lie in the ease with which the data can be assembled for calculating the coefficients, and the relatively low cost of making the water use projections as compared to other methods to be dealt with below. However, there are several problems with the coefficients approach. First, only one variable, usually related to production levels, is assumed to determine water use, with other effects "loading onto" this one variable. Second, the approach is not based on any theoretical principles; rather it rests upon an observed relationship which is assumed to continue into the future. There is, in other words, no theoretical basis on which to argue that the assumed coefficient relationships, constant or otherwise, will persist into the future. Third, water supply is assumed to be infinite, and the price of water to be zero. Yet, as many economic studies, a few of which will be outlined later in the chapter, have shown, water use may exhibit some of the characteristics of an economic good in the sense that the quantity demanded falls as price rises. Thus, the coefficients approach makes assumptions which are at variance with the results of recent research, and may lead to overestimates of future water use. Fourth, no mechanism exists under the coefficients approach to produce an equilibrium level between water supply and demand. Finally, the coefficients approach takes no account of interindustry relationships and industrial structure. As shown in Chapter two, these interindustry linkages, or multiplers, may be important components of a water use analysis.

The coefficients approach is the simplest one available for industrial water use studies. When used alone, this approach may produce large uncontrollable errors. Further, no structural relationships are built into the approach. However, in studies where a large number of plants are being considered, the coefficients approach can be useful if augmented by other means to overcome its defficiencies. Finally, the approach can be used at all spatial scales, from local to national.

3.2.2 The Regression Approach

An extension of the coefficients approach is based upon the use of regression analysis. In this approach, not just one but several independent variables are used to "explain" the level of industrial water use. A water use relationship is hypothesized to exist between a measure of water use (e.g. water intake) and one or more independent variables, such as plant age, level of recirculation, operating rate of the plant, cost of water to the plant, and others. Data are then collected on the hypothesized relationships, and the relationships tested using least squares regression techniques.

Many of the same criticisms apply to the regression as to the coefficients approach, but some improvements are noteworthy. Although regression relationships are not necessarily based on theory, the process of hypothesis formulation and testing is a movement toward theory formation. In her research on industrial water use in Southeast England, Rees (1969), for example, found that the levels of employment and raw material input were highly correlated with water use in virtually all of the industries studied. Further, she concluded that these variables were considerably more important in explaining the levels of industrial water use than the effect of water price to the plant (Rees, 1969, p. 74), at least in the short run.

The regression approach is a marked improvement on the coefficients approach because the multivariate nature of industrial water use can be taken into account. Data requirements are larger than those required to calculate coefficients, but these requirements are not insurmountable, and regression techniques can be used at all spatial scales. However, it is difficult to include considerations of industrial structure in the regression approach, because regression models are most frequently built for single industrial sectors. In other words, an effort is made to understand the variables affecting one industrial sector in isolation from the others. Other approaches should be explored to find a more suitable means of incorporating considerations of industrial structure into the study of industrial water use.

3.2.3 The Demand Management Approach

Despite frequent assertions made that water is "vital to life" and that "water is different from other resources", resource economists and others (among them several geographers) have found well-behaved relationships between the quantity of water demanded and its price (Howe, 1979, pp. 311-315). References to price throughout this section refer to the price of water faced by private firms, not to the broader concept of social price or social cost of industrial water use. Studies of residential water use (Howe and Linaweaver, 1967; Lee, 1969; Grima, 1972), industrial water use (Calloway et al. 1974; Thompson and Young, 1974) and agricultural water use (Heady, 1974) have all documented this price-quantity relationship. Bower (1968, p. 89) listed the price of water as one of the important determinants of industrial water use.

In his study of water use in the New Jersey petrochemical industry, de Rooy analyzed the effect of price on water use, basing his work on the theory of derived demand. He stated:

> Since water is employed in the production of goods, its cost is covered by the revenue derived from the sale of these finished products. The demand for water is then the demand for an input or factor of production.(de Rooy, 1970, p. 34)

Following a thorough exposition of the theory of derived demand, he built an econometric model to analyze the effect of several variables, among them water price at the plants under study, on the amounts of water used in the industry under study. Finding no competitively determined price for water, de Rooy chose as a proxy the average cost of water at each plant site. Average water cost included both capital and operating costs for water intake facilities (including intake treatment), water acquisition costs, the costs of recycling water and waste treatment and discharge costs. The research demonstrated that price, as defined in the study, was a significant variable in determining the level of water intake in the set of plants under study. In his last chapter, de Rooy maintained that the pricing relationship was important in the forecasting of water use.

Whittington (1978, pp. 19-22) reviewed the economic approach to water demand forecasting, stating that:

> Economic theory offers a simple behavioral model to explain industrial water use in competitive free market economies. For a given technology the quantity of water demanded by an industry is assumed to be a function of the price of water, the price of other inputs and the level of industrial output. The supply of water is assumed to be a function of the price of water and various institutional factors. In equilibrium we assume that the supply of water equals the demand for water. In this simple model, the quantity of water used is determined just as any other factor input.

According to this line of reasoning, as the price of water rises the quantity used will fall. Two effects occur during the process of adjustment. First, an "output effect" will be felt as the increased price of water raises the product price, thereby lowering its demand. Second, a "substitution effect" occurs as the water user tends to substitute other inputs for the now more expensive water factor. An example of this substitution effect would tend to occur if, given a rise in the price of new water intake, water recirculation equipment were to be installed in the plant. By this process of substituting capital costs for input acquisition costs, the plant would be making a technological change resulting in more efficient water use.

In work conducted for the U.S. National Water Commission, Russell(1971) examined the use of water in the petroleum refining industry. Some of his results are summarized as follows:

> a. the intakes of petroleum refineries are price sensitive, and may be reduced up to 95% by a water intake charge of two cents per 1,000 gallons;
> b. discharges of biochemical oxygen demand (BOD) materials are sensitive to effluent charges, with charges of two cents per pound of BOD emitted producing an estimated fifty to sixty-five percent reduction in BOD emissions, depending on plant age;
> c. the costs of reducing waste discharge are approximately similar to the costs of developing sufficient additional flow to dilute the waste stream (to meet ambient water quality standards; and
> d. the costs of reducing BOD discharges would raise gasoline price at the pump by about one-fiftieth of a cent per gallon.

These findings demonstrate, at least in petroleum refining, that industrial water use is economic in nature by means of being responsive to price. The major implication is that management of demands through use of pricing principles may present a less expensive means of overcoming supply deficiencies than developing new supplies.

There is little doubt that many aspects of industrial, municipal and other water uses show conventional economic response to price rises, and that water pricing should be investigated in studies which are intended to result in allocative decisions. Nevertheless, the economic approach is not without criticism, both theoretical and practical.

On the theoretical front, since there is no market for water, not only in Canada but also in most of the rest of the world, there can be no competitively determined price for water. As indicated above, de

Rooy used average water cost as a proxy for price. The difficulty here is that average cost of water depends partially upon the quantity of water taken into the plant. Thus, in a regression relationship, the amount of water intake, the subject of enquiry, is built into both sides of the regression equation. Whittington (1978, p. 32) mentioned this problem in his review of industrial water demand forecasting, stating:

> To the extent that there are significant economies of scale in the use of water, (the use of average instead of marginal costs) will result in the estimated price elasticities of demand for water being biased upwards.

On the more practical side of the issue, the problem of data availability is a particularly severe one. In contrast to the collection of data on water use, where mailed questionnaires have proven quite successful, collection of cost information, apart possibly from water billing data, requires plant site visits and detailed cost accounting procedures. The average cost approach requires some allowance for capital costs, posing difficulties in making consistent the different approaches to depreciation calculations. While theoretically, of course, these problems can be overcome, realistically the effort involved in doing so would be high. For these reasons, reliable cost estimates for water at industrial plants are nonexistent on a broad basis.

From a water management policy viewpoint, there are also difficult questions involved with the economic approach. First, in a relatively water rich country like Canada, it is difficult to convey the view that water should be allocated to the highest valued uses by employing a marginal cost pricing approach. The traditional answer to supply problems has been to develop new sources, literally a "new pipes in the ground" approach. This approach to water management is commonly called the "supply management" approach. Second, and somewhat paradoxically in view of the importance of market mechanisms in Western societies, public policy in many areas including water resources have been biased toward regulation and away from the use of market-type solutions.Schultze(1977) exemplified these regulatory policies when he stated:

> It is indeed ironic that a society whose citizens absorb the praises of the market's libertarian and economic virtues with their mother's milk, and an economics profession which cut its teeth on demonstrating how a decentralized incentive system can produce socially desirable outcomes, should give such short shrift to the same concepts when it comes to forging the tools for collective action.

Without making any assessments as to the applicability of economic instruments for environmental control, the fact remains that Canada has not relied any more upon economic instruments than has the U.S. An additional point to be made in assessing the practicality of policy initiatives based upon the economic aspects of industrial water use is brought out if water is considered as only one part of the production system of society. In other words, instead of focussing on the water resource, industrial production might be viewed as a system. In such a system, cheap water might be offered to promote industrial location, with the costs to society of such a policy being recouped in the form of employment, corporate income taxes and the like. Thus, a trade-off occurs between socially sub-optimal resource use and economic gains through other parts of the system. It is suggested that this type of trade-off is commonly made, and that it may provide one explanation for the failure to use marginal cost pricing of water resources on a more widespread basis.

The demand management approach is used to analyze the trade-offs between water uses, and to minimize the social costs of bringing water supply and demand into equilibrium. The approach can be used regionally, although at considerable cost and with some uncertainty as to success. The approach is only peripherally related to the study of industrial structure. Accordingly, it has not been used in this study.

3.2.4 The Process Modelling Approach

Statistical studies such as those carried out by Rees (1969), de Rooy (1970) and others treat the water use system of a plant as a "black box". The models deal with how much water is used, but not how and why it is used. The process modelling approach attempts to analyze the purpose of water use, the responses of water use to process change, and how the patterns of in-plant use can be changed. Two types of study exemplify this approach: process engineering and linear programming.

Studies by Cootner and Lof (1965), Lof and Kneese (1968) and Bower, Lof and Hearon (1971) are examples of the process engineering approach. Water use is conceptualized as a response to technological options in use at individual plants. The initial efforts, therefore, are aimed at identifying technological options for changing existing water use patterns and the costs of these options. Second, a determination is made about whether the savings due, for example, to reducing water intake following a price rise, are sufficient to justify making such reductions. The decision making rule is to lower the water intake if savings exceed costs. A demand curve for water can be synthesized by examining the least cost method of production associated with several different levels of water price and the quantities of water intake implied by each of these least cost methods. The third stage of the process engineering approach broadens the scope of the study by examining the interactions between water and other input, such as energy, process technologies and product specifications. The number of alternatives and solutions quickly becomes very large as the number of factors considered in the relationship grows.

The linear programming approach was developed by Russell (1973; see also Russell and Vaughn, 1976) as a method of systematizing the process engineering approach and also to investigate the economic aspects of industrial water use. The linear programming approach establishes an objective function to be maximized (e.g. profits) subject to a number of resource constraints, such as labour availability, capital availability, and the availability of various raw materials, one of which is water. The solution of this "primal" problem will show the optimal pattern of resource use required to maximize the objective. For each resource availability constraint, the value of the resource to the production process is implicit in the profit maximization problem. In the dual formulation of this problem, however, the factor input values become explicit as a set of shadow prices calculated when the dual is solved. In this case, the dual is a cost minimization problem, with constraints which require that "...The value of resources used in the production of a unit of output be greater than or equal to the net profit per unit of output." (Whittington, 1978, p. 41). The input factor shadow prices show the value in real terms if one additional unit of the resource becomes available; alternatively it shows the opportunity cost if the marginal unit of the resource is unavailable. Whittington (1978, p. 41) stated that:

> For each amount of water, there is a corresponding solution of the dual problem for the shadow price of water. By systematically, or "parametrically" varying the amount of water available and then solving the dual problem for the associated shadow price of water, (it is possible to) trace out a demand curve for water, i.e. a relationship between the quantity of water and its marginal benefit to the industrial facility.

A number of cautions about using this approach have been given by Whittington in his review of the method. These relate to the handling of capital costs, the difficulty of applying the model to established plants and the fact that the model produces normative solutions which may not apply to actual situations. From the viewpoint of the present research the difficulty with the process modelling approach is much less esoteric, namely the very high level of effort required to produce a process model of even one plant. Each plant has to be examined in detail individually, thus making the approach an expensive one to implement at the regional level. In addition to the cost of the approach, which is but one consideration in research design, the plant specificity of process modelling makes it difficult to deal with structural change on a large area basis because each plant must be dealt with individually.

3.2.5 The Input-Output Approach

As in other fields of economic and spatial analysis, input-output methods have proven useful in water use and demand investigations. This section presents a review of studies representative of applications of input-output techniques to analyses of industrial water use.

The Lofting-McGauhey Study: One of the earliest water use studies based upon input-output analysis was that by Lofting and McGauhey (1963) for the California economy. As part of a larger state-sponsored study entitled "Economic Evaluation of Water", several objectives were set by the authors: (a) to develop a general insight into the major water-using sectors of the state economy and the water use interdependencies of these industries; (b) to develop a solid base for future studies concerning the technological and structural interdependencies of water use; (c) to forecast the levels of expected water use as a basis for state-wide water development programming; and (d) to establish some basic economic parameters (e.g. income and water use multipliers, shadow prices for water) as the basis of evaluative studies. In satisfying these objectives, Lofting and McGauhey used both an input-output and a linear programming approach (Lofting and McGauhey, 1968) which, as shown, for example, by Dorfman, Samuelson and Solow (1958, pp. 204-229), are very closely related. Only the former work is reviewed here.

The Lofting-McGauhey approach used a state-wide input-output table, which was both static in nature, and based on 1947 data, some 16 years prior to the 1963 publication date of the research. In this regard, the authors stated that, "Although the table is based on 1947 data, it is felt that the structural relationships still give a reasonably good description of the current relationships." They cited as evidence of this assumed stability research findings by Leontieff and Hoffenberg (1961).

For the purposes of the research, the 57-sector table published for the state was aggregated to 31 sectors, based upon the availability of water use data. A matrix of technical coefficients was calculated, following which the inverse was found. Water use coefficients for total intake, freshwater intake and gross water use for each of the 31 industries were derived from secondary sources. Each set of coefficients was then used to form a 31-order square matrix in which the coefficients formed the principal diagonal, and all other elements were zero. The inverse was then post-multiplied by each of the water use matrices in turn to produce what the authors termed three "water use interactions" matrices. These matrices showed the direct plus indirect water requirements per unit of output in each industry.

The Davis Study: Davis' (1968) study formed part of the same California series as that of Lofting and McGauhey. The basic logic employed in the study was also similar to that described in the previous sub-section. The innovation made by Davis was to develop a multiregional approach to examining water use in the Western states of the U.S. One of the basic questions faced related to the increase in the water requirements of each state-region resulting from an increase in final demand in any one state.

Much of Davis' work concentrated on preparing a multiregional input-output table for nine individual states plus one four-state composite. Thus all thirteen of the Western U.S. states were included in the analysis. In addition to the input-output table itself, Davis also constructed an interregional trade flow matrix to link the individual states together. The Leontieff-Strout gravity model method (Richardson, 1972, pp. 70-75) provided the basis for this work. The detailed descriptions provided by Davis of this complex undertaking (1968, pp. 92-120) indicate the degree of effort required in interregional input-output studies.

With the basic model developed, the author formulated interregional water use interactions matrices and multipliers to quantify the effect of final demand increases in one of the states on the water uses of all the other states in the system. Also, he developed a basic forecasting application similar to that used in the Lofting-McGauhey study. Again, water use coefficient constancy was used in this model.

The Victor Study: Victor's (1972) study constituted an attempt to integrate environmental and ecological considerations into an economic framework. Such work is important in terms of environmental management because there was at the time and continues to be a need to place economic valuations on the use of environmental resources, many of which are unpriced. This point is closely related to points made earlier in discussing water pricing. The study by Victor was built upon earlier ones by Ayres and Kneese (1969), Cumberland (1966), Daly (1968), Isard (1969) and Leontieff (1970). Victor (1972, p.23), however, in developing a workable system for integrating economic and environmental flows, was able to claim that his was "....the first study in which comprehensive estimates of material flows (were) used to extend input-output analysis in order to quantify some of the more obvious links between the economy and the environment of a country." Although this study was not a water use study in the first instance, it was valuable in establishing a methodology for linking the economy and the environment.

In view of his discussion of commodity-by-industry input-output tables, which was referred to at length in Chapter two, Victor employed a 40 x 16 commodity-by-industry input-output table for the 1961 Canadian economy. This table was developed by Statistics Canada (Canada, 1969) as an early output of its structural analysis program. Richardson (1972, p. 225) identified two advantages of the commodity-by-industry approach for ecological analysis:

> ....(Advantages are) the fact that all production involves wastes so that each industry is characterised by joint products; and that each commodity does not have to be measured in the same units so that the economic data in the model can be expressed in monetary units whereas the ecological data can be expressed in terms of weight.

The tabular format adopted by Victor is contained in his book on the study (Victor, 1972, p. 56) and is reproduced by Richardson (1972, p. 226). The framework has two major divisions, a conventional commodity-by-industry input-output table and a new ecologic sector, with space for water-, air- and land-based flows. It contains seventeen matrices and vectors and one scalar. In addition to the standard input-output accounting identities, Victor also developed physical identities to incorporate the flows of ecologic resources; these identities were based upon the law of conservation of mass, which implies that, assuming no capital accumulation, the flows of material into a system must equal the flows out of the system. This materials balance approach was similar to that used by Ayres and Kneese (1969).

Having developed the model, Victor examined in detail a number of applications using Canadian data then available. These applications included: (a) the interindustry flows of waterborne waste; (b) a series of ecologic impact tables (similar to the water use interaction matrices of the Lofting-McGauhey and Davis studies; (c) development of a set of shadow prices to indicate the ecologic costs of producing each economic commodity; and (d) a linear programming version to examine the ecologic value expected by curtailing motor car usage by 50%. The results of these applications will not be outlined here, as they are not relevant to the present study.

The Earmme Study: In contrast to the studies reviewed above, research by Earmme (1979) applied input-output methods to the problem of river basin water balances. The aims of the study were: (a) to develop an input-output table for the Alberta portion of the North Saskatchewan River Basin of Western Canada; (b) to formulate income, employment and water use multipliers for the study area based on the table; (c) to use the table to forecast water use to 1980 and 1985; and

(d) to determine whether the projected water uses would exceed the available water supplies in the basin.

On the basis of the 1966 provincial input-output table and 1972 economic statistics for the study area, a commodity-by-industry input-output table was constructed for 1972. Water use statistics were derived from a recently-completed provincial water use survey. These coefficients were used in exactly the same manner as that developed by Lofting and McGauhey, as outlined above. The desired multipliers and forecasts were calculated, and the forecasts used to compute future water balances. It was found, using three different development scenarios, that the projected levels of water usage were no threat to the basin's current water supplies.

The Earmme study was interesting in its achievement of a river basin input-output table, although this had been accomplished in the early 1970s in the Okanagan River Basin Study (Canada-British Columbia Okanagan River Basin Consultative Committee, 1973). The study was also important in determining water balances in what some studies (Canada, 1972b; Foster and Sewell, 1981) have designated as a basin where water uses are threatening to outstrip available supplies.

The input-output approach to industrial water use analysis uses coefficients to convert production data to water use data. It is thus subject to the same limitations as the coefficients approach. In contrast to the latter, however, the input-output approach incorporates the industrial structure of the spatial unit being analyzed. In a regional context, water use coefficients generalize the quantitative nature of water use in fairly broad groupings of industry. These generalized coefficients are accurate summaries of the water usage of the region.

3.2.6 Summary of the Approaches to Analyzing Industrial Water Use

The five approaches outlined in the chapter for analyzing industrial water use are compared in Table 3.1 with respect to their spatial and structural suitability for this study. It is clear that the input-output approach is the only one which both is suitable for regional analysis and incorporates considerations of industrial structure and structural change. Accordingly, it is the approach upon which this study is based. The framework developed in the following chapter is based upon augmenting the structural change model described at the end of Chapter two to include considerations of industrial water use.

Table 3.1 Comparison of Approaches to the Study of Industrial Water Use

Approach	Spatial Applicability	Structural Applicability
Coefficients	Can be used at any spatial scale.	No consideration of industrial structure.
Regression	Can be used at any spatial scale.	No consideration of industrial structure.
Demand Management	Not appropriate for studies of large areas with many industries because of large data collection costs.	No consideration of industrial structure.
Process Modelling	Not appropriate for studies of large areas with many industries because of large data collection costs.	No consideration of industrial structure. Plants dealt with individually.
Input-output	Appropriate at the regional and national levels when combined with the coefficients approach.	Industrial structure incorporated into input-output tables.

CHAPTER IV

FORMULATION OF THE CONCEPTUAL FRAMEWORK

This chapter draws together the concepts outlined in Chapters two and three to form the framework for analyzing industrial water use in the context of structural change. In the structural change model outlined at the end of Chapter two, demand and supply factors were subsumed under the final demand concept of input -output analysis. The technical coefficients and, accordingly, the inverse matrix of input-output were shown to capture the effects of the productivity and technological components of structural change. (Throughout the remainder of this thesis, the combined effects of productivity change and technological change will be referred to as the "production technology" factor.) In this section the structural change model is augmented to include considerations of industrial water use through the incorporation of water use coefficients. This framework can then be used to examine the role played by each factor in changing industrial water use.

This augmented framework can be used at both national and regional levels. The analysis at the national level will indicate the overall effect of the various factors in changing industrial water use. The analysis is extended to the regional level to determine whether there is any spatial variation in the effects of the factors across the country.

The approach developed here is an innovative one in the analysis of industrial water use over time, and is useful for three reasons. First, it will identify a set of structurally-related factors which underlie changes in industrial water use. Second, and related, it will quantify some of the overall influences of trends in production technology on water use. This type of information is not readily available at the present time. Finally, the resulting framework has valuable applications in the area of water use forecasting, as will be suggested in the final chapter of this thesis.

4.1 THE FRAMEWORK

The framework can be described most conveniently in mathematical terms. It is assumed that the conversion of the national commodity-by- industry input-output tables to an interindustry format has been accomplished and that inverse matrices have been calculated.

Let F^t, F^z, y^t and y^z be as defined in Chapter 3. Then, from Equation 2.17.

$$x^{z-t} = F^t.y^t - F^z.y^z \qquad \text{(Eq. 4.1)}$$

4.1.1 Incorporating Water Use Factors

Water use can be added to this framework by inserting a diagonalized vector of water use coefficients, in a manner following Lofting and McGauhey (1963, pp. 28-29).

Let: M^t = a diagonal matrix of water use coefficients in the final time period for any water use parameter.

M^z = a diagonal matrix of water use coefficients in the initial time period for any water use parameter.

The (column) vector of total water uses for any water use parameter (w^t) in time t is:

$$w^t = F^t.M^t.y^t \qquad \text{(Eq. 4.2)}$$

A column vector of changes in total water use between time periods z and t (n^{z-t}) can be defined as:

$$n^{z-t} = F^t.M^t.y^t - F^z.M^z.y^z \qquad \text{(Eq. 4.3)}$$

This vector has built into it changes in final demand, changes in technical coefficients and changes in water use patterns. In this context, the water use coefficients are considered as a third structural change related factor.

The water use coefficients reflect the use of water as a factor of production, and theoretically, the cost of water is part of an industry's production function. This means that the amount of water used in an industrial operation, converted to dollar terms, is included in the input-output table, in the technical coefficients and in the coefficients of the inverse matrix. In theory, then, to include a specific reference to water in the proposed model might be criticized for double counting.

The cost of water in Canada is very small in proportion to total industrial output. For example, in 1976, a federal government study found that the ten largest water using SIC groups paid a total of 32.4 million dollars for water intake acquisition, treatment and waste water treatment. This amounted to 0.06% of the total output value of these ten groups. Even were the water-related cost to be low by a factor of ten, it would still constitute a very small proportion of total output. Thus, it is argued that the effect of water-related costs on the figures recorded in the input-output tables and in the associated inverse matrices is very small, and that, at most, an insignificant amount of overlap occurs by using the water use coefficients in conjunction with the inverse matrices.

4.1.2 Partitioning the Total Changes in Water Use into Structural Change Components

Having integrated water use considerations into the input-ouput framework, the remaining task is to formulate the method for apportioning the total interperiod change in water use to the three components suggested to underlie these changes, namely changes in final demand, changes in the coefficients of the inverse and changes in the water use coefficients. The three components of change can be quantified as follows:

$$P^{z-t} = F^t.M^t.y^t - F^t.M^z.y^t \qquad \text{(Eq. 4.4)}$$

where: p^{z-t} = a difference vector denoting changes in total water use for any water use parameter between time periods z and t due to "pure" changes in water use coefficients. A subscipt i used in conjunction with this vector refers to the industry i component of the vector.

$$r^{z-t} = F^{t}.M^{z}.y^{t} - F^{t}.M^{z}.y^{z} \qquad \text{(Eq. 4.5)}$$

where: r^{z-t} = a difference vector denoting changes in total water use for any water use parameter between time periods z and t due to "pure" changes in final demand. A subscript i used in conjunction with this vector refers to the industry i component of the vector.

$$s^{z-t} = F^{t}.M^{z}.y^{t} - F^{z}.M^{z}.y^{z} \qquad \text{(Eq. 4.6)}$$

where: s^{z-t} = a difference vector denoting changes in total water use for any water use parameter between time periods z and t due to "pure" changes in production technology. A subscript i used in conjunction with this vector refers to the industry i component of this vector.

Thus:

$$n^{z-t} = p^{z-t} + r^{z-t} + s^{z-t} \qquad \text{(Eq. 4.7)}$$

Equation 4.7 represents the partitioning of total interperiod changes in water use into the three components of the framework, changes in water use coefficients, changes in final demand and changes in production technology.

4.1.3 Relative Importance of the Structural Change Factors in Interperiod Water Use Changes

With this framework established, it is useful to identify the relative importance of each factor in influencing the total change in water use from period to period. If the final demand component is most important, the implication for intermediate term water use forecasting is that reasonable forecasts can be prepared simply by using projected final demands for the set of industries included in the input-output tables. If, on the other hand, the production technology factor is shown to be most important, the implication is that much more attention should be paid to the coefficients of the inverse matrices used in the analysis. Primary importance of the water use coefficients factors would mean that particular attention should be paid to the formulation of the coefficients.

To determine the relative importance of each factor, the least squares algorithm of linear regression analysis can be used. The procedure is set up in the same manner as a step-wise multiple regression analysis. For the purposes of the analysis, the total change in water use between periods can be taken as the "dependent" variable. The three factors contributing to the change, as measured in the three difference vectors developed above, can be taken as the "independent" variables. Formally, the analytical model can be stated as:

$$n_i^{z-t} = f(p_i^{z-t}, r_i^{z-t}, s_i^{z-t}) \qquad \text{(Eq. 4.8)}$$

where all variables are as defined above.

This functional form can be translated into a form suitable for analysis using the least squares technique (Wonnacott and Wonnacott, pp.255–283):

$$n_i^{z-t} = b_o + b_1 p_i^{z-t} + b_2 r_i^{z-t} + b_3 s_i^{z-t} \qquad \text{(Eq. 4.9)}$$

where: b_o = the intercept value of the regression plane

b_1, b_2. b_3 = the regression coefficients

For reasons to be discussed below, there is no error term in this formulation of the model.

The data to calibrate this model are found in the vector of total water uses and the three difference vectors. The data in each row of these vectors taken in order represent independent observations on the relationship represented in equation 4.9. In order to use these data in the least squares framework, they must be adjusted for the size of the respective industries. This can be accomplished by dividing the data by the average (constant dollar) output of the corresponding industry between periods z and t. In operational terms, the ith set of variables can be stated as follows:

$$an_i^{z-t} = w_i^{z-t}/h_i^{z-t} \qquad \text{(Eq. 4.10)}$$

$$ap_i^{z-t} = p_i^{z-t}/h_i^{z-t} \qquad \text{(Eq. 4.11)}$$

$$an_i^{z-t} = w_i^{z-t}/h_i^{z-t} \quad \text{(Eq. 4.10)}$$

$$ap_i^{z-t} = p_i^{z-t}/h_i^{z-t} \quad \text{(Eq. 4.11)}$$

$$ar_i^{z-t} = r_i^{z-t}/h_i^{z-t} \quad \text{(Eq. 4.12)}$$

$$as_i^{z-t} = s_i^{z-t}/h_i^{z-t} \quad \text{(Eq. 4.13)}$$

where: h_i^{z-t} = the average output of industry i between periods z and t; and

a = a prefix denoting the adjusted values to be assumed by the variables.

This type of procedure cannot be termed a multiple regression analysis in the conventional sense. The quantity defined as the dependent variable is measured independently of the quantities used as the independent variables. However, it is apparent from the derivation of the variables that the total change in water use is equal to the sum of the changes due to the three structural change factors. In other words, there is no error term in equation 4.9, and the equation is actually an identity. This type of analysis was use by Davies (1977, p. 401) in deriving a proxy measurement of local constuction costs for his study on land and housing markets in London, Ontario.

In spite of the departures made from the conventional procedures of linear regression analysis, the technique outlined will allow determination of the relative importance of the three factors in determining the total interperiod changes in industrial water use. The factor which explains the greatest percentage of the total variation in water use, as measured by the R^2 statistic will be the most important factor. The second- and third-most important factors can also be determined using the step-wise regression procedure.

4.1.4 Application of the Framework

The remainder of this thesis involves testing the usefulness of the analytical framework developed in this chapter. Following a discussion of data collection in the next chapter, Chapter six will discuss the results obtained from using the framework. The research strategy used will be to calculate the difference vectors p^{z-t}, r^{z-t} and s^{z-t} in the manner given in Equations 4.4 through 4.6. With these vectors calculated, observations will be made, first of all, on the structural change effects on water use in the various industrial sectors. Then the data will be normalized and analyzed in the least squares framework to determine the relative importance of the three structural change factors. The conclusions drawn from these observations will be outlined in Chapter seven.

CHAPTER V

PATTERNS OF CANADIAN INDUSTRIAL WATER USE

The water use patterns of Canadian industries will be described in this chapter, commencing with a discussion of data sources, and then proceeding to a description of the trends, patterns and anomalies which exist in the data. These data will be used to test the analytical framework presented in Chapter four.

5.1 TAKING INVENTORY

Throughout the world, complete inventories of industrial water use are relatively rare, compared to inventories of commodities, resources and goods which trade on the open market. This relative scarcity of water use data reflects the ready availability of water in many areas, and the resulting lack of attention paid to its use. Yet, there have been efforts within the past 30 years to collect such data. In the United States, for example, the first industrial water use survey was conducted by the Bureau of the Census in 1954, with subsequent resurveys in 1959, 1964, 1968, 1972 and 1976. In Canada, Thomas (Canada, 1961, p. 360) conducted surveys of industrial water resources, constituting the first effort in this country to view industrial water use in a comprehensive manner. Thomas' work, however, was oriented to water quality requirements, and contained only limited data on the quantities of water used. In work done for the Resources for Tomorrow conference in 1961, Cass-Beggs (Canada, 1961, pp. 173-189) compiled national industrial water use estimates, based on coefficients of water use developed from U.S. surveys. The National Water Needs Study (Canada, 1972b), carried out by the federal Department of the Environment, used a similar approach to Cass-Beggs' in compiling national water use estimates for industry.

The first Canadian survey of water quantities used by a broad spectrum of industries was conducted by the same federal department, in conjunction with Statistics Canada and the Alberta Department of the Environment, in 1973, with summary results published in 1977 (Canada, 1977b). Two resurveys have been conducted, the first in 1978 (for 1976 data) and the most recent in 1982 (for 1981 data). The results for the 1976 survey have just recently been published (Canada, 1983), while the results for 1981 are currently being compiled. Full access was given to the data from the 1972 and the 1976 surveys for the purposes of this research. A final source of information for the three Prairie Provinces was the recently published Prairie Provinces Water Demand Study (Canada-Alberta- Saskatchewan- Manitoba, 1983).

The federally-sponsored industrial water use surveys for 1972 and 1976 were the principal sources of water use data for this chapter. For this reason, they are described in detail here, with regard to the questionnaires used, selection of respondents, response rates and estimation of results for non-respondents.

5.1.1 Questionnaire Design

The Canadian water use surveys have used questionnaires mailed to respondents. Design of the questionnaires was based upon the well-established work of the U.S. Bureau of the Census. Major sections of the questionnaires asked for data on water intake by source, water intake by purpose, recirculation by purpose and discharge quantities by type of treatment and point of discharge. In 1976 and 1981, questions were added on monthly quantities of intake and discharge, and on operating and maintenance costs for water intake treatment, water recirculation, and effluent treatment. A sample questionnaire from the 1976 survey is included in Appendix G.

5.1.2 Selection of the Survey Universe

There were over 30,000 manufacturing firms in Canada when the industrial water use surveys were begun in 1973. With the addition of the mineral extraction and power generation sectors, the potential universe for the first survey was estimated at around 35,000. To survey this total number of establishments was much beyond the scope and budget of this initial exercise, and one of the first requirements was to narrow the universe to be surveyed to major water users. This narrowing was achieved with a preliminary question on Statistics Canada's census of industries for 1971, which elicited information on annual water withdrawal quantities. Firms which marked the box indicating a withdrawal of over ten million gallons were designated as recipients of the detailed water use questionnaire. In addition to this selection procedure, the list of potential respondents was augmented manually with the inclusion of known large operations which were missed by the preliminary respondent selection procedure. No effort was made to include in the survey small water users, such as metal finishers, which may cause serious environmental pollution problems.

For the 1976 survey, the results of the 1972 survey were used to refine further the size of the survey universe. For manufacturing, the 1972 results were arrayed by 2-digit SIC group in order of their total water withdrawal. It was decided to survey only the top ten SIC groups, as the remaining groups constituted only a small portion of the total intake by the surveyed manufacturing firms. Within the ten SIC groups designated for surveying, it was decided to canvas only the larger establishments. This decision was made in consultation with officials of Statistics Canada, the co-sponsor of the survey, and was necessitated because of budgetary constraints and concerns about response burden.

Statistics Canada, in its annual surveys of manufacturing, sends out both "long" survey forms and "short" forms. The long forms contain detailed questions on the respondents' operations, while the short forms ask only summary information. To determine the recipients of the long forms, firms within each 4-digit SIC group are ordered with respect to value of production. Establishments which together account for at least 95% of the groups' total value of production are sent long forms, while the remaining establishments receive the short forms. For the 1976 industrial water use survey, the respondent population included only those firms within the designated SIC groups which received the long form questionnaires on the Statistics Canada surveys. For the mineral extraction sector, the 1972 mailing list was left essentially intact except for establishments which had gone out of operation. The power generation sector was limited to thermal generating plants, omitting the hydro plants which had been surveyed in 1972.

For the 1981 survey, the same criteria as used for the 1976 exercise were used again to select the respondent population. Minor revisions were made in the manufacturing sector to eliminate respondents in those 4-digit SIC groups with minimal water use.

5.1.3 Response Rates

For the manufacturing sector in 1972, the number of plants surveyed was 4,437 (Canada, 1977b, p. 3), including those surveyed by Alberta. Of these, some 3,800, or 85% of those surveyed, returned questionnaires. About 500 questionnaires, or 11% of those returned, were discarded because of lack of information. The chief reason given for this lack of information was that the firms involved did not meter and could not estimate their water use. Thus, 3,298, or about 74% of the manufacturers surveyed, completed usable questionnaires (Canada, 1977b; p.2). Because of an oversight, no records were kept of the respondents to the mineral extraction or the power generation sectors of the 1972 survey.

In 1976, just over 7100 questionnaires were mailed to establishments in the manufacturing, mineral extraction and power generation sectors. For the manufacturers, 5,110 out of a total of 6,532 (78%) completed usable questionnaires. For mineral extraction 273 out of 496 (55%) questionnaires were completed acceptably. In the power sector, 71 out of 74 (96%) of the establishments returned usable questionnaires. The aggregate response rate over the three sectors was 76%.(Canada, 1983, p. 3)

5.1.4 Estimation of Results for Non-Respondents

Based upon the responses to the survey, water uses were estimated for the non-respondents, in an effort to gain as complete a picture as possible of industrial water use. For 1972, the estimation procedure was described as follows:

> Initially, the estimation involved calculating a coefficient of total water intake per employee for each four-digit industry group in each province. The survey results plus employment information from Statistics Canada's records provided the data for the calculation of coefficients. These coefficients were then multiplied by the number of employees in the plants being estimated to determine the total water intake at those plants. Following this procedure, all of the parameters of quantitative water use were calculated as a percentage of total water intake. These percentages were then multiplied by the total water intake for the plants being estimated to arrive at estimated values for the various parameters of quantitaive water use (Canada, 1977b, p. 2)

The choice of employment as a basis for estimation was made because (1) employment is commonly related for estimation purposes to water use, as shown in Chapter three, and (2) because Statistics Canada would not release data on the value of output or on value added for individual plants, because of confidentiality restrictions.

In 1976, a somewhat different estimation procedure was adopted, based on the fact that establishment-by- establishment employment data were available. Coefficients of water quantity per employee were developed for each element of the questionnaire. The coefficients were developed at the 4-digit level in each province. The coefficients were multiplied by employment at each non-respondent establishment, this operation generating the required water use estimates, which were then added to the respondent data to produce the national totals.

5.2 WATER USE DATA FOR THE STRUCTURAL CHANGE MODEL

5.2.1 General Description of the Data

In selecting data for developing a test of the model outlined in Chapter four, two considerations were important: data availability and data disaggregation to a meaningful level. Considerations of data availability led to the adoption of an industry-by-industry approach, because water use data were unavailable on a commodity-by-industry basis.

To make the case study meaningful, in the sense that as the industrial breakdown used was as detailed as possible, a 30-industry format was adopted. The basis for this breakdown was Statistics Canada's medium level of reporting their input-output tables (Canada, 1979b, p. 11). At this level of disaggregation, some 43 industries are dealt with individually. The reaggregation to 30 industries was made by combining several industrial categories, which were unimportant for industrial water use. For example, the wholesale and retail trade sectors were placed in separate categories in the Statistics Canada medium level of reporting; for research purposes here they were combined.

Two exceptions were necessary to this procedure to make the 30-industry breakdown more useful in terms of industrial water use. First, the primary metals sector was split into "iron and steel" and "other primary metals". This modification was made because of the dominance of the iron and steel industry in the total water use of the primary metals sector. Second, "electric power" was split from the "electric power, gas and other utilities" sector. Again, this modification was made in recognition of the importance of the electric power industry in terms of industrial water use. The 30-industry breakdown which resulted from the above considerations is shown in Table 5.1.

Table 5.1 Details of the 30-Industry System Used

Primary Industries	Secondary Industries	Tertiary Industries
Agriculture	Food and Beverages	Construction
Forestry, Fishing Hunting and Trapping	Tobacco	Transportation, Storage and Communication
Metal Mining	Rubber and Plastics	Electric Power
Mineral Fuels	Leather	Gas and Other Utilities
Nonmetal Mining and Services Incidental to Mining	Textiles, Knitting Mill and Clothing	Wholesale and Retail Trade
	Wood Products	Other
	Furniture and Fixtures	
	Paper and Allied	
	Printing and Allied	
	Primary Metals, except Iron and Steel	
	Iron and Steel	
	Metal Fabricating	
	Machinery	
	Transportation Equipment	
	Electrical Products	
	Nonmetallic Mineral Products	
	Petroleum and Coal	
	Chemicals and Chemical Products	
	Miscellaneous Manufacturing	

To facilitate the discussion of data trends presented in this chapter, the data have been condensed from thirty to six sectors: agriculture; forestry, fishing, hunting and trapping; mineral extraction; manufacturing; electric power; and other tertiary industries. The detailed data are shown in Appendix A.

5.2.2 Estimation of Water Use Data for 1966

Estimation of the water use data for 1966 was based upon the 1972 data, combined with time series information on two major economic parameters, employment and the constant (1971) dollar value of output by industrial group (Statistics Canada, 1979, pp. 337-342; and pp. 445-450) The procedure adopted was a straight-forward one, based upon an assumed direct relationship between industrial water use and both of these parameters. For 1972, coefficients of water use per employee and per million dollars of output were calculated for each of the 30 industries. These coefficients were assumed to be constant for the 1966-1972 period. Thus, when they were multiplied by the 1966 industry values for employment and output respectively, the result was two sets of estimates of industrial water use for that year. These two sets were then averaged to produce the 1966 water uses for the case study. The detailed calculations resulting from using this method are tabulated in Appendix B for Canada and its five economic regions.

Two alternatives to the above procedure were investigated. First, consideration was given to not calculating 1966 water use data at all, and of limiting the case study to the 1972-1976 period. This alternative was rejected because a 4-year time period was of insufficient length to draw conclusions about structural change as it affects industrial water use. The second alternative involved using comparable U.S. water use data as the basis of "backcasting" the Canadian water use to 1966. The problem encountered here, however, was that the U.S. water use information was not compatible with the Canadian data with respect to the underlying characteristics of use rates, consumption rates and water use per employee. This finding meant that the U.S. data could not be used as the basis of Canadian water use estimations.

Regional water use estimates were prepared in a similar manner to that outlined for the national data, except that the 1974 regional data were used as the basis for estimation. Data on employment in 1966 were derived from Statistics Canada's annual surveys of industry, while output data were provided by that agency's Input-output Division, based on the unpublished 1966 interregional input-output table.

In some cases, mainly in the Atlantic and Prairie Regions, because of their limited industrial bases, employment data for the smaller industrial groups were unavailable because of confidentiality restrictions. For the manufacturing industries, the publications used reported the number of plants in each 4-digit SIC group by employment size range. Employment for the particular industry was estimated by number of plants in each employment size range by the mid-point employment of the range, and then summing over all size ranges. The regional employment data obtained in this manner was then added to the (known) employment of the other regions to approximate the national total employment in each group. These approximations were then compared to the published national totals, and minor adjustments made to the regional estimations in order to "force" the summed regional employment to the published totals for Canada.

For the non-manufacturing SIC groups, Statistics Canada sources were also used to obtain employment data. Such data are reported in the 1974 and 1978-79 Canada Yearbooks (Canada, 1974b, p. 323; Canada, 1978, p. 362), and also in specialty publications related to the mineral extraction industry (Canada, 1970, pp. A28-A30).

5.3 CANADIAN INDUSTRIAL WATER USE PATTERNS

In 1966, Canadian industries withdrew a total of 18 938 million cubic metres (m^3)of water in support of their operations (Table 5.2). By 1976, this total had increased by 45% to 26 894 million m^3 (an average annual growth rate of 3.8%). Because of recirculation,

Table 5.2 Industrial Water Intake, 1966, 1972 and 1976 (million cubic metres)

Sector	1966	1972	1976
Agriculture	3193.2	2854.5	3299.6
Forestry, Fishing, Hunting and Trapping	0.0	0.0	0.0
Mineral Extraction	364.7	362.0	667.3
Manufacturing	8049.8	8409.3	8672.2
Electric Power	6559.2	9320.6	13163.6
Others	771.4	987.2	1091.0
Total	18938.3	21933.7	26893.7

Source: Appendix Tables A-1, A-2 and A-3 these intake totals met gross water uses of 31 474 million m^3 in 1966, 34 956 m^3 in 1972 and 39 986 m^3 in 1976 (Table 5.3). The largest sector, in terms of total water intake in 1966 was manufacturing, but, by 1972, this sector had been displaced from its leading position by electric power. Since all of the water used by the electric power sector was accounted for by thermal power plants, the growth in water use by this sector is evidence of the inceasing reliance of certain Canadian power authorities (e.g. Ontario Hydro) on thermally-based generation, both conventional and nuclear.

5.3.1 An Overview by Industrial Sector

Patterns of water use vary markedly amongst different industries. One way to demonstrate this fact is by compiling statistics on the five main characteristics of water use, namely intake, recirculation, gross water use, consumption and discharge. Such compilations have been done in Table 5.3. for the years 1966, 1972 and 1976. In discussing the characteristics of industrial water use the greatest emphasis has been placed upon the two survey years, 1972 and 1976. The discussion draws upon some information in Appendix A, as well as on the tables included in the text.

Agriculture: Water use in the primary industries was dominated by the agriculture sector in both 1972 and 1976. Of the total agricultural withdrawal (2 855 million ^{3}) in 1972, 88% was accounted for by irrigation, principally in the Prairie Region. Irrigation was a heavy consumer of water, with 68% of withdrawal (1 709 million m^3) not being returned directly to receiving waters. The remaining 12% of withdrawal by this sector, some 334 million m^3, was required by

Table 5.3 Water Use Patterns by Industry, 1966, 1972 and 1976
(million cubic metres)

Sector	Intake	Recirculation	Gross Use	Consumption	Discharge
			1966		
Agriculture	3193.2	0.0	3193.2	2285.1	908.1
Forestry etc.	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	364.7	1889.2	2253.9	86.1	278.6
Manufacturing	8049.8	10646.1	18695.9	328.5	7721.3
Electric Power	6559.2	0.0	6559.2	71.3	6487.9
Others	771.4	0.0	771.4	0.0	771.4
Total	18938.3	12535.3	31473.6	2771.0	16167.3
			1972		
Agriculture	2854.5	0.0	2854.5	2042.8	811.7
Forestry etc.	0.0	0.0	0.0	0 .0	0.0
Mineral Extraction	362.0	1805.7	2152.5	87 .1	274.9
Manufacturing	8409.3	11328.4	19640.7	330 .0	8079.3
Electric Power	9320.6	0.0	9320.6	101 .3	9219.4
Others	987.2	0.0	987.2	0.0	987.2
Total	21933.7	13044.1	34955.6	2561 .2	19362.7
			1976		
Agriculture	3299.6	0.0	3299.6	2369.0	930.7
Forestry etc.	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	667.3	1730.3	2397.6	105.2	562.2
Manufacturing	8672.2	11357.5	20034.6	456.5	8215.6
Electric Power	13163.6	0.0	13163.6	160.4	13003.2
Others	1091.0	0.0	1091.0	0.0	1091.0
Total	26893.7	13092.6	39986.4	3091.1	23802.7

Source: Appendix Tables A-1, A-2 and A-3.

stockwatering. All of this water is considered here as having been consumed. Thus, with two principal activities which consume most of their withdrawals, water consumption in agriculture totalled 72% of intake (2 043 million m^3).

By 1976, intake in the agricultural sector had increased to almost 3 300 million m^3. Irrigation water withdrawals increased slightly to 89% (2 951 million m^3) of the sector's total withdrawal. The proportion of this total which was consumed fell to 61% (from 68% in 1972). When the withdrawals by stockwatering (348 million m^3) are considered, the sectoral consumption rate remained at 72% of total withdrawals. This consumption rate was the highest by far of any sectoral rate in Canadian industry in both years discussed here.

Forestry, Fishing, Hunting and Trapping: There was no record of significant water withdrawal by any of the activities in this sector. This does not suggest that water had no importance here, but merely that nonwithdrawal water uses were overwhelmingly more important. In fact, most of the sector's activities could not exist without water. However, the sector is of no importance for this research, since there were no water withdrawals.

Mineral Extraction: Three major subsectors, metal mining, mineral fuels and nonmetal mining, comprise the mineral extraction sector. In 1972, the total withdrawal of 362 million m^3 was dominated equally by the metallic and nonmetallic minerals subsectors (at about 160 million m^3 each), with the mineral extraction sector lagging substantially at 42 million m^3. Water recirculation was significant in the metal mining subsector in meeting the total gross water use of 2 152 million

m^3. The use rate in this subsector was over 10, compared to use rates in the nonmetal and mineral fuels subsectors of 2.2 and 2.6 respectively. All of the recirculation in the latter subsector occurred in coal mining. The other activity comprising the mineral fuels subsector, the extraction of crude petroleum and natural gas, used water for well injection to maintain pumping pressures. None of this water was recirculated.

Water consumption in the mineral extraction sector totalled 87 million m^3, or 24% of total withdrawal in 1972. Amongst the subsectors, the consumption rate varied between 8.5% in metal mining and over 90% in mineral fuels. The high consumption rate in the latter subsector reflected the fact that all of the water used for deep well injection was consumed.

By 1976, water intake in this sector had increased by 84% to 667 million m^3. A significant factor in this increase was a 3.4-fold climb in water intake by the metal mining sector. Accompanying this change was a substantial decline in the use rate to 3.7 (cf. over 10 in 1972). At the same time, recirculation in the nonmetal mining sector rose to 4.5 (from 2.2 in 1972), causing a fall in the amount of water withdrawn by plants in this subsector. Water withdrawals in the mineral fuels subsector decreased slightly to 39 million m^3, reflecting a fall in the amount of water used for deep well injection. All of these factors combined to produce a sectoral use rate of 3.7 and a consumption rate of 16% in 1976. These represented changes from 6.0 and 24% respectively in 1972.

Manufacturing: In 1972, the manufacturing sector as a whole withdrew the second largest amount of water, after electric power, of any of the withdrawal sectors included in this research, some 8 409 million m^3. Of all the sectors, manufacturing is the most complex to describe, because it includes 20 subsectors at the two digit SIC level. For this reason, in a later section of this chapter, supplementary descriptive detail will be provided on manufacturing. In the present section, the purpose is to describe the aggregate patterns of water use in the sector.

The total water intake in 1972 was "stretched" some 2.3 times via recirculation to meet a total gross water use of 19 641 million m^3. The consumption rate was slightly above 4% for the sector as a whole (330 milllion m^3). This constituted one of the lowest rates of any of the sectors.

By 1976, the water withdrawals by firms in the manufacturing sector had increased to 8 672 million m^3; this represented an annual increase of 0.7% on a compound basis. Gross water use increased at an even slower annual rate of 0.5%, to a total of 20 035 million m^3. Both of these rates were below the sectoral growth rate of output, as will be shown in a later table. The use rate remained unchanged at 2.3, while the consumption rate increased to 5.2% of total intake.

Electric Power Generation: In both 1972 and 1976, this sector (which included both conventional coal- and oil-fired and nuclear generation plants) withdrew the largest amounts of water of any sector. The withdrawal of 9 321 million m^3 constituted over 40% of total national industrial withdrawal in 1972. This percentage rose to just under

50% in 1976, indicating a relatively rapid sectoral growth rate of 9% per year. This growth rate represented the combined effects of rapid growth in electricity demand throughout the country and a gradual increase in the proportion of generating capacity accounted for by nuclear power plants, which use relatively more water than the conventional coal- and oil-fired thermal plants. There were no recorded instances of recirculation of water at any of the thermal power stations in either of the two years under discussion.

In relation to their combined total withdrawal, thermal power plants consumed a relatively low amount of water; the consumption rates for both years was just over 1%. The fact that no water recirculation occurred in the sector, and therefore that no cooling towers or cooling ponds were in use, was responsible for the observed low amount of consumption in the sector.

Other Tertiary Industries: Five subsectors were included in this residual category: construction; transportation, storage and communication; gas and other utilities; wholesale and retail trade; and "other". The latter subcategory included firms devoted to financial management (e.g. banking, insurance, etc.), entertainment and other related activities which are insignificant in terms of industrial water use despite their high monetary value.

The total water use in this sector consisted of withdrawls by the wholesale and retail trade subsector. These withdrawals, which were based upon statistics developed by Tate and Lacelle (1977), totalled 987 million m^3 in 1972 and 1091 million m^3 in 1976. There was neither any recirculation nor any consumption in this subsector.

5.3.2 Water Intake by Source

Industrial water sources are shown in Table 5.4. There were no data available on the sources of water used in the agricultural sector,

Table 5.4 Industrial Water Intake by Source, 1972 and 1976
(million cubic metres)

Sector	Public Water	Self-Supplied Surface Water	Self-Supplied Ground Water	Self-Brackish and Mine Water	Total
			1972		
Agriculture		information not available			2854.5
Forestry, etc.	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	8.3	303.9	22.7	27.1	362.1
Manufacturing	1248.1	6670.1	205.6	379.4	8420.4
Electric Power	3.5	8238.1	7.8	1071.3	9320.6
Others	987.2	0.0	0.0	0.0	987.2
Total	2247.1	15212.1	236.1	1477.8	21933.7
			1976		
Agriculture		information not available			3299.6
Forestry, etc.	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	84.4	481.3	64.1	37.6	667.3
Manufacturing	1119.6	7110.7	83.0	359.6	8672.2
Electric Power	5.7	9901.9	2.4	3253.6	13163.6
Others	1091.0	0.0	0.0	0.0	1091.0
Total	2300.7	17493.2	149.5	3650.9	26893.7

Source: Appendix Tables A-4 and A-5.

as noted in these tables, although it is reasonable to assume that much of the sector's water supply was drawn from self-supplied surface water, with some stockwatering withdrawals being derived from ground water.

In both 1972 and 1976, self-supplied surface water sources were exploited most extensively, supplying 80% of the known water withdrawals in the former year, 74% in the latter. For mineral extraction, manufacturing and electric power, self-supplied surface water was the most frequent source, but, for manufacturing, it was slighly less important. Public water supplies were also important for manufacturing, reflecting two factors: (a) there were many smaller operations in this sector which tended to be connected to public systems (i.e. not large enough to have their own water intake systems); and (b) some of the subsectors (e.g. food and beverages) required high quality potable water.

Public water systems supplied the second most frequent source in 1972, but fell to third position in 1976, with brackish and mine water assuming second position in that year. Brackish water was relatively important for electric power plants in both years, and was also significant for manufacturing. In both years, ground water sources were relatively unimportant (236 m^3 and 150 m^3 respectively).

5.3.3 Water Intake by Purpose

Industry, as the term is used in this paper, exhibited a large variety of water uses, making it difficult to generalize, since, even within individual industry groups, methods and purposes for using water could vary substantially. Many factors account for these variations, such as technology employed, scale of operations, locality of the plant, and many others. For statistical purposes here, it is sufficient to describe the purpose of water intake in terms of four categories, as shown in Table 5.5

Table 5.5 Industrial Water Intake by Purpose, 1972 and 1976 (million cubic metres)

Sector	Process	Cooling, Condensing and Steam	Sanitary Service	Other	Total
			1972		
Agriculture	2854.5	0.0	0.0	0.0	2854.2
Forestry, etc.	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	219.2	87.5	3.8	51.5	362.1
Manufacturing	4062.2	4009.6	124.6	213.0	8409.4
Electric Power	0.0	9320.6	0.0	0.0	9320.6
Other	0.0	0.0	987.2	0.0	987.2
Total	7135.9	13417.7	1116.6	264.6	21933.7
			1976		
Agriculture	3299.6	0.0	0.0	0.0	3299.6
Forestry, etc.	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	385.7	120.5	80.3	80.8	667.3
Manufacturing	3464.3	4630.0	401.6	176.5	8672.2
Electric Power	0.0	13163.6	0.0	0.0	13163.6
Other	0.0	0.0	1091.0	0.0	1091.0
Total	7149.6	17913.9	1572.9	257.3	26893.7

Source: Appendix table A-7.

Process water was defined in the survey questionnaires as water which comes into contact with the product in some manner, for example through washing or incorporation into products. Cooling, condensing and steam generation are self-explanatory water uses, and all involve some type of heat transfer process. This group of uses involved water circulation in systems separate from those of the product. Water for sanitation purposes is likewise self-explanatory. Water used for this purpose is frequently derived from public supply systems. The "other" category is a residual one used to account for uses such as landscaping and general plant maintenance.

In both years for which data have been collected, cooling, condensing and steam generation were the most frequent uses of water intake, accounting for 61% of withdrawal in 1972 and 67% in 1976. One factor contributing to this dominance was the fact that the largest water user, electric power, used practically all of its intake for this purpose. The second most frequent use of new water intake was for processing. All agricultural withdrawals were considered to be in this category, as were considerable portions of manufacturing intake. Sanitary purposes accounted for between 5% and 6% of total intake in both years. The increase in snaitary water use between the two periods is a survey result, for which no explanation has been found.

5.3.4 Water Use in Manufacturing

Twenty of the thirty sectors included in Table 5.1 are sub-sectors of manufacturing. Thus, the manufacturing sector exhibited a wide variety of water use patterns. To show the diversity of manufacturing water use, this section of the chapter is devoted to a description of the basic water use characteristics for the most important components of manufacturing. The statistics for this description are given in Table 5.6 and 5.7 for 1972 and 1976 respectively.

Table 5.6 Water Use Patterns for Major Water-using Manufacturing Groups, 1972 (million cubic metres)

Sector	Intake	Recirculation	Gross Use	Consumption	Discharge
Food and Beverages	380.1	160.9	541.0	25.1	355.0
Rubber and Plastics	353.9	111.7	465.6	2.8	351.1
Wood	175.3	43.4	218.7	5.3	170.0
Paper and Allied	3094.3	6594.5	9688.7	111.8	2982.4
Primary Metals[1]	356.8	505.1	861.9	8.5	348.63
Iron and Steel	1291.7	796.2	2087.8	35.5	1256.2
Transportation Equip't	192.4	85.9	272.3	8.0	184.4
Non-metallic Mineral Prod.	133.2	122.6	255.7	5.9	127.3
Petroleum and Coal	699.9	781.0	1481.0	35.3	664.6
Chemicals etc.	1524.8	1830.5	3355.3	93.9	1430.9
Total	8202.2	11031.9	19234.1	331.9	7870.3

1. except iron and steel.
Source: Appendix Table A-2.

Ten components of the manufacturing sector accounted for between 97% and 98% of the sectoral water intake in both years under discussion. The paper and allied products industry was most important in terms of intake, with 37% of the manufacturing total in 1972, and 36% in 1976. The next three industries in order of importance were chemicals and chemical products, iron and steel, and petroleum and coal products.

Table 5.7 Water Use Patterns for Major Water-using Manufacturing Groups, 1976
(million cubic metres)

Sector	Intake	Recirculation	Gross Use	Consumption	Discharge
Food and Beverage	358.8	161.9	520.6	31.0	327.8
Rubber and Plastics	59.5	80.6	140.0	5.4	54.1
Wood	331.4	157.5	488.8	8.6	322.7
Paper and Allied	3132.8	5735.6	8867.7	170.3	2961.7
Primary Metals[1]	726.4	1087.4	1813.8	36.4	690.13
Iron and Steel	1367.9	888.9	2256.6	40.3	1327.6
Transportation Equip't	375.7	427.2	802.9	2.2	373.5
Non-metallic Mineral Prod.	94.7	151.8	246.5	15.5	79.1
Petroleum and Coal	615.7	1017.2	1633.0	35.4	580.4
Chemicals etc.	1462.7	1547.6	3010.3	104.1	1358.6
Total	8524.8	11255.5	19780.3	449.2	8075.7

1. except iron and steel.
Source: Appendix table A-3

As shown earlier, the national use rate for the manufacturing sector, indicating the importance of recirculation, was 2.3 in both 1972 and 1976. Use rates varied quite widely amongst the sector's component industries (Table 5.8), with the highest aggregate rates being experienced in the paper and allied products industry (3.13 in 1972 and 2.83 in 1976). The lowest rates were experienced in the wood products and the food and beverages sectors. As shown in Table 5.8, the use rates for most of the components of manufacturing rose between 1972 and 1976. The notable exception to this statement was the largest

Table 5.8 Use Rates and Consumption Rates for Major Water-Using Manufacturing Groups; 1972-1976

Sector	Use Rates[1] 1972	1976	Consumption Rates[2] 1972	1976
Food and Beverages	1.42	1.45	0.07	0.09
Rubber and Plastics	1.32	2.35	0.01	0.09
Wood	1.25	1.48	0.03	0.03
Paper and Allied	3.13	2.83	0.04	0.05
Primary Metals[3]	2.42	2.50	0.02	0.05
Iron and Steel	1.62	1.65	0.03	0.03
Transportation Equipment	1.45	2.14	0.04	0.01
Non-metallic Mineral Prod.	1.92	2.60	0.04	0.16
Petroleum and Coal	2.12	2.65	0.05	0.06
Chemicals etc.	2.20	2.06	0.06	0.07
National Manufacturing	2.33	2.31	0.04	0.05

1. The use rate is computed by dividing gross water use by water intake.
2. The consumption rate is computed by dividing consumption by water intake.
3. except iron and steel

Source: Appendix Tables A-2 and A3.

water use, paper and allied products, where the decline in recirculation relative to intake was exactly sufficient to offset the effects of the apparent rise in recirculation in the other component industries.

Consumption rates for the major water-using manufacturing groups are also shown in Table 5.8. Again, the influence of the largest water user can be seen, for the consumption rates for paper and allied products is the same as the national rates for manufacturing.

Table 5.9 Water Intake by Region, 1972 and 1976
(million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairie	British Columbia	Total
			1972			
Agriculture	20.5	74.7	128.1	2160.2	470.9	2854.6
Forestry, etc.	0.0	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	47.8	58.6	73.4	134.0	48.3	362.1
Manufacturing	974.1	1692.0	3991.5	362.7	1387.0	8409.3
Electric Power	1162.6	413.7	5629.2	2058.3	56.8	9320.6
Other	73.2	339.4	355.4	111.0	108.2	987.2
Totals	2280.3	2578.3	10177.7	4826.2	2071.2	21933.7
			1976			
Agriculture	24.0	50.7	155.6	2555.1	519.9	3299.7
Forestry, etc.	0.0	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	111.3	222.6	155.2	103.6	75.3	667.4
Manufacturing	943.9	1863.8	3948.7	352.3	1563.6	8672.3
Electric Power	3004.5	433.1	6685.6	2384.7	655.8	13163.6
Other	81.0	375.4	392.3	122.7	119.6	1091.0
Totals	4164.7	2945.5	11337.5	5512.9	2933.4	26893.7

Source: Appendix Tables A-9 and A-11.

5.3.5 Regional Water Use

Industrial water intake by region for 1972 and 1976 is indicated in Table 5.9. In both years, total intake was dominated by Ontario. Ontario's predominance over Quebec, the next most industrialized region, was accentuated in terms of industrial water use because of the importance of thermal power generation in Ontario. Quebec relied overwhelmingly on hydroelectric generation as a source of energy, and since hydro power is a nonwithdrawal water use, it has not been included here. The Quebec region, in fact, was only third (in 1972) and fourth (in 1976) in terms of regional water intake, since the relatively large amounts of irrigation water used in the Prairie region enhanced that region's position in the total national water withdrawal. The rapid growth of electric power generation in the Atlantic region led to the region's change from fifth position in 1972 to third position in 1976 with respect to water withdrawal. The gross water use statistics (Table 5.10) show essentially the same regional patterns as those outlined for water intake.

A somewhat different regional pattern emerged in terms of water consumption, as compared to that described for water intake. For water consumption , the national total in both 1972 and 1976 was dominated by the Prairie region (Table 5.11). The high amounts of water consumed in the region for irrigation and stockwatering were responsible for this dominance. The same factor tended to increase water consumption in British Columbia.

In terms of the present research, it is important to note that the water use patterns for both intake and consumption were quite dif-

Table 5.10 Gross Water Use by Region, 1972 and 1976
(million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairie	British Columbia	Total
1972						
Agriculture	20.5	74.7	128.1	2160.2	470.9	2854 .6
Forestry, etc.	0.0	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	171.7	258.9	1236.0	324.6	161.7	2152.5
Manufacturing	2188.7	4264.0	7422.1	1629.3	4136.7	19640.7
Electric Power	1162.6	413.7	5629.2	2058.3	56.8	9320.6
Other	73.2	339.4	355.4	111.0	108.2	987.2
Totals	3616.2	5350.8	14770.9	6283.5	4934.2	34955.6
1976						
Agriculture	24.0	50.7	155.7	2550.1	519 .3	3299.7
Forestry, etc.	0.0	0.0	0.0	0.0	0 .0	0.0
Mineral Extraction	553.9	677.3	634.1	316.6	215.7	2397.6
Manufacturing	1869.8	4255.6	8181.3	1829.4	3928 .8	20034.6
Electric Power	3004.5	433.1	6685.6	2384.7	655 .6	13163.6
Other	81.0	375.4	392.3	119.6	122.7	1091.0
Totals	5533.2	5762.0	16048.8	7203.6	5439 .0	39986.5

Source: Appendix Tables A-12 and A-14.

Table 5.11 Water Consumption by Region, 1972 and 1976 (million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairie	British Columbia	Total
			1972			
Agriculture	20.2	74.5	101.7	1623.8	222.6	2042.8
Forestry, etc.	0.0	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	3.5	7.8	2.0	67.9	6.0	87.1
Manufacturing	35.1	66.2	148.7	34.6	66.5	351.0
Electric Power	1.4	0.0	98.3	1.3	0.3	101.3
Other	0.0	0.0	0.0	0.0	0.0	0.0
Totals	60.2	148.5	350.7	1727.6	295.3	2582.2
			1976			
Agriculture	23.6	50.5	123.4	1928.0	244.5	2369.0
Forestry, etc.	0.0	0.0	0.0	0.0	0.0	0.0
Mineral Extraction	12.1	19.1	24.1	41.3	8.6	105.2
Manufacturing	51.2	112.3	158.3	46.9	86.8	456.5
Electric Power	15.0	17.0	116.7	6.4	4.9	160.4
Other	0.0	0.0	0.0	0.0	0.0	0.0
Totals	102.1	199.4	422.4	2022.5	344.7	3091.1

Source: Appendix Tables A-15 and A-17.

ferent from what one would expect based on economic characteristics alone. Specifically, production patterns alone would give more emphasis to Quebec and Ontario, and less to the Atlantic and Prairie Regions.

5.4 IMPLICATIONS FOR THE CURRENT RESEARCH

The water use data described in this chapter were used in developing the coefficients for the structural change model. The sources of information and the methods used in compiling the coefficients are described in detail in Appendix C.

Patterns of industrial water use, both amongst industries and between regions, clearly reflect the underlying regional industrial structures. Numerous examples have been shown in this chapter. For instance, in areas where thermal power generation is a significant activity, water withdrawal is high, especially since no Canadian power plants recycle water at the present time. In areas where irrigation is important, water consumption is high. In areas where heavy industry locates (e.g. in the Great Lakes basin) water withdrawals are high, water consumption is moderate and consequently return flow is also high. The objective of this research is to examine the role of structural change factors in determining how the regional water use patterns change over time. This subject is addressed in the next chapter.

CHAPTER VI

WATER USE AND STRUCTURAL CHANGE: AN EMPIRICAL TEST

An empirical test of the model developed in Chapter four is presented in this chapter. In that model, three principal forces related to structural change were suggested to underlie the change in industrial water use over time, namely changes in final demand, changes in production technology and changes in the intensity of water use within various industries. This chapter will show how these forces were made operational and were analyzed.

The methods used for the investigation are outlined in the next section. This outline is followed by a discussion of indices which measure industrial water use in the context of industrial structure. An outline of industry-specific results from the analysis is then presented. This is followed by a discussion of the results of using a least squares type of analysis on the quantified structural change data. Finally, the principal findings of the test will be outlined.

6.1 OUTLINE OF THE INVESTIGATION

6.1.1 Data Compilation

Inverse Matrices: As outlined in Chapter two, the square form of input-output table was used for this research, because of the nature of available water use data. The required input-output tables and their inverse matrices were derived from Statistics Canada data, and were produced by members of the Input-Output Division staff of that agency. The Statistics Canada input-output tables are in a rectangular, commodity-by industry form. The conversion of the rectangular tables to a square format has been outlined briefly in Chapter two.

Since the analysis was concerned with changes in domestic water use and domestic productivity, either national or regional, the inverse matrices used were calculated as excluding imports. With imports exogenous, changes in domestic productivity, and subsequently demestic water uses alone could be examined.

Since the analysis was concerned with changes in domestic water use and domestic productivity, either national or regional, the inverse matrices used were calculated as excluding imports. With imports exogenous, changes in domestic productivity, and subsequently demestic water uses alone coould be examined.

For the regional portion of the analysis, 1966 input-output inverse matricies were unavailable. The 1966 exercise carried out by Statistics Canada was an experiment, aimed at testing procedures for interregional input-output analysis in Canada. The exercise was not completed to the publication stage due to some technical problems, such as definitional inconsistencies and compilation problems. For this reason, the table was not used in its inverted form in this thesis. However, because of the nature of the algoritm used here, it was not required. According to equation 4.2:

$$w^t = F^t.M^t.y^t$$

(where all symbols were defined previously.) Thus, the inverse for any one year is implicit in the total water uses for the system's industries. Since the 1966 water uses were estimated as part of the research, the 1966 regional inverses were not required.

National Final Demand and Output Data: All of the national analyses were conducted in terms of 1971 dollars in order to discount the effects of inflation. The year 1971 was chosen as the base year because Statistics Canada's constant dollar input-output tables were published in terms of 1971 dollars (Statistics Canada, 1982). The final demand data for 1966, 1972, and 1976 were derived directly from computer runs by the Input-Output Division staff of Statistics Canada.

The output data for 1972 and 1976 used in calculating the water use coefficients were derived by solving the conventional input-output equation linking final demand and output (i.e. equation 2.5). For 1966, a small problem arose due to change in the deflationary procedures used to compile the constant dollar input-output data. To circumvent this problem, the Input-Output Division provided data on 1966 outputs by industry groups in terms of 1961 dollars, 1971 outputs in terms of 1961 dollars and 1971 outputs in terms of 1971 dollars. The conversion of the 1966 outputs to 1971 dollars is given by:

$$\text{1966 outputs(\$'71)} = \frac{\text{1966 outputs(\$'61).1971 outputs(\$'71)}}{\text{1971 outputs (\$'61)}}$$

The detailed data and calculations used in this procedure are given in Appendix E.

Regional Final Demand and Output Data: The regional portion of the test was carried out in terms of 1974 dollars, because 1974 was the year for which the latest regional input-output data were compiled. Final demand data for 1974 were provided by the Input-Output Division of Statistics Canada, and the outputs were computed by the input-output model.

For 1966, final demand and output vectors were somewhat more difficult to compile, and the following method was used. The first inter-regional input-output table produced by Statistics Canada had 1966 as a base year, and was never published, having been superceded by the 1974 table. This initial inter-regional modelling effort had been removed from computer files by the time the present research was begun, making it necessary to work from printouts of the original input-output tables. It was assumed at the outset that the methods used to compile the 1966 tables were similar to those used for the 1974-based exercise. In any event, having available the 1966 table, even in its current form, was judged superior to constructing compatible output and final demand vectors for 1966 from first principles.

The 1966 tables had been compiled in a commodity by industry format for each of the five Canadian regions. Thus, the initial step required was to collapse the commodity dimension into the appropriate industrial categories. The groupings of commodities into industry groups is shown in Appendix F. For two of the industrial groups, primary metals and electric power, gas and other utilities, a more detailed breakdown of output and final demand data was required. It will be recalled that, in the 30-industry breakdown used in the present research, the primary metals industry consisted of iron and steel and other primary metals; the electric power, gas and other utilities sector consisted of electric power (alone) and gas and other utilities. The necessary adjustment was made by splitting the 1966 data into the required industrial groups on the basis of regional employment totals (in the case of primary metals) and regional labour force totals (in the case of electric power, gas and other utilities).

The 1966 regional tables following the compilation into the 30 industrial groups recorded interindustry flows and total output, but not final demand, for each industrial group. Final demand was taken as the algebraic difference between total output and final demand for each group. Thus, at the end of this process, the required final demand and total output vectors were compiled in terms of 1966 dollars based upon the original 1966 interregional tables.

From the national data compilation, national final demand and output vectors were available for 1966 in terms of constant 1971 dollars. The regional final demands and outputs were used to prorate the national vector to the component regions. Thus, the national and the regional analyses used comparable 1966 economic data. The regional outputs and final demands were inflated to 1974 dollars using the ratio of outputs in 1974 terms (Statistics Canada, 1983, pp. 156-161) to outputs in constant 1971 terms (Statistics Canada, 1982, pp. 99-104). The complete set of calculations required to derive the 1966 final demand and outputs vectors in terms of 1974 dollars is shown in Appendix F.

<u>Derivation of Water Use Coefficients</u>: The compilation of water use statistics used in this research was documented in Chapter five. For the purposes of testing the structural change framework, water intake and gross water use parameters were used. In the discussion which follows, the term "water use" refers to either of the parameters used in the calculations. The water use coefficients for the model were computed simply by dividing the total amount of water reported for each parameter in each industry by the total output for that industry.

6.1.2 <u>An Index Measure of Water Use and Industrial Structure</u>

For descriptive purposes, the distribution of water use as related to industrial structure can be measured using a Lorenz curve (Samuelson, 1961, p.120) Lorenz curves are generally used to measure and illustrate income distributions in an economy. Income earners are stratified with respect to their income levels. The percentage of income earners in each stratum is then plotted against the percentage of national income earned by each respective group. A perfectly even income distribution would plot as a 45 degree line on normal graph paper. The more uneven the income distribution, the more concave is the Lorenz curve to the 45 degree line. An index of the degree of inequality of the income distribution could be obtained by integrating the area under the curve. The smaller the value which results obtained from this integration procedure, the more uneven the income distribution. If the index is compared for different time periods, the movement of the income distribution towards or away from equality can be determined. In sum, this procedure measures the changing structure of income distribution in the economy.

This type of analysis was adapted to describe changing responses of water use to industrial structure for the time spans being dealt with in this research. Industries were ordered with respect to their percentage contribution to total industrial water use. These were then plotted against the corresponding percentage contributions to output value. The "curve" resulting was actually a series of steps because of the discreteness of the data. A numerical integration procedure could therefore be used to calculate the area under the "curve". Comparing these areas over time allowed observations to be made about the aggregate response of water use to changes in industrial structure.

6.1.3 Water Use Simulations and Shifts

Four vectors of shifts in industrial water use were calculated for each time period. Equation 4.2 was used to perform these shift calculations, with the procedure being to alter sequentially each of the components of the equation; this procedure is summarized in Table 6.1. By using equations 4.4, 4.5 and 4.6, the water use shifts due to changes in water use, final demand and production technology were calculated. For use in the least squares analysis, these shifts were normalized by dividing each industry's shift figure by the average interperiod output in the respective industry groups.

Table 6.1 Summary of Water Use Shift Calculations

Simulation Number	Water Use Coefficient Vector	Final Demand Vector	Input-Output Inverse	Product
1	final	final	final	$F^t.M^t.y^t$
2	initial	final	final	$F_t.M^z.y^t$
3	initial	initial	final	$F^t.M^z.y^z$
4	initial	initial	initial	$F^z.M^z.y^z$

final = the vector or matrix component of equation 4.2 related to the final year of the period,
initial = the vector or matrix component of equation 4.2 related to the initial year of the period.
All symbols are as defined in Chapter 4.

6.1.4 Least Squares Analysis

The least squares analysis of the normalized water use shift data was performed to examine which of the three structural change factors was most closely related to the total interperiod change in water use. As outlined in developing the analytical framework, this procedure cannot be termed a linear regression analysis in the conventional sense in view of the absence of an error term in the estimating data. Nevertheless, the coefficient of determination (R^2) can be used as a measure of the amount of total variation explained by each structural change factor. The analysis was conducted across industries for one time period. This allowed overall observations to be made on the correlations of the three factors to changes in total water use. Those sectors with no recorded water use were omitted from the analysis.

6.1.5 Analysis of Predominant Factors of Change

Each of the water use shift measurements were either positive or negative in their impact on sectoral water use. A Kolmogorov-Smirnov analysis on the distribution of signs amongst the various possibilities was used to determine the predominant patterns of influence of the various factors on changes in water use. These analyses were conducted for both water intake and gross water use and for each time period in turn. Again, those sectors with no recorded water use data were omitted from the analysis.

6.2 INDUSTRIAL WATER USE RESPONSES TO INDUSTRIAL STRUCTURE

An overview of the results obtained from the empirical test of the structural change model is presented in this section . The Lorenz curve description of the responses of water use to industrial structure is dealt with first. The shifts in industrial water use are then examined under the major categories of agriculture, mineral extraction, manufacturing, electric power and other uses. The results of the Kolmogorov-Smirnov analysis of sign distribution are then outlined, followed by the results obtained using the least squares analysis across industries, and regions.

6.2.1 Lorenz Curve Analysis

The distribution of industrial water use in response to industrial structure over the time period of analysis was highly polarized (Table 6.2). As shown in Chapter five and verified by the Lorenz curve analysis, a few industrial groups accounted for a large proportion of total water use for both water intake and gross water use parameters. In contrast, a few industries, which accounted for a substantial

Table 6.2 Lorenz Curve Analysis of the Response of Industrial Water Use to Industrial Structure, by Water Use Parameter, Canada and Regions, 1966-1976

Area Covered	Year	Area Under Curve	
		Water Intake	Gross Water Use
Canada	1966	0.1195	0.0848
Canada	1972	0.0613	0.0648
Canada	1976	0.0555	0.0589
Regions			
Atlantic	1966	0.0857	0.0818
Atlantic	1974	0.0722	0.1237
Quebec	1966	0.1457	0.1154
Ontario	1966	0.0592	0.0707
Ontario	1974	0.0394	0.0679
Prairies	1966	0.0911	0.0991
Prairies	1974	0.1046	0.1225
B.C.	1966	0.0938	0.1092
B.C.	1974	0.1092	0.0914

proportion of economic output, had no reported water use. If the latter industries were to be excluded, there would be more area under each curve, indicating a more even distribution of industrial water use with regard to industrial structure, but there would still be a pronounced polarization.

The trends indicated that this polarization was increasing over time, for both Canada and its regions. For instance, the index of polarity for national water intake decreased from 0.1195 in 1966 to 0.0555 in 1976. This trend indicates that the large water-using industries accounted for an increasingly higher proportion of total industrial water use over the decade. The only exception to this finding occurred in the Atlantic region for the gross water use parameter over the 1966-1974 period.

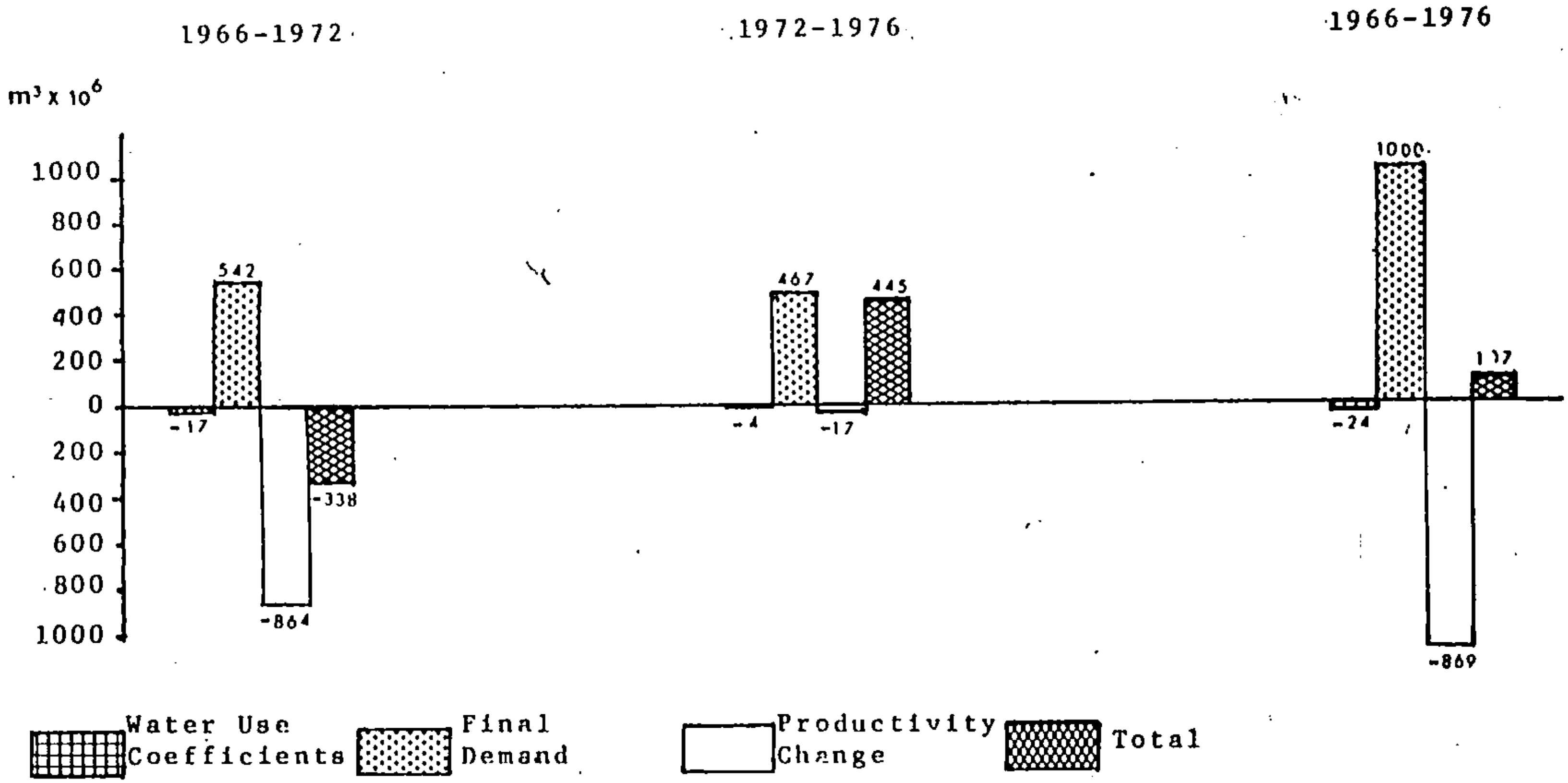
The polarization index was generally higher for the regions, indicating that industrial water use was less polarized for the regions than for Canada as a whole. For each region across the 1966-1974 period, the ordering of industries with respect to their total water use for both parameters was constant. This finding verified the national trend that the large water using industries were accounting for an increasing proportion of total water use.

6.2.2 Water Use Shifts in Response to Structural Change

The effects of changing water use patterns, final demands and production technologies are quantified in this section of the chapter. Heavy reliance is placed here on the detailed statistical material contained in Appendix D. Summaries only of this material are included in the text.

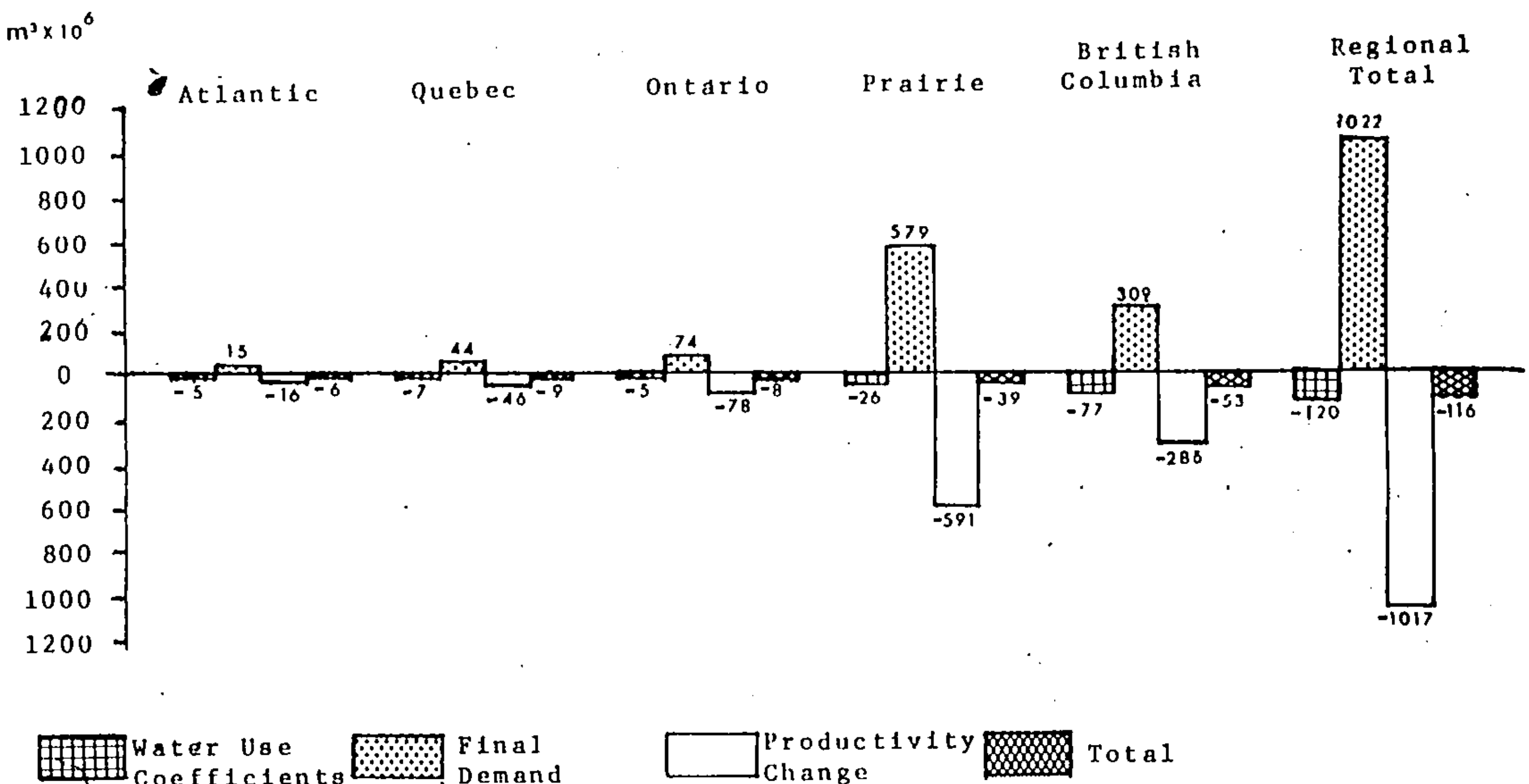
Agriculture: The data on water use shifts between 1966 and 1976 are shown in histogram form in Figure 6.1 for Canada and Figure 6.2 for the regions. Water intake and gross water use have the same statistics since there was no recorded recirculation. Water use declined in the 1966-72 period by 339 million m^3, and then increased in the 1972-76 period by 445 million m^3. The net effect of these trends was an increased water use of 106 million m^3 over the 1966-76 period. In general, because of the high proportion of irrigation water use in the agriculture sector, agricultural water use tends to increase during dry years. The climatic influence is reflected in the water use

Figure 6.1 Effects of Structural Change on Agricultural Water Use by Factor, Canada, 1966 - 1976



Source: Appendix Tables D-1 to D-16

Figure 6.2 Effects of Structural Change on Agricultural Water Use by Factor, Regions, 1966-1974



Source: Appendix Tables D-1 to D-16

coefficient component of the structural change model.

Changes in production technology had the greatest influence on the decrease in water use between 1966 and 1972 (−864 million m^3) and continued to act negatively between 1972 and 1976 (−17 million m^3). For the entire period, this negative influence totalled −869 million m^3. The decline in water use was due to increased productivity in the industry, as reflected by the input and output linkages for the five industries most closely related to agriculture (Table 6.3). The input coefficients declined almost without excep-

Table 6.3 Trends in Input and Output Linkages by the Five Sectors Most Closely Linked to Agriculture,[1] Canada, 1966-1976

	Input Linkages		
	1966	1972	1976
Food and beverages	0.19359	0.14244	0.14318
Trade	0.11779	0.05479	0.05181
Chemicals, etc.	0.08247	0.03269	0.04025
Petroleum and Coal	0.07665	0.04534	0.03845
Electric Power	0.04003	0.05071	0.02252
	Output Linkages		
	1966	1972	1976
Food and Beverages	0.43209	0.32235	0.32034
Trade	0.08256	0.01521	0.01758
Leather Products	0.03422	0.01022	0.00925
Chemicals, etc.	0.02481	0.01067	0.00902
Wood Products	0.02453	0.00671	0.00756

1. excluding the industrial sectors with no water use, and the agriculture sector itself.

Source: Appendix Tables F-1 through F-8.

tion over the 1966-76 period, showing that fewer inputs per dollar of final demand were required towards the end of the period. The output coefficients also declined over this period, showing that fewer outputs were required of the agriculture sector per unit of final demand in the five most closely linked sectors. This decline in both input and output coefficients demonstrates the increasing productivity over time, which led to a decline in water use due to "pure" changes in this factor.

The influence of final demand was large and positive for both water intake and gross water use. In the 1966-1972 period, this positive influence totalled 542 million m^3, decreasing to 467 million m^3 in the 1972-1976 period. Thus, the net effect of final demand was to increase industrial water use by about 1,000 million m^3 over the entire decade.

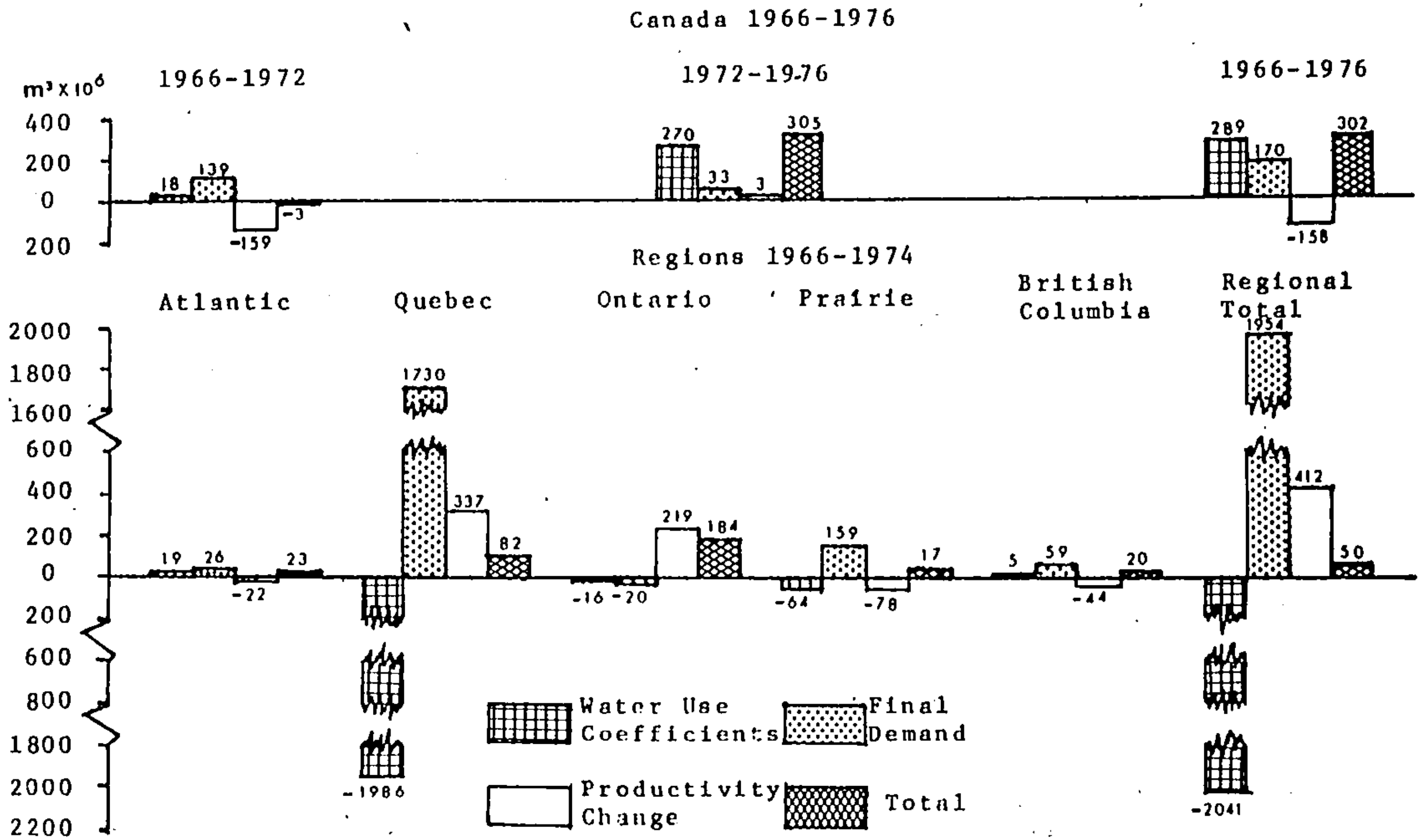
Changes in the water use coefficients over the period of study showed a marginally negative impact in both the 1966-1972 period (-17 million m^3) and the 1972-1976 period (-4 million m^3). This effect occurred because the water use coefficients declined in the majority of cases through this decade, showing a short-term trend to increasing the efficiency of water use.

The regional effects of the three structural change patterns over the period 1966-1974 mirrored exactly the national patterns, with negative influences being shown by the production technology and water use cofficient factors and strongly positive influences by the final demand factor. For all factors, the influences were most strongly felt in the two western regions of the country, particularly in the Prairies, where the bulk of the national agricultural water use took place. The factor influences were weakest in the Atlantic region.

To summarize the findings for agriculture, changes in production technology had strongly negative impacts on the sector's water withdrawal and gross water use, both nationally and regionally. This finding implies that productivity improved in the sector over the study period, such that fewer inputs per unit of final demand were required, as shown in Table 6.3. These decreases in water use attributable to improvements in production technology were offset more than completely by growth in final demand. This growth indicates that food production rose over the study period causing an upward push in water use. This effect was felt most stongly in the Prairie and B.C. regions, and least strongly in the Atlantic region. The change in water use due to the water use coefficient factor was negative, but minor in comparison with the other two factors. The negative effect attributable to the water use coefficient factor indicates that the industry became somewhat more efficient in its use of water over the period of study.

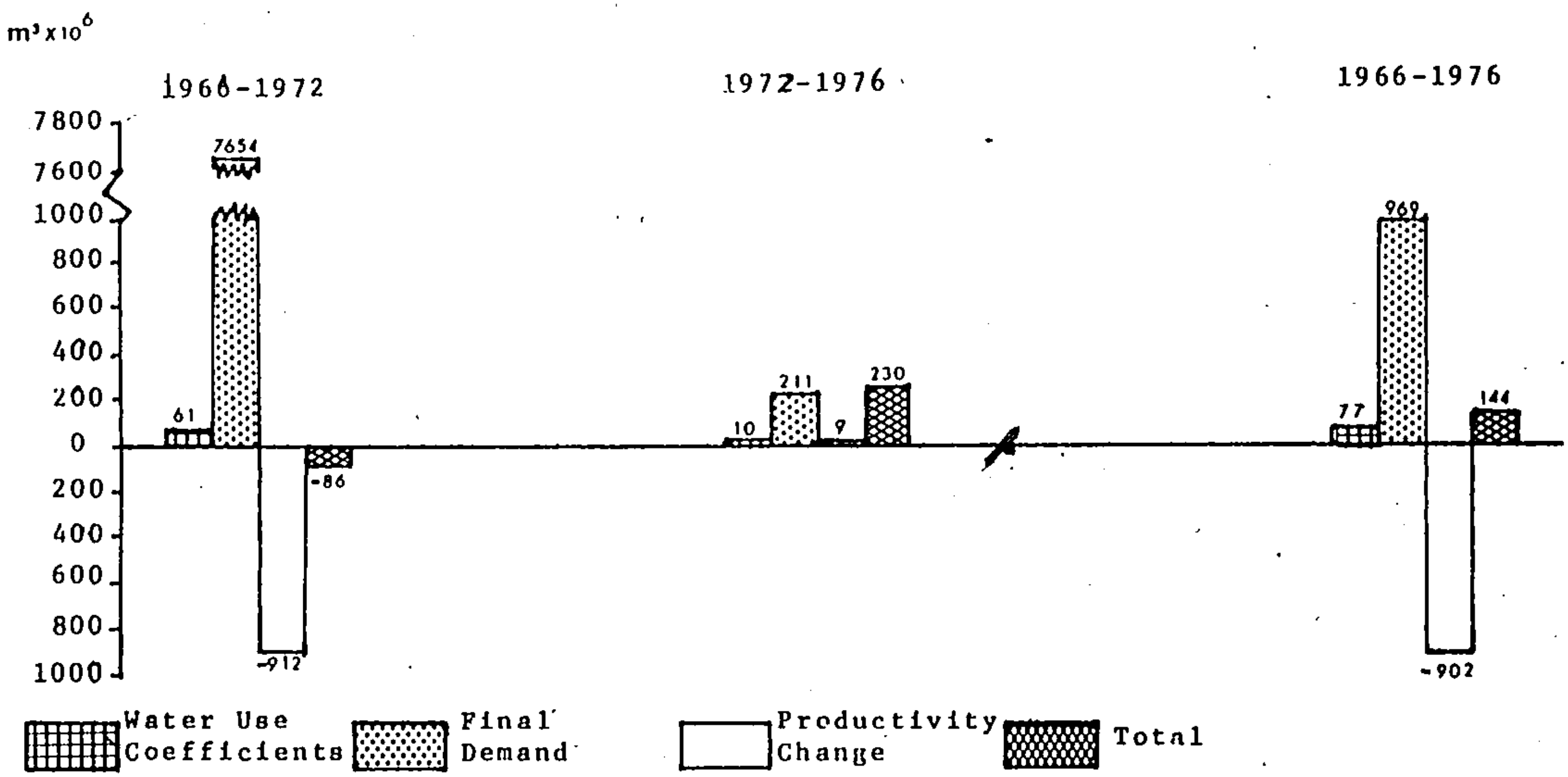
Mineral Extraction: Histograms showing the shifts in water intake and gross water use in the three mineral extraction sectors (i.e. metallic metal mining, non-metallic metal mining and mineral fuels) are presented in Figures 6.3, 6.4 and 6.5. Nationally, the the water intake coefficient changes (Figure 6.3) and final demand changes exerted a positive influence on both water use

Figure 6.3 Effects of Structural Change on Mineral Extraction Water Intake by Factor, Canada and Regions



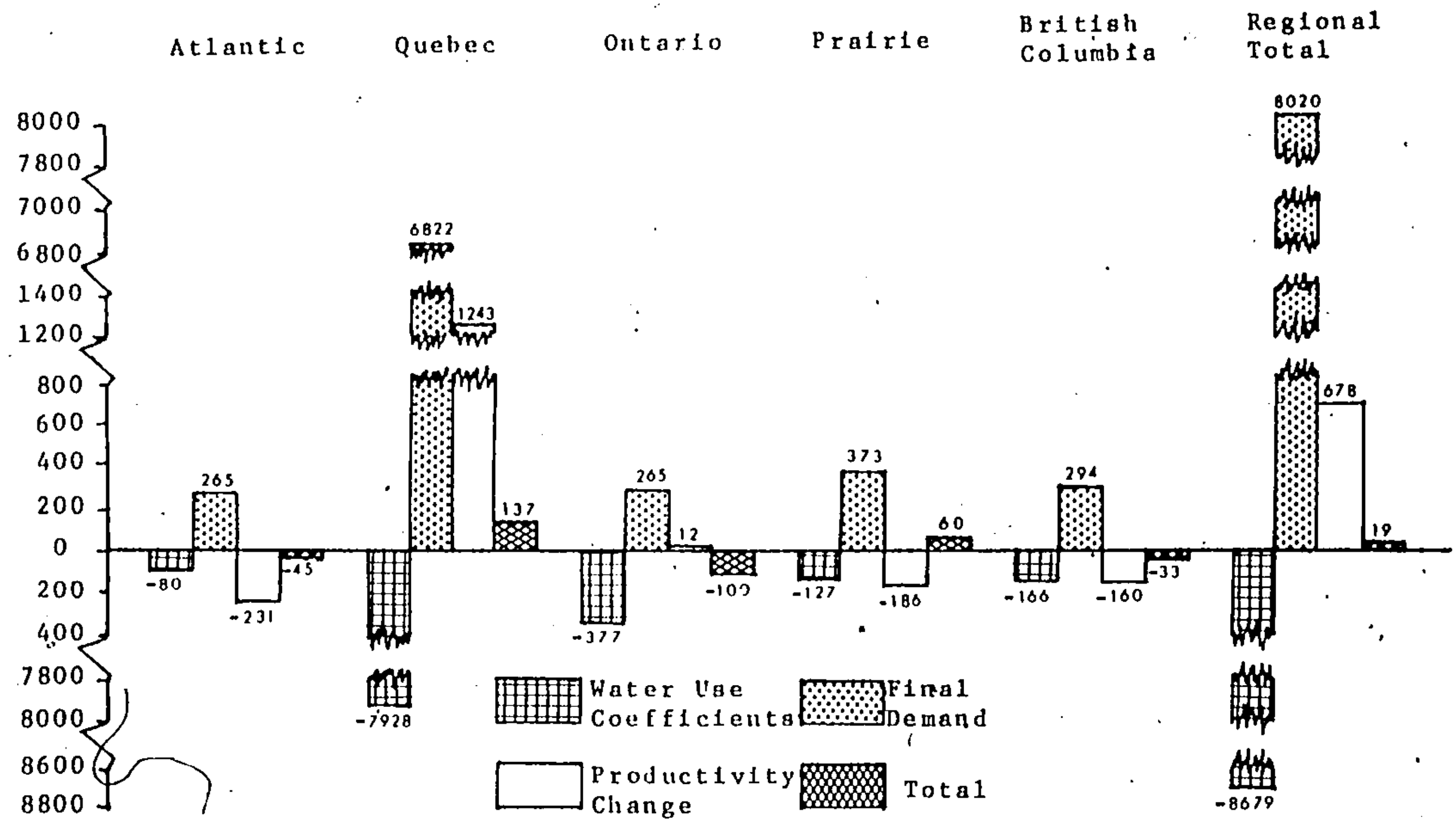
Source: Appendix Tables D-1 to D-16

Figure 6.4 . Effects of Structural Change on Mineral Extraction Gross Water Use by Factor, Canada, 1966 - 1976



Source: Appendix Tables D-1 to D-16

Figure 6.5 Effects of Structural Change on Mineral Extraction Gross Water Use by Factor, Regions, 1966 - 1974



Source: Appendix Tables D-1 to D-16

Table 6.4 Trends in Input Linkages by the Five Sectors Most Closely Linked to Mineral Extraction, Industries, Canada, 1966-1976[1]

	1966	1972	1976
Metallic Minerals			
Trade	0.06595	0.02814	0.03304
Non-metallic Minerals	0.05521	0.04462	0.04705
Chemicals, etc.	0.05123	0.02330	0.02696
Electric Power	0.04896	0.03165	0.03565
Metal Fabricating	0.02985	0.00868	0.01029
Mineral Fuels			
Trade	0.05818	0.02685	0.03301
Non-metallic Minerals	0.05050	0.04616	0.05555
Electric Power	0.02908	0.01813	0.02664
Printing and Publishing	0.02317	0.00972	0.01109
Chemicals, etc.	0.02220	0.00962	0.01344
Non-metallic Minerals			
Trade	0.09093	0.03802	0.03648
Petroleum and Coal	0.04549	0.02744	0.02848
Paper and Allied	0.04434	0.01271	0.01086
Chemicals, etc.	0.04164	0.01978	0.01959
Metal Fabricating	0.03147	0.00819	0.00753

1. excluding the industrial the industrial sectors with no water use, and the intra-industry linkages.

Source: Appendix Tables F-1 through F-8.

parameters for all periods under consideration. Between 1966 and 1972, they totalled 156 million m^3, and were even stronger between 1972 and 1976 (303 million m^3 for the 1966-1972 period, the positive effect of these two factors were more than offset by the negative influences of production technology (-159 million m^3), with the result that net total water intake decreased marginally over the period by 3 million m^3. The production technology factor reversed its influence in the 1972-1976 period, becoming slightly positive, thereby reinforcing the effects of the water use coefficients and final demand. The same patterns of water use shifts were apparent for gross water use, as shown in Figures 6.4 and 6.5.

As in the case of agriculture, the pattern of influence of the production technology factor on water use shifts is revealed by examining the input and output linkages for the three sectors of mineral extraction (Tables 6.4 and 6.5). Only the most important linkages are shown in these two tables, but a consistent pattern is apparent. The coefficients fell over the period 1966-1972 for all linkages in all three sectors of the industry. These declines are interpreted here as a movement to more efficient input use, which, in turn, generated a negative shift in water use due to the production technology factor. In almost all cases, this trend to declining input coefficients was reversed between 1972 and 1976, with the result that the water use shifts due to production technology became positive, as shown in Figures 6.3, 6.4 and 6.5. The decrease between 1966 and 1972, however, was sufficiently great to be the dominant one for the entire 1966-1976 period.

Slight departures from the aggregated industry patterns are apparent in examining the individual sectors of mineral extraction (Appendix tables D-1 through D-16). The changes in water use caused by all factors between 1966 and 1972 reflect exactly those described for the aggregated data. Between 1972 and 1976, however, the water use coefficient factor showed negative influences on water intake in the non-metallic metal mining sector, and on gross water use in the

Table 6.5 Trends in Output Linkages by the Five Sectors Most Closely Linked to Mineral Extraction Industries[1], Canada, 1966–1976

	1966	1972	1976
Metallic Minerals			
Primary Metals except Iron and Steel	0.45141	0.34140	0.36581
Iron and Steel	0.08770	0.08972	0.08783
Electrical Products	0.06948	0.03173	0.01180
Metal Fabricating	0.05618	0.03491	0.03854
Machinery	0.04065	0.01804	0.01887
Mineral Fuels			
Petroleum and Coal	0.38951	0.33 87	0.35493
Iron and Steel	0.03578	0.01914	0.02100
Chemicals, etc.	0.03363	0.02132	0.02291
Agriculture	0.03334	0.01652	0.01485
Paper and Allied	0.02878	0.01536	0.01704
Non-metallic Minerals			
Non-metallic Mineral Products	0.06550	0.04484	0.04776
Metallic Minerals	0.05521	0.04462	0.04705
Mineral Fuels	0.05050	0.04616	0.05555
Primary Metals except Iron and Steel	0.03032	0.01814	0.01992
Petroleum and Coal	0.02295	0.01714	0.02145

1. excluding the industrial sectors with no water use, and the intra-industry linkages.

Source: Appendix Tables F-1 through F-8.

same sector and also in the mineral fuels sector. These patterns amongst the three sectors are attributable to the relative change in the coefficients of water use. An interperiod decline in either water intake or gross water use coefficients resulted in a negative resultant impact on total water use. In all but one case, interperiod final demand grew, thus causing the impact of final demand on water use to be positive. The exception occurred in the mineral fuels sector for the 1972-1976 period. Various explanations are possible for this negative trend, but are probably related to falling demand for petroleum products -- an aftermath of rising prices following the 1973 world oil crisis.

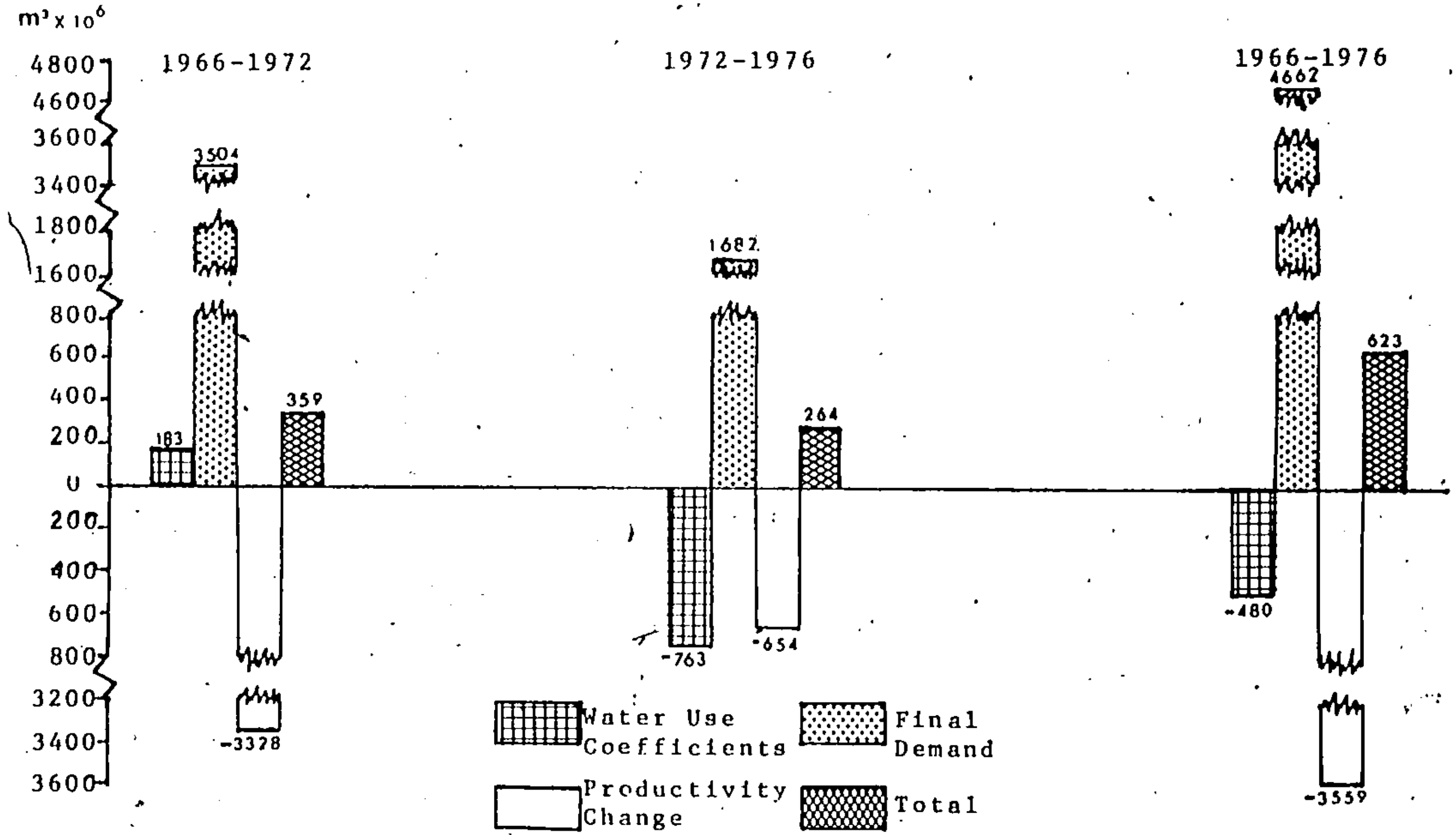
With respect to regional water use shifts between 1966 and 1974, the influences of the structural change factors were somewhat different than those described for the national data. The water use coefficient factor had a large negative impact on both water intake and gross water use. This effect was offset by positive influences due to the final demand and production technology factors.

However, this pattern of shifts was due in part to an anomaly in the basic data. From Figures 6.3, 6.4 and 6.5, it is clear that Quebec dominated all three types of shifts. The size of the shifts observed for the water use coefficient and final demand factors are due in large part to a relatively low final demand amount for 1966 in the metallic minerals sector. Specifically, final demand in this sector totalled \$17.2 million (in 1974 dollar values). In 1974, the corresponding figure was \$244.2 million. The relatively small 1966 value generated a relatively small output, and this in turn caused a relatively large water use coefficient for both water use parameters (i.e. 2.2 million m^3 per million dollars of output for water intake and 14.2 million m^3 for gross water use.) In 1974, the corresponding figures were 0.2 million m^3 and 0.8 million m^3. The net result of this large contrast in water use coefficients was to produce the dominating negative shift caused by the coefficients and the large positive shift due to the final demand factor. This anomaly was not reflected in the national results, for the 1966 demands nationally mask the effects of Quebec final demand and output values.

<u>Manufacturing:</u> The effects of structural change on the manufacturing sector's water use (Figures 6.6 through 6.9) is very similar to that displayed earlier for agriculture. The generalized results presented in these figures indicate that both the production technology and the water use coefficient factors were negative in their influence, and, while quite large, were offset in all but one case by the final demand factor. Water intake for the aggregated manufacturing industry rose by 359 million m^3 between 1966 and 1972. This was the only period during which the effect of the water use coefficient factor was positive in its influence. Total manufacturing water use rose again by 264 million m^3 between 1972 and 1976, making the total positive change some 623 million m^3 in the entire 1966 to 1976 period. Patterns of growth in gross water use nationally were almost the same as for water intake. Only the sign of the water use coefficient factor for 1966-1972 changed.

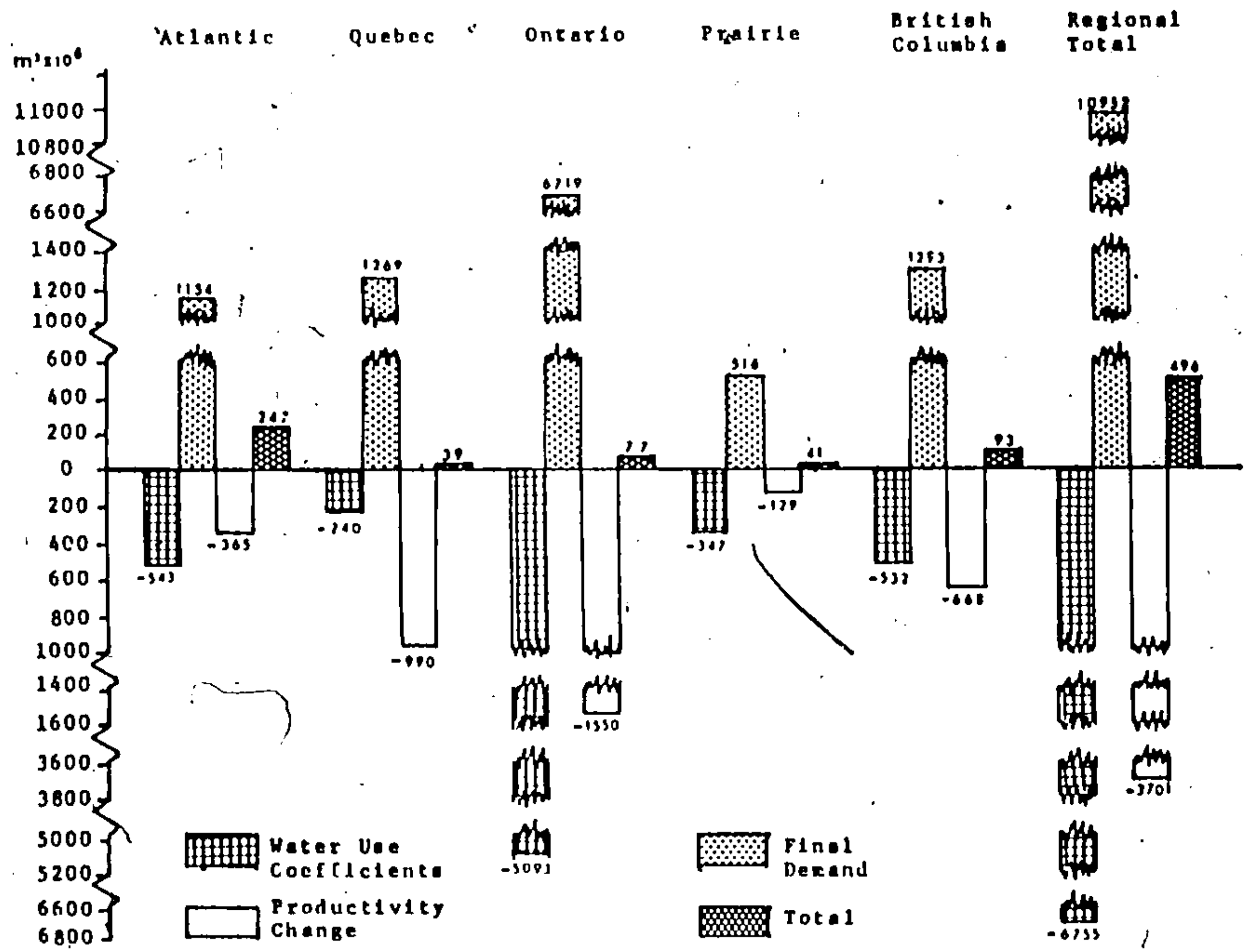
Changes in production technology were the strongest negative forces on manufacturing water use over the decade of study, totalling 3 559 million m^3 for water intake, and somewhat more than double this (7 902 million m^3) for gross water use. The largest negative influence of production technology on both parameters was for the 1966-1972 period. This pattern of influence, as in the other sectors outlined to this point, is attributable to the patterns of change for the input and output linkages amongst the various sub-sectors of manufacturing and between other major industrial sectors. These

Figure 6.6 Effects of Structural Change on Manufacturing Water Intake by Factor, Canada, 1966-1976



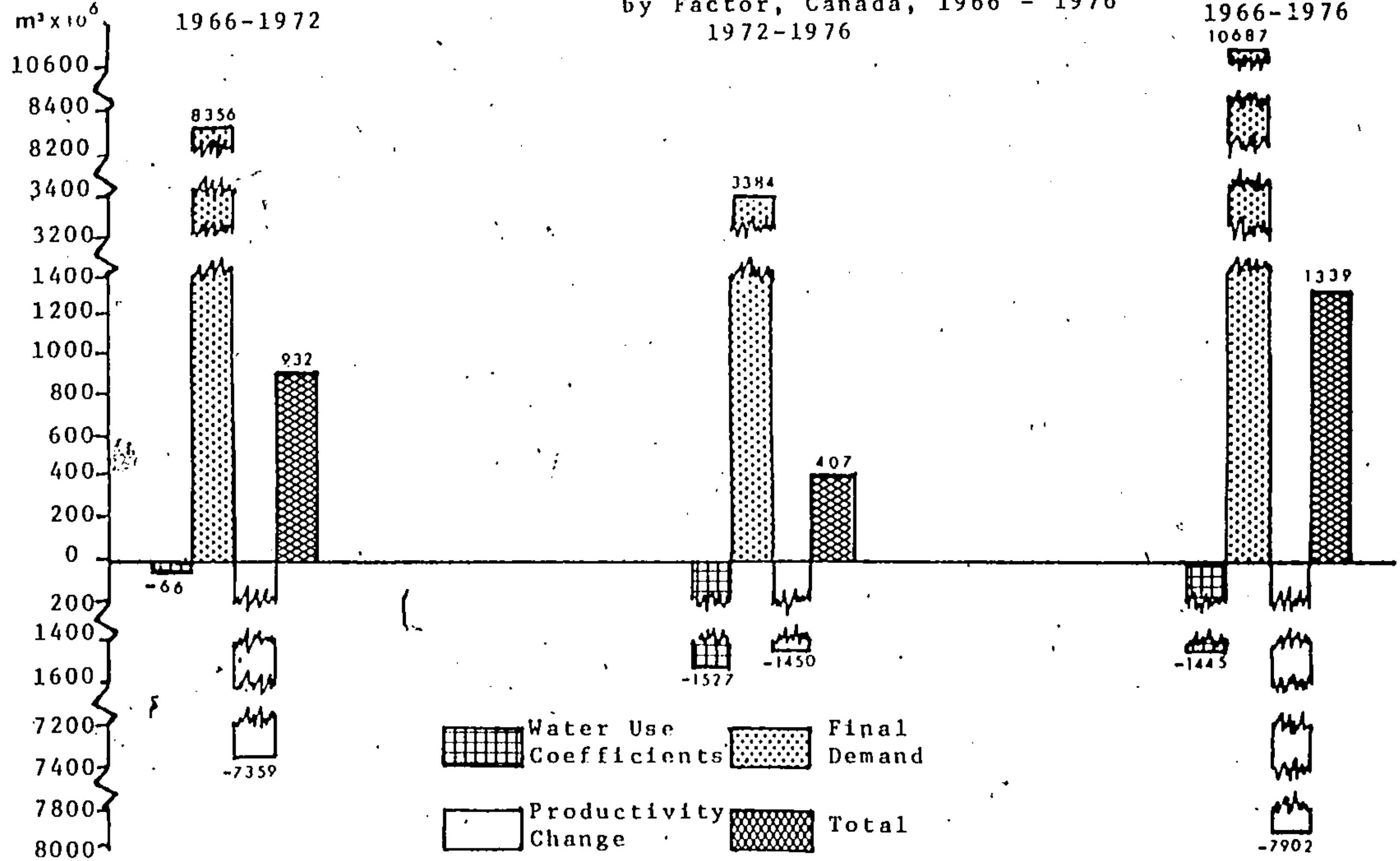
Source: Appendix Tables D-1 to D-16

Figure 6.7 Effects of Structural Change on Manufacturing Water Intake by Factor, Regions, 1966-1974



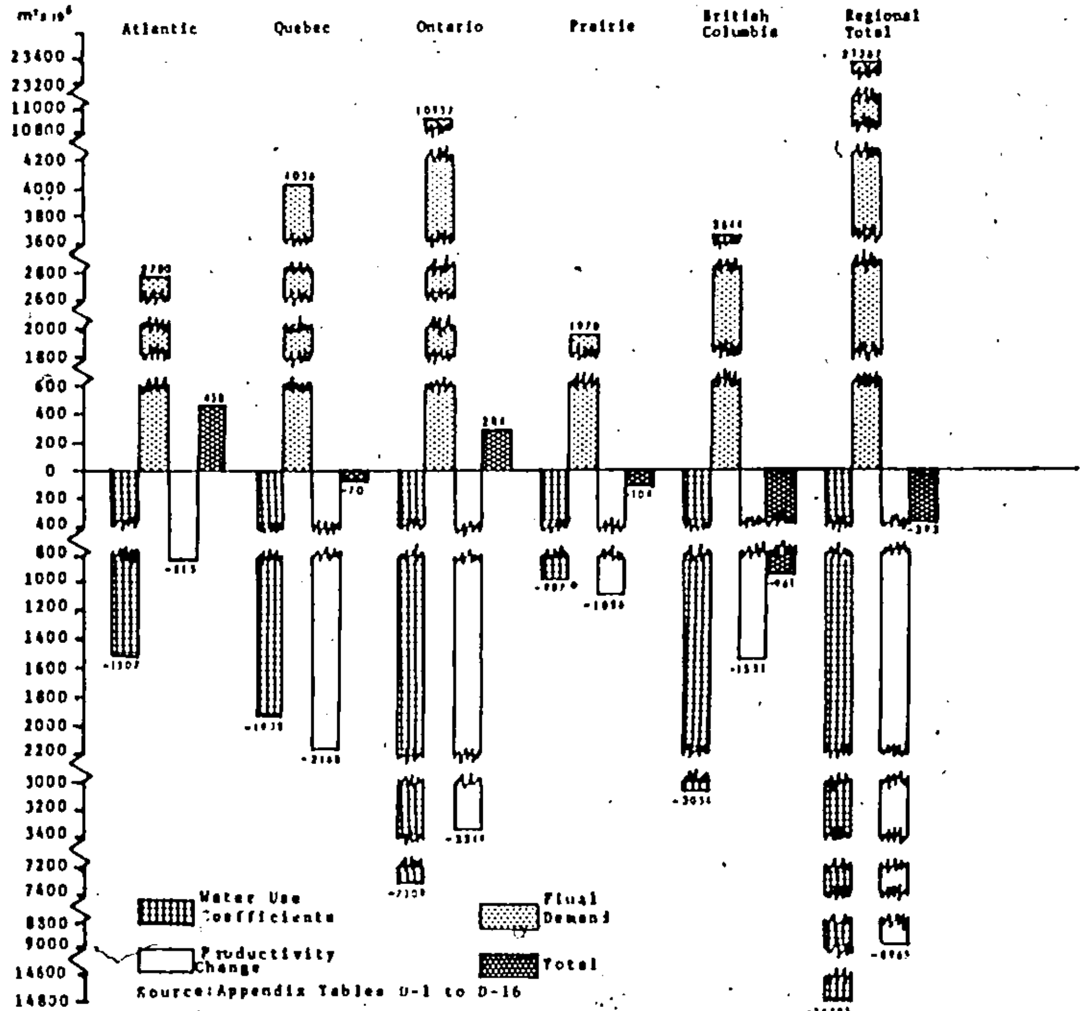
Source: Appendix Tables D-1 to D-16

Figure 6.8 Effects of Structural Change on Manufacturing Gross Water Use by Factor, Canada, 1966 - 1976



Source: Appendix Tables D-1 to D-16

Figure 6.9 Effects of Structural Change on Manufacturing Gross Water Use by Factor, Regions, 1966-1974



Source: Appendix Tables D-1 to D-16

Table 6.6 Trends in Input Linkages by the Five Sectors Most Closely Linked with Major Water Using Manufacturing Industries,[1] Canada, 1966-1976

	1966	1972	1976
		Paper and Allied	
Trade	0.09800	0.04055	0.04090
Chemicals, etc	0.08279	0.04410	0.05251
Wood Products.	0.07394	0.05523	0.07461
Electric Power	0.06591	0.03794	0.04096
Petroleum and Coal	0.04947	0.02782	0.03094
		Chemicals,etc.	
Trade	0.09712	0.04375	0.03912
Paper and Allied	0.07632	0.03709	0.03244
Petroleum and Coal	0.05314	0.03465	0.03583
Food and Beverages	0.05019	0.03236	0.02730
Electric Power	0.04570	0.02851	0.02621
		Iron and Steel	
Trade	0.08917	0.04597	0.04837
Metallic Minerals	0.08770	0.08972	0.08783
Primary Metals except Iron and Steel	0.04936	0.03741	0.04073
Electric Power	0.04322	0.02861	0.03267
Metal Fabricating	0.04246	0.02435	0.02932
		Petroleum and Coal	
Mineral Fuels	0.38951	0.33437	0.35493
Trade	0.09712	0.02201	0.02500
Chemicals, etc.	0.04177	0.03592	0.03613
Metal Fabricating	0.03181	0.01397	0.01424
Electric Power	0.02435	0.01542	0.02055
		Food and Beverages	
Agriculture	0.43209	0.32235	0.32034
Trade	0.12351	0.05647	0.05430
Paper and Allied	0.07737	0.04533	0.04245
Metal Fabricating	0.06080	0.03142	0.03212
Chemicals, etc	0.05391	0.02164	0.02271

1. excluding the industrial sectors with no water use, and the intra-industry linkages.

Source: Appendix Tables F-1 through F-8.

Table 6.7 Trends in Output Linkages by the Five Sectors Most Closely Linked with Major Water Using Manufacturing Industries[1] Canada, 1966-1976

	1966	1972	1976
		Paper and Allied	
Printing, etc.	0.38603	0.20705	0.18258
Food and Beverages	0.07737	0.04533	0.04245
Chemicals, etc	0.07632	0.03709	0.03244
Rubber and Plastics	0.07385	0.03161	0.02946
Trade	0.05390	0.01805	0.01429
		Chemicals, etc.	
Rubber and Plastics	0.23158	0.14015	0.15127
Paper and Allied	0.08279	0.04410	0.05251
Agriculture	0.08246	0.03270	0.040[illegible]5
Textiles	0.06244	0.02899	0.02496
Leather	0.06028	0.02940	0.03350
		Iron and Steel	
Metal Fabricating	0.29988	0.18970	0.17584
Machinery	0.14027	0.07412	0.07501
Primary Metals except Iron and Steel	0.09035	0.06539	0.05608
Electrical Products	0.08974	0.05470	0.03929
Transportation Equipment	0.08510	0.04833	0.03927
		Petroleum and Coal	
Agriculture	0.07665	0.04534	0.03845
Chemicals, etc.	0.05314	0.03645	0.03583
Paper and Allied	0.04947	0.02781	0.03094
Food and Beverages	0.04691	0.02142	0.01870
Wood Products	0.04640	0.01677	0.01656
		Food and Beverages	
Agriculture	0.19359	0.14244	0.14318
Chemicals, etc.	0.05019	0.03236	0.00273
Leather	0.06885	0.03105	0.02844
Trade	0.03991	0.00790	0.00792
Wood Products	0.02987	0.00942	0.00957

1. excluding the industrial sectors with no water use, and the intra-industry linkages.

Source: Appendix Tables F-1 through F-8.

linkages were quantified in Tables 6.6 and 6.7 for the large water using manufacturing sub-sectors. The selection of the top five sub-sectors was chosen so as to account for a large percentage of manufacturing water use. The linkages fell uniformly between 1966 and 1972, denoting a movement toward more efficient use of inputs and outputs for these sub-sectors of manufacturing, thereby causing large negative influences on water use. The predominant, but not uniform, trend for the 1972-1976 period was for a slight increase in the value of the linkages. The net effect in this later period was a negative influence on manufacturing water use, but a much smaller one than in the previous period.

The final demand factor was a large, positive influence on national industrial water use during the entire period, totalling about 4 660 million m^3. This influence was somewhat more than twice as strong in the 1966-1972 period (3 504 million m^3) as in the 1972-1976 period. This positive effect was attributable to the positive growth in final demand levels over the period of study.

Changes in water use due to the impact of the water use coefficient factor were largely negative in their impact on total changes in manufacturing water use. This negative influence occurred because of the apparent decline in a majority of the water use coefficients. These declines attest to improving efficiency on industrial water use over the decade of study.

Regional water use changes in response to the structural change factors (Figures 6.7 and 6.9) mirrored almost exactly the national patterns. In total, the negative impact of the water use coefficient factor was relatively larger for the regional data than for the national data. For water intake, it totalled -6 755 million m^3 as compared with -3 701 million m^3 for the production technology factor. For the national data, the water use coefficient factor totalled only -479 million m^3, as compared to -3 559 million m^3 for the production technology factor. Regionally, the final demand factor's influence on manufacturing water intake (10 952 million m^3) offset the negative influences of the water use coefficient and the production technology factors. The net effect of all three factors was to raise manufacturing water intake over the 1966-1974 period by 496 million m^3. The patterns of structural change influence on gross water use were similar to those outlined for water intake.

For the most part, Ontario was the most significant region contributing to the observed changes in water use due to the three structural change factors. However, this region accounted for total changes of only 77 million m^3 in water intakes and 284 million m^3 in gross water use over the 1966-1974 period, due to the interaction of the three factors. The dominance of this region with respect to the individual structurally induced water use changes was to be expected since the Ontario region contained the largest proportion of Canada's manufacturing industry and accounted for the largest proportion of total water use. The highest total change in manufacturing water use (246 million m^3) occurred in the Atlantic region, ahead of not only Ontario, but also Quebec and B.C., all of which contained more manufacturing activity. In the latter three regions, the changes in water use due to production technology were relatively large (in a negative direction) as compared to the Atlantic region. This indicates that production technology was becoming relatively more efficient in these three regions than it was in the latter region. The changes in water use due to the various structural change factors in the Prairie region were relatively small in comparison to those for the other regions.

Detailed data on the influence of each type of structural change on manufacturing water use have been tabulated in Appendix D. For production technology the shifts in water use were almost uniformly negative. Minor exceptions occurred to this generalization, but these were negligible in their impact on the industry-wide results. The influence of final demand was overwhelmingly positive, with the only exception occurring in the leather products sector in the 1972-1976 period, and in the 1966-1976 period as a whole.

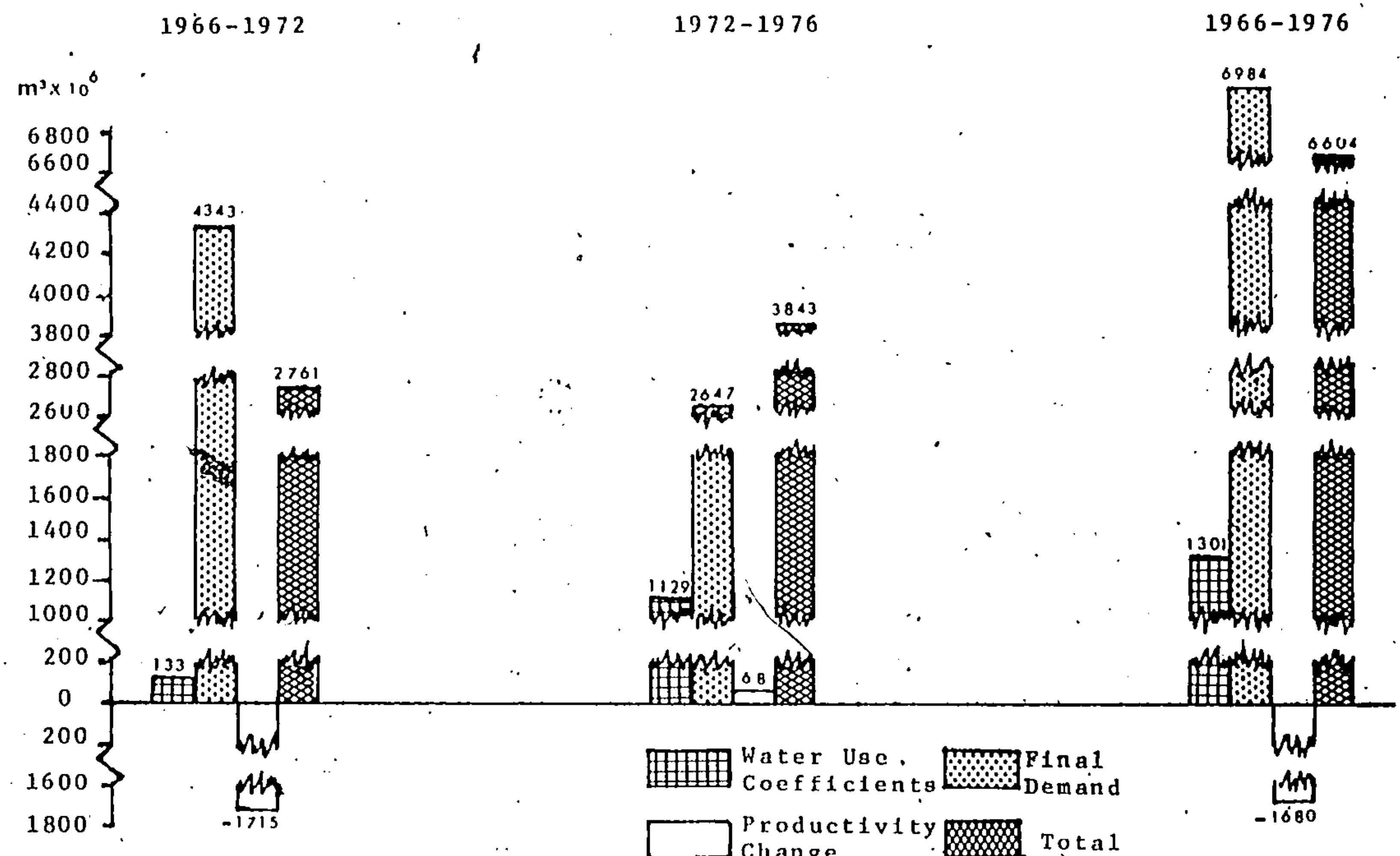
The direction of the changes in water use due to the coefficient factor was slightly more variable, but was most frequently negative. Individual variations were attributable to the interperiod changes in the water use coefficients. In cases where the end-of-period coefficient was greater than that for the beginning-of-period, the influence of the coefficient factor on total water use was positive. In the opposite case, the influence was negative. The former case is interpreted here as a movement to less efficient water use; the latter to more efficient water use.

In summary, the production technology factor was overwhelmingly negative in its impact on both water intake and gross water use over the period of study. This finding held true both in Canada as a whole and in the regions. Examination of input and output linkages showed that the trend over this period was for a movement to increasing the efficiency of input use. The final demand factor was almost uniformly positive in its influence on manufacturing water use, a direct consequence of final demand growth over the study period. The third factor, water use coefficients, exhibited a negative, but slightly more variable influence on total water use, according to whether water use became more or less efficient through the period of study. The net result of the three factors acting together produced an increase in manufacturing water use.

<u>Electric Power:</u> For the electric power generation industry, the statistics on water intake and gross water use shifts (Figures 6.10 and 6.11) are identical, since there was no water recirculation at any Canadian plant during the period of study. Water use increased nationally during both the 1966-1972 period (by 2 761 million m^3) and the 1972-1976 period (by 3 843 million m^3).

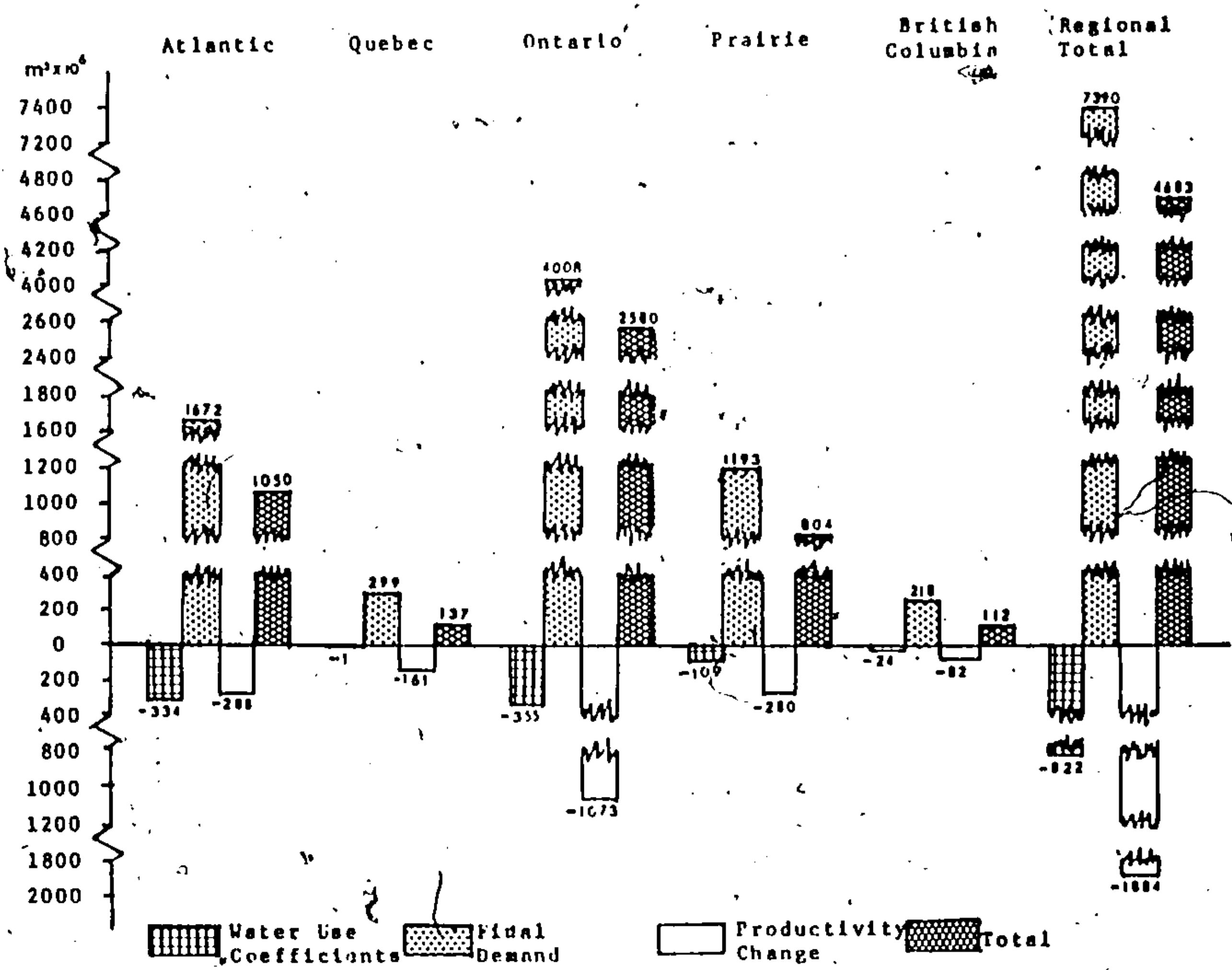
Both the final demand and the water use coefficient factors of structural change were positive in their influence on the industry's total water use, and combined, they produced a total upward change of just under 8 300 million m^3 over the 1966-1976 period. These shifts were in response to increases in both the water use coefficients and and in final demand over the period. The change in water use coefficients was most pronounced during the 1972-1976 period, producing an upward shift of some 1 129 million m^3. The

Figure 6.10 Effects of Structural Change on Electric Power Water Use by Factor, Canada, 1966 - 1976



Source: Appendix Tables D-1 to D-16

Figure 6.11 Effects of Structural Change on Electric Power Water Use by Factor, Regions, 1966-1974



Source: Appendix Tables D-1 to D-16

greatest impact of the final demand factor was felt in the earlier period (4 343 million m^3). Both changes were directly attributable to the relative changes in the respective variables.

The positive influences of the water use coefficients and final demand levels were offset by a negative change due to the influence of production technology (-1 680 million m^3). This was the only factor at the national level to show a sign reversal over the decade, being large and negative in the 1966-1972 period, and small and positive in the 1972-1976 period. The input and output linkages for the five sectors most strongly linked to the electric power industry (Table 6.8) were somewhat mixed in their direction of change. For three of the industries, a steady decline in the input linkages attested to the growth in efficiency of electric power use over the 1966-1976 decade. For the petroleum and coal, and the wood products industry, the input linkages grew during the 1972-1976 period, showing a reversal in the efficiency of electric power usage. In fact, the reversals in the latter two industries were sufficient to produce the positive production technology influence shown in Figures 6.10 and 6.11. This same pattern was not, however, apparent for the output linkages.

The regional patterns of influence of the various structural change factors in the 1966-1974 period were notably different from the national pattern. The production technology and the water use coefficient factors were almost uniformly negative in their influence on total water use, the only exception occuring in the case of Quebec with respect to the water use coefficient factor.

Final demand, as in the case of the national results was constantly positive in its influence. The net result of all factors acting together was to produce a rise in national water use of 4 681 million m^3 over the 1966-1974 period.

Table 6.8 Trends in Input and Output Linkages by the Five Sectors Most Closely Linked to Electric Power,[1] Canada, 1966-1976

	1966	1972	1976
Input Linkages			
Mineral Fuels	0.02501	0.01845	0.00252
Trade	0.01994	0.00825	0.00802
Metal Fabricating	0.01598	0.00518	0.00445
Petroleum and Coal	0.01361	0.01261	0.18535
Wood Products	0.00744	0.00075	0.00237
Output Linkages			
Paper and Allied	0.06591	0.03794	0. 4096
Primary Metals except Iron and Steel	0.05101	0.03216	0.03393
Metallic Minerals	0.04896	0.03165	0.03565
Petroleum and Coal	0.04570	0.01543	0.02055
Non-metallic Mineral Products	0.04564	0.02580	0.02757

1. excluding the industrial sectors with no water use, and the intra-industrial linkages.

Source: Appendix Tables F-1 through F-8.

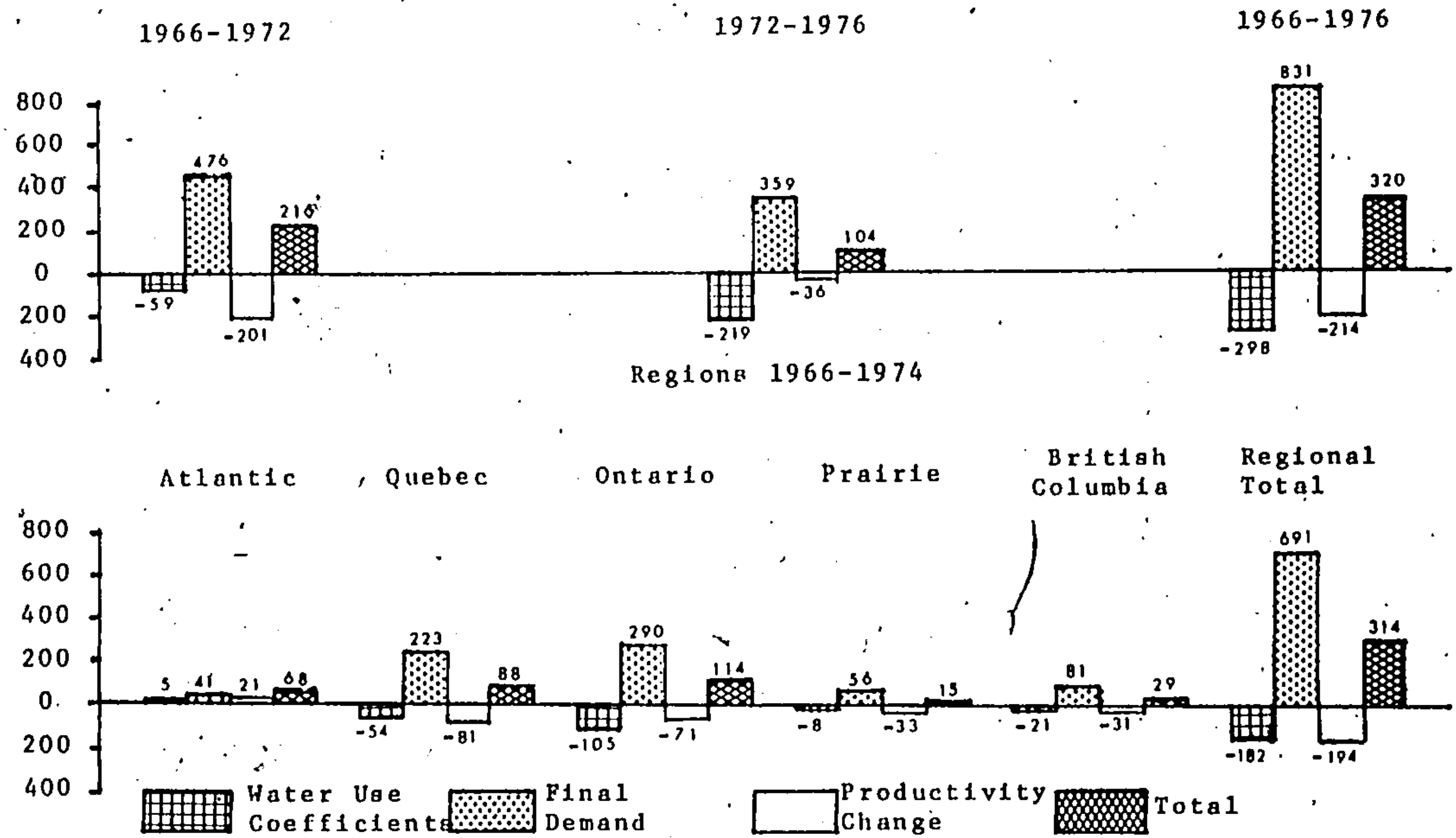
In summary, the final demand factor was a large positive influence on water use in the electric power industry over the study period. A steady, strong final demand for power was responsible for this influence. The production technology factor, related directly to the nature of the input and output linkages was an almost uniformly negative influence on total water use in the industry. The water use coefficient factor nationally was a positive influence in the growth of industrial water use, but was negative in its impact regionally.

Trade: It will be recalled that the category "other water uses" used in the tables of Chapter five contained only one sector, wholesale and retail trade, which had recorded water use data. For the purposes of the current discussion, this industry is referred to as the "trade" sector, data for which are given in Figure 6.12 and Table 6.9. The patterns of influence of the structural change factors on water use in the trade sector were very similar to those observed for the other sectors, and are only summarized here.

The final demand factor for both national and regional data sets was positive in its influence on the trade sector's water use over the period of study. The influence of this factor, in fact, governed the (positive) change in total water use. Offsetting the positive effects of the final demand factor were the production technology and the water use coefficient factors. The former's influence was due to the pattern of change in the input and output linkages (Table 6.9), while the latter's was due to the fall in the water use coefficients over the study period. Minor and insignificant exceptions to the water use coefficient effects occurred in the Atlantic and Prairie regions.

Summary of Structural Change Effects on Industrial Water Use: Taken across all of the industries in the system, the effects of the three structural change factors is quite consistent. In response to rising final demand over the study period, the final demand factor acted to

Figure 6.12 Effects of Structural Change on Trade Sector Water Use by Factor, Canada and Regions Canada 1966-1976



Source: Appendix Tables D-1 to D-16

Table 6.9 Trends in Input and Output Linkages by the Five Sectors Most Closely Linked to the Trade Sector,[1] Canada, 1966-1976

Input Linkages

	1966	1972	1976
Agriculture	0.08256	0.01521	0.01758
Paper and Allied	0.05390	0.01805	0.01430
Petroleum and Coal	0.04194	0.01178	0.01180
Food and Beverages	0.03991	0.00790	0.00792
Metal Fabricating	0.03768	0.00698	0.00636

Output Linkages

	1966	1972	1976
Paper and Allied	0.06591	0.03794	0.04096
Primary Metals except Iron and Steel	0.05101	0.03216	0.03393
Metallic Minerals	0.04896	0.03165	0.03565
Petroleum and Coal	0.04570	0.01543	0.02055
Non-metallic Mineral Products	0.04564	0.02580	0.02757

1. excluding the industrial sectors with no water use, and the intra-industrial linkages.

Source: Appendix Tables F-1 through F-8.

increase industrial water use, and was usually the factor which governed the sign of total water use change. The production technology factor acted to offset the effects of the final demand factor, and, acting as the sole agent of water use change, would have decreased substantially the level of total water use in nearly all industries and over nearly all time periods. This negative influence was traced to the patterns of change in the most important input and output linkages acting in each sector. The influence of the water use coefficients was usually negative, and was somewhat more variable in its impact on water use. The size and sign of the water use change attributable to the coefficient factor was traceable directly to the relative change in the coefficients of water use in each individual sector. The water use coefficients are an index of the efficiency of water use in each industry. Over the study period, it is clear that, in many cases, the efficiency of industrial water use improved. However, this generalization is weakened somewhat by the many exceptions to it which occurred.

6.2.3 Dominant Directions of Structural Influence on Industrial Water Use

To confirm the results of the previous section, the Kolmogorov-Smirnov technique was used. The data on water use shifts were pooled across all regions and the country as a whole, and across all time periods for the purposes of this analysis, the results of which are shown in Table 6.10.

Of the 348 sets of water use shift data, just over 67% showed the dominant pattern of change, that is, a positive influence of the final demand factor, combined with the negative influence of production technology and water use coefficient factors. The test confirms that this pattern is statistically significant at above the 99% level of probability. This finding adds strength to the overall observation made in the previous section that <u>the growth in industrial water use over the study period was composed in most cases of an upward trend due to growing final demand, offset by downward pressures due to production technology and factors related to the way in which industry used water</u>. The second most important pattern of change was different from the predominant pattern in that the water use coefficient influence was positive.

Table 6.10 Results of the Kolmogorov-Smirnov Test on Water Use Shift Statistics, Canada and Regions, 1966-1976

Sign Combination	Percent Frequency of Occurence		
	Null Hypothesis	Thesis Result	Difference (absolute)
+/+/+	0.125	0.023	0.102
+/+/-	0.250	0.233	0.017
+/-/+	0.375	0.236	0.139
+/-/-	0.500	0.236	0.264
-/+/+	0.625	0.293	0.332
-/+/-	0.750	0.968	0.218
-/-/+	0.875	0.991	0.116
-/-/-	1.000	1.000	

H: signs are uniformly distributed.
A: signs are not uniformly distributed.
Number of cases = 348
D = 0.332
Reject null hypothesis (H) if D>= 0.087
Therefore null hypothesis is rejected, and the thesis pattern is significantly different from a random distribution.

where: the first sign in the combination pertains to the direction of influence of the water use coefficient factor;
the second sign of the combination pertains to the direction of influence ot the final demand factor; and
the third sign of the combination pertains to the direction of influence of the production technology factor

6.2.4 Least Squares Analysis

Sixteen analyses were carried out using the step-wise least squares technique. The results are shown in Table 6.11 for Canada as a whole and tables 6.12 and 6.13 for the five regions. By adding the variables to the regression equation in order of their contribution to explaining the total variance, the relative importance of each structural change factor in contributing to the change in total water use was derived.

For the six sets of national water use shifts, the final demand factor was the one most highly correlated with total water use change in five of the six cases (Table 6.11), with the gross water use shift factor being most important in the remaining case. For the 1966-1972 and the 1966-1976 periods, the R^2 coefficients for the final demand factor used alone were over 0.9 for water intake, and over 0.7 for gross water use. For the 1972-1976 period, the power of explanation of the final demand factor was somewhat diminished, as shown by the reduced R^2 coefficient. In fact, for gross water use, the final demand factor was superseded in importance by the water use coefficient factor. The F statistic for the least squares analysis using only the final demand factor was significant at over the 99% level of confidence in all cases for the national level results.

For all of the national level analyses, the production technology factor explained only a small, but significant, amount of variance in the dependent variable, that is, the change in total water use. The F statistics obtained using production technology as the only independent variable showed significance at the 99% level in all cases. The water use coefficient factor was also significant in the all time periods. For the decade as a whole, all independent variables were significant in explaining the change in total water intake.

For the regional data, the final demand variable was most important in six of ten cases in explaining the change in total water

Table 6.11 Results of Least Squares Analysis of Normalized Water Use Shift Data, Canada, 1966-1976

Variables in Equation	Canada 1966-1972 Name	R^2 Added	Significance	Canada 1972-1976 Name	R^2 Added	Significance	Canada 1966-1976 Name	R^2 Added	Significance
1. Water Intake									
First	X_2	0.938	***	X_2	0.700	**	X_2	0.926	***
Second	X_3	0.046	**	X_1	0.289	***	X_3	0.041	**
Third	X_1	0.016	**	X_3	.011	**	X_1	0.033	**
2. Gross Water Use									
First	X_2	0.754	**	X_1	0.496	**	X_2	0.735	**
Second	X_3	0.200	**	X_2	0.481	***	X_3	0.165	**
Third	X_1	0.046	**	X_3	0.023	**	X_1	0.100	**

where: X_1 represents the normalized water use shift variable.
X_2 represents the normalized final demand shift variable.
X_3 represents the normalized production technology shift variable.

*** represents a very high sigificance level according to the R statistic.
** represents significance at the 1% level according to the F statistic.

Table 6.12 Results of Least Squares Analysis of Normalized Water Intake Shift Data, Regions, 1966-1974

Variables in Equation	Atlantic Region			Quebec Region			Ontario Region		
	Name	R^2 Added	Significance	Name	R^2 Added	Significance	Name	R^2 Added	Significance
First	X_2	0.937	***	X_2	0.470	**	X_2	0.432	**
Second	X_1	0.053	***	X_1	0.183	**	X_1	0.494	***
Third	X_3	0.01	**	X_3	0.347	**	X_3	0.074	**
	Prairie Region			B.C. Region					
First	X_3	0.797	**	X_3	0.848	***			
Second	X_2	0.074	**	X_2	0.128	***			
Third	X_1	0.129	**	X_1	0.024	**	X_1	0.100	**

where: X_1 represents the normalized water use shift variable.
X_2 represents the normalized final demand shift variable.
X_3 represents the normalized production technology shift variable.

*** represents a very high sigificance level according to the F statistic.
** represents significance at the 1% level according to the F statistic.

Table 6.13 Results of Least Squares Analysis of Normalized Gross Water Use Shift Data, Regions, 1966-1974

Variables in Equation	Atlantic Region			Quebec Region			Ontario Region		
	Name	R^2 Added	Significance	Name	R^2 Added	Significance	Name	R^2 Added	Significance
First	X_3	0.466	**	X_2	0.929	***	X_2	0.413	**
Second	X_2	0.087	*	X_3	0.030	NS	X_1	0.363	***
Third	X_1	0.447	**	X_1	0.041	NS	X_3	0.224	**
	Prairie Region			B.C. Region					
First	X_2	0.192	*	X_3	0.923	***			
Second	X_1	0.459	**	X_2	0.004	NS			
Third	X_3	0.349	**	X_1	0.073	**			

where: X_1 represents the normalized water use shift variable.
X_2 represents the normalized final demand shift variable.
X_3 represents the normalized production technology shift variable.

*** represents a very high sigificance level according to the F statistic.
** represents significance at the 1% level according to the F statistic.
* represents significance at the 5% level according to the F statistic.
NS represents no significance, or significance above the 5% level.

use. In the other four cases the production technology factor proved sligly more important. Only in B.C. did the final demand factor prove insignificant (once) as an explanatory variable in total water use change.

6.3 SUMMARY

This chapter has described an empirical test of the framework developed in Chapter four for analyzing the effects of structural change on industrial water use. The economic data and the input- output tables were obtained from various Statistics Canada sources, while the water use data were based upon original survey work conducted, by the author. The final demand factor was the major positive factor in the growth of water use over the study period. This positive influence was offset by the negative effects of the production technology and the water use coefficient factors. The least squares analysis showed that, in the majority of cases, final demand changes were most closely correlated with changes in industrial water use.

CHAPTER VII

CONCLUSIONS, IMPLICATIONS AND RESEARCH DIRECTIONS

The research reported in this thesis has led to a number of conclusions. These conclusions in turn have implications for water resource management, for geography as a field of study and for future reseach. Each of these subjects is dealt with in this chapter.

7.1 CONCLUSIONS

The conceptual basis used in this research considered changes in industrial water use as a response to changes in the structure of the industrial base. (i) The first structural change factor, allied with supply and demand conditions, was related for measurement purposes to changes in final demand in the input-output analysis sense. (ii) A second structural change factor, related to the productivity and technological conditions of the industrial base, was linked to changes in the coefficients of the inverse matrix of an input-output table. (iii) A third structural change factor, related particularly to water use, was measured by variations in the water use coefficients from period to period. The result of employing a model based upon this conceptualization was a partitioning of changes in industrial water use over time into water use shifts attributable to each structural change factor.

The technique developed has several analytical advantages. It is based upon a general equilibrium model of the economy, in which industries are interlinked. By using such a model, interindustry impacts of changing economic conditions, production technology conditions, and water use conditions can be measured. A second advantage lies in the measurement of technological change impacts on industrial water use. Technological conditions have often been touted as important in changing water use (for example, Canada, 1968, pp. 90-99), but have proven difficult to measure in an aggregate sense (Canada, 1973a, pp. 6-7). Third, the technique offers insights into the interplay of factors during interperiod changes in industrial water use. These insights are useful in suggesting areas of further research. Fourth, the technique accounts for the total variation in water use between periods, thereby removing some of the uncertainties involved particularly in forecasting industrial water use. There are also significant disadvantages to the technique, which will be dealt with later in this chapter.

The principal findings of the test cases conducted using the structural change model related to the various shifts in water use which occurred between various periods and across regions. The shifts due to the final demand factor of structural change were overwhelmingly positive in nature. They were offset partially, but not entirely, by negative shifts due to the production technology and the water use coefficient factor. This pattern of water use shifts applied in over 67% of the cases analyzed in the empirical test. The water use coefficient factor was the least consistent with respect to its direction of influence. Taken across all industries for the various time periods, the final demand factor explained the highest amount of variance in total water use in all of the national analyses and in 60% of the regional analyses. For the other 40% of the regional analyses, the production technology factor proved to be most closely correlated with changes in water use.

The primary cause of the positive shifts in water use due to the final demand factor was the growth over the study period of the demand for industrial products. The study period was a time of expansion for the Canadian economy in general, due to rising populations, rising per capita incomes and rising world demand, particularly in the primary resource sectors. Towards the end of the period, economic growth had begun to slow down, in response to factors such as the effects of large increases in energy prices. The earlier growth period and the slowing down of the economy toward 1976 and beyond, are both reflected in the final demand patterns used in the case study. Particular patterns in particular industries remain unaddressed here, but the overall pattern of final demand change is clearly related to overall world economic conditions.

The negative influence of the production technology factor was linked to relatively large overall decreases in the input and output linkages amongst the various industries. Admittedly, this is a somewhat incomplete argument in that, while the effects are beyond question in the majority of cases, the causes of these increased efficiencies remain unexplained. To attempt a definitive analysis would involve a detailed industry-by-industry examination of conditions in each industry, which is beyond the scope of this study.

As shown in Table 6.15, in 266 of the 348 individual sets of measurements relating the water use shifts to structural change factors, the influence of the water use factor was negative. This seems to indicate an intermediate term shift toward more efficient water use on the part of industry. Recent federal government support of the World Conservation Strategy (U.N., 1981) calls in part for the measurement of movement toward or away from resource conservation. The results obtained here seem to suggest that water use on the part of industry became generally more efficient over the study period. This finding is weakened somewhat by the fact that the 1966 water use data were estimated, not measured; however, several attempts were made to carry out these estimations, and the one adopted is considered the best possible, given the data available. Thus the conclusion related to increasing water use efficiency must be qualified by assuming the validity of the 1966 water use estimations. Verification or rejection of this finding must await the availability of better time series data.

This finding can be restated in terms of factor substitutability. It was suggested in Chapter 3 that a process of adjustment occurs in industrial water use as the price of water increases. One of the factors of adjustment was suggested to be factor substitution. While the current research did not deal with water pricing adjustments, it did demonstrate that the same substitutability mechanism operates as industrial structure changes. Moreover, the research enabled calibration of the mechanism.

7.2 IMPLICATIONS OF THE STUDY FOR WATER MANAGEMENT

A primary and fundamental implication for water management is for the importance of establishing and maintaining time series data on Canadian water use, similar to those collected on physical aspects (e.g. streamflow) of the resource. Primary data collection on industrial water use began in 1972, and will likely continue into the future. Although the data were not collected with this particular piece of research in mind, the work was enhanced by the availability of the data. The perspective obtained on the process of water use change would not have been possible without these previous data collection efforts (Canada, 1979, 1983). This research is the first of its kind, to the author's knowledge, to compile and use a time series of strictly Canadian water use data.

A second implication for water management is the potential use of the model for water use forecasting purposes. The least squares regression results showed that all three of the structural change factors were important to varying degrees in accounting for the total variance of industrial water use over the period of study. This finding confirms the results of other research approaches that water use forecasts should not be carried out simply by on the basis of an extrapolated set of final demands. Rather, forecasts should take into account the changing structure of the industrial base and anticipated changes in the efficiency of water use in individual industries. This suggests the need for forecasting the input-output structure of the economy as part of the water use forecasting process.

A third implication for water management is the finding that the production technology factor exerted a negative influence on industrial water use. This finding suggests that trends in production technology, at least during the study period were toward production patterns which became more efficient with respect to their use of water. This, in turn, implies that water use can be influenced by technological decision-making. In instances where water shortages either occur or are anticipated, production patterns can be adopted to be consistent with the ambient water availability conditions. In other words, water availability need not be a constraint to economic development, at least in Canada and its regions. This "water as an economic development" arguement has been expressed in the past as a justification for development of large supply manipulation works. The findings of this reseach suggest that adaptation is feasible to water shortage conditions and that massive water transfer schemes, based upon the "need" for water for economic development, are not warrented until the possibilities for adaptation to water shortage conditions have been implemented, particularly in view of the environmental disruptions which normally attend large water development projects.

7.3 IMPLICATIONS OF THE RESEARCH FOR GEOGRAPHY

Resource management studies have been carried out by geographers since the inception of geography as a field of study. More recent Canadian studies by geographers in the water use and demand field have been by Sewell (in Canada, 1968), Grima (1972), Lee (1969), Sewell and Roeche (1974), Mitchell and Leighton (1977), and Robinson (1979), as well as several by the author himself. In expanding the research base of water use studies, this research has expanded upon a well established tradition in geography.

The study has shown the usefulness of a time series inventory of industrial water use. Inventory-type activities have been a most common geographical theme in land use studies. As mentioned in Chapter one, a parallel is thought to exist between land use and water use studies with respect to the value of inventory-type activities. In the same manner that basic land use data are important for land management, so also are water use studies important for water management. Sewell and Foster (1981) wrote of an emerging Canadian water crisis. If, indeed, that particular viewpoint is assumed, water use inventories, and the studies built upon them, will be of central importance in water management in the future.

The study has also contributed to the interdisciplinary nature of geography as a field of study. By adopting the input-output approach, a technique developed and used mostly in economic (especially regional) studies, the research is a blend of economic and geographical methods. This study is not, by far, the first one to use input-output analysis, but the fact that meaningful conclusions have emerged proves once again both the versatility of the technique and the value of interdisciplinary studies.

As indicated in Chapter two of this thesis, geographers have done much work in the area of structural change. The research conducted here expands this research thrust into the area of resource management, which has seldom been done in previous research. The fact that meaningful results have emerged demonstrates that the structural change theme of geographical research is a fruitful one.

7.4 RESEARCH DIRECTIONS

One of the main purposes for undertaking this study was to expand the theoretical base of water use studies. Numerous research approaches used in the past were explored in Chapter three, but none of these had focussed on structural change as a theme for the analysis of water use. By abstracting the main factors involved in structural change and by developing an operational framework within which to test the impact of these factors on changing industrial water use, the study has achieved a modest contribution to the conceptual nature of the field.

De Bono (1967) wrote that thinking is composed of both vertical and lateral activities. The vertical activity involves expanding upon work accomplished by others; in de Bono's somewhat homely analogy, this involves "digging in a previously dug hole". Lateral thought, on the other hand, involves exploring new directions, or starting a "new hole". This research is a blend of the two types of activity. In basing the work on an inventory type of study, the research is based on a well established research activity, both in geography and in water management. In investigating structural change as a framework against which to view changes in industrial water use, the study has used a lateral type of approach.

There are shortcomings to the research reported here, and a brief discussion of these suggests future research directions. Perhaps the major shortcoming was the problem of time series data compilation. The 1966 industrial water use data were estimated using 1972 survey findings and an extrapolation method. This estimating procedure was forced by the lack of adequate Canadian time series data. To confirm the findings of the study, the test cases should be redone as more data become available. The availability of new data would eliminate the need for using the estimated data for 1966.

Second, both the industrial disaggregation and the spatial units employed in the study are rather broad, and were adopted in view of data availability considerations. The cost of preparing input-output table at a sub-regional level is currently prohibitive, but, should this become possible in the future, the study should be augmented to explore the possibilities of sub-regional variation in the structural change effects.

Third, although production technology proved to be an important factor in influencing industrial water use, and although the reasons were traced back to the nature of the input and output linkages acting in the industrial system, the study still tended to see production technology in a "black box" fashion. In other words, precise reasons underlying the changed industrial linkages were not explored. This is a common research problem in that the selection of how far back to trace effects depends very much upon overall purposes, scope of the enquiry, spatial scale and resources which can be devoted to the study. For present purposes, the decision was made, considering all these factors, to conduct the study at a fairly broad scale. Work now could be carried out in detail on the reasons behind the structural effects on industrial water use which have been observed in each industry.

Finally, the model used here is a versatile one indeed, as mentioned earlier. Although primarily a structural change model, it does have direct application to water use forecasting. By projecting the input output structure and the final demand conditions, the model provides a good framework for analyzing future water uses. Once computerized, a wide range of final demands and water use coefficients can be examined with regard to their impact on national and regional water uses. With interregional linkages incorporated, the impacts of growth in any one region on any of the other regions can be analyzed. An extension to forecasting industrial waste loadings can be readily incorporated into the framework. In sum, the research has achieved both observations and conclusions about the primary subject of concern, and has also spun-off a number of promising research directions to be followed in the future.

REFERENCES

Alberta (1979). Alberta Industrial Water Use Survey, 1976. Edmonton: Edmonton: Alberta Environment, Planning Division.

Alexander, J.W. (1955). "The Basic-Nonbasic Concept of Urban Economic Functions." Economic Geography, 30, (July), pp. 246-61.

Anderson, A.W., Manning, T.W. (1983) "The Use of Input-Output Analysis in Evaluating Water Resource Development." Cdn. J. of Agric. Economics, 31, #3, pp. 15-26.

Ayres, R.U., Kneese, A.V. (1969). "Production, Consumption and Externalities." American Econoimic Review, 59, #6, pp. 282-297.

Boudeville, J.R. (1966). Problems of Regional Economic Development Planning. Edinburgh: Edinburgh University Press.

Bower, B.T. (1966). "The Economics of Industrial Water Utilization." in Kneese, A.V. and S.C. Smith (eds.) Water Research. Baltimore: Johns Hopkins Press, pp. 143-173

Bower, B.T. (1968). "Industrial Water Demands"; in Canada (1968). Forecasting the Demands for Water. by Sewell, W.R.D., Bower, B.T. (eds.). Ottawa-Hull: Department of Energy, Mines and Resources, pp. 85-125.

Bower, B.T. (1980). "Appraisal of Approaches Used to Forecast Water Demands," unpublished manuscript, Arlington,Va.

Bower, B.T., Lof, G.O., Hearon, W.M. (1971). "Residuals Generation in the Pulp and Paper Industry." Natural Resources Journal, 11, #4, pp. 605-623.

Burns, A.F. (1934) Production Trends in the United States since 1870. New York: National Bureau of Economic Research.

Calloway, J.A., Schwartz, A.W., Thompson, R.G. (1974) "Industrial Economic Model of Water Use and Waste Treatment for Ammonia," Water Resources Research, 10. #4. pp. 650-658.

Canada (1961). Background Papers: Resources for Tomorrow Conference. Ottawa-Hull, Queen's Printer, Catalogue No. R29-5261/1.

Canada (1968). Forecasting the Demands for Water. edited by by Sewell, W.R.D., Bower, B.T. Ottawa-Hull: Department of Energy, Mines and Resources, Policy and Planning Branch.

Canada (1969). The Input-Output Structure of the Canadian Economy, 1961, Vol. 1. Ottawa-Hull: Statistics Canada, Structural Analysis Division. Cataloue No. 15-501.

Canada (1970) General Review of the Mineral Industries. Ottawa-Hull: Statistics Canada, Catalogue 26-201, pp. A28-A30.

Canada (1971). "Water Requirements of the Iron and Steel Industry in the Canadian Great Lakes Basin." by Tate, D.M. Ottawa-Hull: Department of Fisheries and Forestry, Policy, Research and Co-ordination Branch. Discussion Paper 71-2.

Canada (1972a). "Approaches to Water Requirements Forecasting: A Canadian Perspective." by Lee, T.R. Burlington, Ontario: Department of the Environment, Canada Center for Inland Waters. Social Science Series, No. 9.

Canada (1972b). National Water Needs Study. Department of the Environment, Inland Waters Directorate. unpublished working paper, 1972.

Canada (1973a). "Industrial Water Demand Forecasting." by Tate, D.M., Robichaud, R. Ottawa-Hull: Department of the Environment, Inland Waters Directorate. Social Science Series, No. 10.

Canada (1973b). "Invention, Diffusion, and Allometry: A Study of the Growth and Form of the Pulp and Paper Industry in Central Canada." by Roberge, R.A., Ray, D.M., Villeneuve, P. Ottawa: Ministry of State for Urban Affairs. Discussion Paper, B73.20, 1973.

Canada (1974). Canada Year Book, 1974. Ottawa-Hull: Information Caanada, Catalogue #CS11-202/1974.

Canada (1975). Canada Water Year Book, 1975. Ottawa Hull: Information Canada, Catalogue #En36-425/1975.

Canada (1976a). "Design for Commodity-by-Industry Interregional Input-Output Models." by Hoffman, R.B., Kent, J.M. Ottawa-Hull: Statistics Canada, Input-Output Division, unnumbered working paper.

Canada (1976b). General Review of the Mineral Industries. Ottawa-Hull: Statistics Canada, Catalogue 29-201, pp.23-24.

Canada (1977a). "Manufacturing Water Use in Canada, 1972: A Summary of Results." by Tate, D.M. Ottawa-Hull: Department of the Environment, Inland Waters Directorate. Social Science Series, No. 17.

Canada (1977b). The Input-Output Structure of the Canadian Economy, 1961-1971. Ottawa-Hull: Statistics Canada, Structural Analysis Division. Catalogue No. 15-506E.

Canada (1978a). "Methodology for Compiling Interprovincial Trade Statistics." by Hoffman, R.B. Ottawa-Hull: Statistics Canada, Structural Analysis Division, WP78-07-27.

Canada (1978b). "Intertemporal Analysis of Structural Change in the Canadian Economy." by Syed, A.A. Ottawa-Hull: Statistics Canada, Structural Analysis Division, WP78-09-30.

Canada (1978c). "Variations in Input Coefficients of the Canadian Economy, 1961-1971: Some Statistical Experiments." by Lewis, J.S., Syed, A.A. Ottawa-Hull: Statistics Canada, Structural Analysis Division, WP78-10-25.

Canada (1978d). Canada Year Book, 1978-79. Ottawa-Hull: Supply and Services Canada, Catalogue #11-202/1978, p. 362.

Canada (1978e). The Correspondence Between the Urban System and the Economic Base of Canada's Regions. by Boisvert. M. Ottawa-Hull: Economic Council of Canada, Catalogue No. EC22-60/1978.

Canada (1979a). Consumptive Water Use in the Canadian Section of the Great Lakes Basin, by Tate, D.M. Ottawa-Hull: Department of the Environment, Inland Waters Directorate.

Canada (1979b). The Input-Output Structure of the Canadian Economy in Constant Prices: 1961-1974. Ottawa-Hull: Statistics Canada, Input-output Division, Catalogue 15-509.

Canada (1979c). "Structural Change in the Canadian Economy: 1961-1971." by Nijhowne, S., Gribble, S., Hamilton, K. Ottawa-Hull: Statistics Canada, Structural Analysis Division, WP79-04-13.

Canada (1979d). "Canadian Interregional Input-Output Tables: Sources and Methodology." by Gaston, C. Ottawa-Hull: Statistics Canada, Structural Analysis Division, WP79-11-13.

Canada (1980). "Highlights of the 1974 Interprovincial Input-Output Model". by Gaston, C., Boisvert, M. Ottawa-Hull: Statistics Canada, Structural Analysis Division, WP80-12-12.

Canada (1981). User's Guide to Statistics Canada Structural Models. Ottawa-Hull: Statistics Canada, Structural Analysis Division.

Canada, 1982). The Input-Output Structure of the Canadian Economy in Constant Prices, 1971-1978. Ottawa-Hull: Statistics Canada, Input-Output Division.

Canada (1983a). The Input-Output Structure of the Canadian Economy, 1971-1979. Ottawa-Hull: Statistics Canada, Input-Output Division.

Canada, 1983b). "Water Use in the Canadian Manufacturing Industry, 1976." by Tate, D.M. Ottawa-Hull, Department of the Environment, Inland Waters Directorate, Social Science Series, No. 18.

Canada (1983c). Canada Water Yearbook, 1981-1982. Ottawa-Hull: Supply and Services Canada, Catalogue #Em36-425/1981E.

Canada-Alberta-Saskatchewan-Manitoba (1982). Historical and Current Water Uses in the Saskatchewan-Nelson Basin. Regina: Prairie Provinces Water Board.

Canada-British Columbia Okanagan River Basin Study Consultative Board (1973). Final Report of the Board. Penticton, B.C.

Carter, A.P., Brody, A. Contributions to Input-Output Analysis. Amsterdam: North Holland.

Clark, C. (1940). The Conditions of Economic Progress. London: MacMillan.

Cootner, P.H., Lof, G.O.G. (1965). Water Demand for Steam Electric Generation. Baltimore: Johns Hopkins Press.

Cumberland, J.H. (1966). "A Regional Inter-industry Model for Analysis of Development Objectives." Papers, Regional Science Association, 17, pp. 65-95.

Davies, G.W. (1977). "A Model of the Urban Residential and Housing Markets." Cdn. J. of Economics, 10, #3, pp. 393-410.

Davis, H.C. (1968). "Multi-Regional Input-Output Techniques and Western Water Resources Development." Economic Evaluation of Water, Part V. Berkely, Calif.: University of California, Water Resources Center.

de Rooy, J. (1970). The Industrial Demand for Water Resources: An Econometric Analysis. University Microfilms, Ann Arbor.

Dorfman, R., Samuelson, P.A., Solow, R.M. (1958). Linear Programming and Economic Analysis. Toronto: McGraw-Hill.

Earmme, S.Y. (1979). A Water Use Projection Model for the North Saskatchewan River Basin, Alberta, 1980-85: An Input-Output Approach. unpublished Doctoral Dissertation, University of Alberta, 1979.

Fisher, A.G.B. (1933). "Capital and the Growth of Knowledge." Economic Journal, 43, #1, pp. 24-38.

Forsund, F.R., Strom, S. (1976). "The Generation of Residual Flows in Norway: An Input-Output Approach." Journal of Environmental Management, 3, pp. 129-141.

Foster, H.D., Sewell, W.R.D. (1981) Water: The Emerging Crisis in Canada. Ottawa: Canadian Institute for Economic Policy.

Grima, A.P. (1972). Residential Demand for Water: Alternative Choices for Management, Toronto, University of Toronto Press.

Heady, E.O., Madsen, H.C., Nicol, K.J., Hargrove, S.H. (1973). "National and Interregional Models of Water Demand, Land Use and Agricultural Policies." Water Resources Research, 9, #4, pp. 777-791.

Hirschman, A.O. (1958). The Strategy of Economic Development. New Haven, Conneticut: Yale University Press.

Howe, C.W. (1979) Natural Resource Economics: Issues, Analysis and Policy. New York: Wiley.

Howe, C.W., Linaweaver, F.P. (1970). "The Impact of Price on Residential Water Demand and Its Relation to System Design and Price Structure." Water Resources Research, 3, #1, pp. 13-32.

Howe, C.W., Russell, C.S., Young, R.A. (1970). Future Water Demands: The Impacts of Technological Change, Public Policies, and Changing Market Conditions on the Water Use Patterns of Selected Sectors of the United States Economy: 1970-1990. Washington: Resources for the Future, Inc.

Isard, W. (1960). Methods of Regional Analysis. Cambridge, Mass. M.I.T. Press.

Isard, W. (1969). "Some Notes on the Linkage of the Ecologic and Economic Systems." Papers and Proceedings, Regional Science Association, 22, pp. 85-96.

Isard, W., Kuenne, R.E. (1953). "The Impact of Steel Upon the Greater New York-Philadelphia Region." Review of Economics and Statistics, 35, #4, November, pp. 289-301.

Isard, W., Schooler, E.W. (1959). "Industrial Complex Analysis, Agglomeration Economies and Regional Development." Journal of Regional Science, 1, Spring, pp.17-33.

Kuznets, S.S. (1966). Modern Economic Growth: Rate, Structure and Spread. New Haven, Conneticut, Yale University Press.

Lee, T.R. (1969). Residential Water Demand and Economic Development. Toronto: University of Toronto Press.

Leontieff, W.W. (1936). "Quantitative Input-Output Relations in the Economic System of the United States." Review of Economics and Statistics, 18, #2, pp. 105-125.

Leontieff, W.W. (1953). "Structural Change". in W.W. Leontieff, et al.(eds.). Studies in the Structure of the American Economy. New York: Oxford University Press.

Leontieff, W.W. (1970). "Environmental Repercussions and the Economic Structure: An Input-output Approach." Review of Economic and Statistics, 52, #3, pp. 262-271.

Leontieff, W.W. (1977). Structure, System and Economic Policy. Cambridge: Cambridge University Press.

Leontieff, W.W. (1982). "The Distribution of Work and Income." Scientifc American, 247, #3, pp. 188-204.

Leontieff, W.W., Hoffenberg, M. (1961). "The Economic Effects of Disarmament." Scientific American, April, pp. 47-55.

Lloyd, P.E. (1979) "The Components of Industrial Change for Merseyside Inner Area: 1966-1975." Urban Studies, 16, pp. 45-60.

Lof, G.O., Kneese, A.V. (1968). The Economics of Water Utilization in the Beet Sugar Industry. Baltimore: Johns Hopkins Press.

Lofting, E.M., McGauhey, P.H. (1966). "An Interindustry Analysis of the California Water Economy." Economic Evaluation of Water, Part III, Berkeley, Calif., University of California, Water Resources Center.

Lofting, E.M., McGauhey, P.H. (1968). "An Input-Output and Linear Programming Analysis of California Water Requirements." Economic Evaluation of Water, Part IV. Berkeley, Calif., University of California, Water Resources Center.

Lofting, E.M., Davis, H.C. (1968). "The Interindustry Water Content Matrix: Applications on a Multiregional Basis." Water Resources Research, 4, #4, pp. 689-695.

Lofting, E.M., Davis, H.C. (1976). Methods for Estimating and Projecting Water Demands for Water Resources Planning, unpublished manuscript supplied by Dr. H.C. Davis.

Malecki, E.J. (1983). "Technology and Regional Development." Internat-national Regional Science Review, 8. #2, pp. 89-125.

Mansfield, E. (1971) Technological Change. New York: W.W. Norton.

Maxwell, J.W. (1967). "The Functional Structure of Canadian Cities." Geographical Bulletin, 9, #4, pp. 61-87.

Miernyk, W.H. (1966). The Elements of Input-Output Analysis. New York, Random House.

Mitchell, B. (1980). Geography and Resource Analysis. New York: Longman.

Mitchell, B. (1979). "Models of Resource Management." Progress in Human Geography, 4, #1, pp. 33-56.

Mitchell, B., Leighton, P.H. (1977). "A Comparison of Multivariate and Trend Forecasting Estimates with Actual Water Use," Water Resources Bulletin, 13, pp.817-24.

O'Connor, K. (1974). "The Industrial Structure of a Growth Center: An Outline for Research." in Helleiner, F.M. and W. Stohr,(eds.) Spatial Aspects of the Development Process. Toronto: Allister, pp.113-130.

Ontario (1968). "The Input-Output Structure of the Ontario Economy." Ontario Economic Review. Toronto: Department of Treasury, Economics and Intergovernmental Affairs.

Perloff, H.S., Dunn, E.S., Lampard, E.E., Muth, R.F. (1960). Regions, Resources and Economic Growth. Baltimore, Johns Hopkins Press.

Perroux, F. (1955). "Note on the Concept of 'Growth Poles'." translation in McKee, D.L., Dean, R.D., Leahy, W.H. (1970). Regional Economics: Theory and Practice. New York: The Free Press.

Rees, J.A. (1969). Industrial Demand for Water: a Study of South East England. London: Weidenfied and Nicolson.

Rees, J.A. (1971). Factors Affecting Metered Water Consumption. London: Final Report to the Social Science Research Council.

Richardson, H.W. (1972). Input-output and Regional Economics. London: Weidenfield and Nicholson.

Robinson, J.E. (1979). Demand Modification as a Supply Alternative: A Case Study of the Regional Municipality of Waterloo, Ontario, Canada. unpublished manuscript supplied by Prof. Robinson, Waterloo, University of Waterloo, Department of Man-Environment Studies.

Rosenbluth, G. (1968). "Input-Output Analysis: A Critique." Statistiche, 9, #4, pp. 255-68.

Russell, C.S. (1973). Models of Response to Residuals Management Action: A Case Study for Petroleum Refining. Baltimore: Johns Hopkins Press.

Russell, C.S., Vaughn, J. (1976) Steel Production: Processes, Products and Residuals. Washington: Resources for the Future.

Samuelson, P.A. (1961). Economics: An Introductory Analysis, Fifth Edition. Toronto, McGraw-Hill.

Schmookler, J. (1966). Invention and Economic Growth. Cambridge, Mass.: Harvard University Press.

Schultz, C.W. (1977). "The Public Use of Private Interest." The Godkin Lectures. Cambridge, Mass.: Harvard University Press.

Sewell, W.R.D., Roueche, L. (1974). "The Potential Impact of Peak Load Pricing on Urban Water Demands: Victoria, British Columbia, a Case Study." in F.M. Leversedge (ed.)(1974). Priorities in Water Management. Victoria, B.C.: University of Victoria, Western Geographical Series, Vol. 8, pp. 141-161.

Stevens, B.H. and C.L. Moore (1980). "A Critical Review of Shift-Share as a Forecasting Technique." Journal of Regional Science, 20, #4, pp. 419-437

Syed, A.A. (1975). Structural Change, Key Sectors and Linkage-Balanced Growth: An Input-Output Analysis of the Canadian Economy. Unpublished PhD. Dissertation: Simon Fraser University.

Tate, D.M. (1978). "Water Demand Forecasting in Canada: A Review." Laxenberg, Austria: International Institute for Applied Systems Analysis, Research Memorandum 78-16.

Tate, D.M. (1981a). "The Analysis of Manufacturing Employment in Canada Using Shift-Share Analysis: An Examination of Methodology and Empirical Test." Ottawa, University of Ottawa Department of Geography, Research Notes #33.

Tate, D.M. (1981b). "River Basin Development in Canada." in Mitchell, B., Sewell, W.R.D. Canadian Resource Policies: Problems and Prospects. Toronto: Methuen, pp. 151-179.

Tate, D.M., Lacelle, D. (1978). "Municipal Water Use in Canada." Canadian Water Resources Journal, 3, #2, pp. 61-78

Thomas, M.D. (1974). "Structural Change and Regional Industrial Development." in Helleiner, F.M. and W. Stohr (eds.) (74) Spatial Aspects of the Development Process. Toronto: Allister, pp.39-71.

Thomas, M.D. (1975). "Growth Pole Theory, Technological Change and Regional Economic Growth." Papers, Regional Science Association, 34, pp.3-26.

Thompson, R.G., Young, H.P. (1973). "Forecasting Water Use for Policy Making: A Review." Water Resources Research,9, #4, pp.792-799.

Thompson, W.R. (1968). A Preface to Urban Economics. Baltimore: Johns Hopkins Press.

U.S. (1968). "Water Use in Manufacturing." Bureau of the Census, U.S. Bureau of the Census, Census of Manufactures, 1968. Washington: Government Printing Office.

Victor, P.A. (1972). Pollution: Economy and Environment. London: George Allen and Unwin.

Whittington, D. "Forecasting Industrial Water Use." Laxenberg, Austria: International Institute for Applied Systems Analysis, Research Memorandum, 78-71, 1978.

Wollman, N., Bonem, C.W. (1971). The Outlook for Water. Baltimore: Johns Hophins Press.

Wong, S.T. (1972). "A Model on Municipal Water Demands:A Case Study of Northeastern Illinois." Land Economics, 48, #2, pp. 34-44.

Wonnacott, T.H., Wonnacott., R.J. Introductory Statistics. Toronto: John Wiley and Sons, Inc.

Young, H.P., Thompson, R.G. (1973b). "Forecasting Water Use for Electric Power Generation." Water Resources Bulletin, 9, #4, pp. 800-807.

Zimmermann, E.W. (1953). An Introduction to World Resources. Edited by H. Hunker. New York: Harper and Row.

Appendix A

Industrial Water Use Data

General Notes

Throughout Appendix A and subsequent appendicies, the set of industries used in the tables have been referred to by number. The following list describes each numbered industry.

Industry Number	Description
1	Agriculture
2	Forestry, Fishing, Hunting and Trapping
3	Metallic Minerals
4	Mineral Fuels
5	Non-metallic Minerals
6	Food and Beverages
7	Tobacco Products
8	Rubber and Plastics
9	Leather Products
10	Textiles, Knitting Mills and Clothing
11	Wood Products
12	Furniture and Fixtures
13	Paper and Allied Products
14	Printing and Publishing
15	Primary Metals, except Iron and Steel
16	Iron and Steel
17	Metal Finishing
18	Machinery
19	Transportation Equipment
20	Electrical Products
21	Non-metallic Mineral Products
22	Petroleum and Coal Products
23	Chemicals and Chemical Products
24	Miscellaneous Manufacturing
25	Construction
26	Transportation, Communication and Storage
27	Electric Power
28	Gas and Other Utilities
29	Wholesale and Retail Trade
30	Other (i.e. Finance, Insurance, Real Estate, etc)

Note that this list has also been placed in the endpapers for reference when reviewing the appendicies.

Table A-1 **Industrial Water Use, by Parameter, Canada, 1966**
(million cubic metres)

	Intake	Recirculation	Gross Use	Consumption	Discharge
Industry 1	3193.18	0.00	3193.18	2285.13	908.05
Industry 2	0.00	0.00	0.00	0.00	0.00
Industry 3	170.17	1633.25	1803.42	14.36	155.81
Industry 4	42.00	67.88	109.88	37.94	4.06
Industry 5	152.49	188.11	340.60	33.82	118.67
Industry 6	349.85	148.13	497.98	23.06	326.79
Industry 7	0.00	0.00	0.00	0.00	0.00
Industry 8	262.57	82.87	345.44	2.06	260.51
Industry 9	4.01	0.44	4.45	0.27	3.74
Industry 10	94.86	34.62	129.48	3.34	91.52
Industry 11	152.20	37.69	189.89	4.57	147.63
Industry 12	0.46	0.16	0.62	0.02	0.44
Industry 13	2811.41	5991.64	8803.05	101.61	2709.80
Industry 14	2.82	32.19	35.01	0.00	2.82
Industry 15	384.51	544.45	928.96	9.12	375.39
Industry 16	1375.58	847.89	2223.47	37.76	1337.82
Industry 17	35.41	42.28	77.69	1.36	33.80
Industry 18	8.40	6.25	14.65	0.61	7.79
Industry 19	178.94	79.91	258.85	7.44	171.50
Industry 20	30.07	54.27	84.34	0.79	29.28
Industry 21	131.51	121.05	252.56	5.78	125.73
Industry 22	609.08	679.66	1288.74	30.74	578.34
Industry 23	1618.13	1942.59	3560.71	99.67	1518.46
Industry 24	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00
Industry 27	6559.23	0.00	6559.23	71.27	6487.96
Industry 28	0.00	0.00	0.00	0.00	0.00
Industry 29	771.39	0.00	771.39	0.00	771.39
Industry 30	0.00	0.00	0.00	0.00	0.00
TOTAL	18938.27	12535.33	31473.59	2770.72	16167.30

Source: Appendix B, Table 1

Table A-2 Industrial Water Use by Parameter, Canada, 1972
(million cubic metres)

	Intake	Recircu-lation	Gross Use	Consump-tion	Dis-charge
Industry 1	2854.50	0.00	2854.50	2042.65	811.72
Industry 2	0.00	0.00	0.00	0.00	0.00
Industry 3	160.56	1540.97	1701.53	13.55	147.01
Industry 4	42.41	68.55	110.97	38.32	4.09
Industry 5	159.06	196.20	355.26	35.28	123.78
Industry 6	380.08	160.92	541.01	25.05	355.03
Industry 7	1.23	6.77	8.00	0.32	0.91
Industry 8	353.90	111.69	465.59	2.77	351.13
Industry 9	3.36	0.36	3.73	0.23	3.14
Industry 10	127.83	46.64	174.47	4.50	123.33
Industry 11	175.29	43.41	218.70	5.27	170.02
Industry 12	1.23	0.41	1.64	0.05	1.18
Industry 13	3094.26	6594.46	9688.72	111.83	2982.43
Industry 14	3.59	40.91	44.50	0.00	3.59
Industry 15	356.76	505.14	861.90	8.46	348.31
Industry 16	1291.67	796.17	2087.84	35.46	1256.21
Industry 17	31.87	38.05	69.92	1.45	30.41
Industry 18	6.91	5.14	12.05	0.50	6.41
Industry 19	192.38	85.92	278.30	8.00	184.38
Industry 20	31.14	56.19	87.33	0.82	30.32
Industry 21	133.15	122.56	255.71	5.86	127.29
Industry 22	699.93	781.03	1480.96	35.32	664.61
Industry 23	1524.79	1830.54	3355.33	93.92	1430.87
Industry 24	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00
Industry 27	9320.64	0.00	9320.64	101.28	9219.36
Industry 28	0.00	0.00	0.00	0.00	0.00
Industry 29	987.19	0.00	987.19	0.00	987.19
Industry 30	0.00	0.00	0.00	0.00	0.00
TOTAL	21933.73	13032.05	34965.78	2571.02	19362.72

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1972. Data were compiled from confidential individual returns. Data for the agriculture sector werederived from: Canada-Alberta-Saskatchewan-Manitoba, 1983.
Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1972 were "backcast" from 1975 data on the basis of average growth rates.
Data for the wholesale and retail trade sector were based upon "backcasting" 1976 data in Tate and Lacelle, 1976.

Table A-3 Industrial Water Use by Parameter, Canada, 1976
(million cubic metres)

		Intake	Recirculation	Gross Use	Consumption	Discharge
Industry	1	3299.64	0.00	3299.64	2369.00	930.65
Industry	2	0.00	0.00	0.00	0.00	0.00
Industry	3	541.55	1421.67	1963.22	58.51	483.05
Industry	4	39.00	0.67	39.67	31.28	7.73
Industry	5	86.78	307.89	394.67	15.37	71.42
Industry	6	358.76	161.89	520.65	30.96	327.80
Industry	7	—	—	—	—	—
Industry	8	59.46	82.03	141.49	5.36	54.10
Industry	9	0.23	0.00	0.23	0.00	0.23
Industry	10	138.70	103.70	242.40	7.23	131.47
Industry	11	331.35	157.23	488.58	8.64	322.71
Industry	12	—	—	—	—	—
Industry	13	3132.08	5735.47	8867.55	170.33	2961.74
Industry	14	—	—	—	—	—
Industry	15	726.43	1087.93	1814.36	36.37	690.07
Industry	16	1367.91	888.68	2256.59	40.32	1327.58
Industry	17	8.41	2.79	11.20	0.14	8.27
Industry	18	0.00	0.00	0.00	0.00	0.00
Industry	19	375.72	427.70	803.42	2.23	373.49
Industry	20	—	—	—	—	—
Industry	21	94.69	151.91	246.60	15.55	79.14
Industry	22	615.74	1015.62	1631.36	35.37	580.38
Industry	23	1462.69	1547.46	3010.15	104.06	1358.63
Industry	24	—	—	—	—	—
Industry	25	0.00	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00	0.00
Industry	27	13163.56	0.00	13163.56	160.38	13003.18
Industry	28	0.00	0.00	0.00	0.00	0.00
Industry	29	1091.02	0.00	1091.02	0.00	1091.02
Industry	30	0.00	0.00	0.00	0.00	0.00
TOTAL		26893.72	13092.63	39986.36	3091.07	23802.66

— not surveyed in 1976

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1976. Data were compiled from confidential individual returns. Data for the agriculture sector were derived from: Canada-Alberta-Saskatchewan-Manitoba, 1983. Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1976 were interpolated from 1975 and 1980 data on the basis of average growth rates. Data for the wholesale and retail trade sector were based upon data in Tate and Lacelle, 1976.

Table A-4 Industrial Water Intake by Source, Canada, 1972 (million cubic metres)

	Public	Self-Supplied Surface Water	Self-Supplied Ground Water	Brac-kish Water	Total Intake
Industry 1		information	not available		2854.50
Industry 2	0.00	0.00	0.00	0.00	0.00
Industry 3	1.79	143.31	7.91	7.57	160.58
Industry 4	0.05	41.00	1.05	0.32	42.41
Industry 5	6.46	119.60	13.77	19.25	159.08
Industry 6	190.15	94.19	39.69	56.05	380.08
Industry 7	1.23	0.00	0.00	0.00	1.23
Industry 8	329.94	18.46	5.46	0.05	353.90
Industry 9	3.00	0.27	0.09	0.00	3.36
Industry 10	40.59	82.64	3.36	1.23	127.83
Industry 11	28.55	118.65	0.73	27.37	175.29
Industry 12	1.14	0.00	0.09	0.00	1.23
Industry 13	211.20	2832.96	30.82	19.27	3094.26
Industry 14	3.59	0.00	0.05	0.00	3.64
Industry 15	29.96	323.17	11.71	0.64	356.76
Industry 16	47.10	1146.48	86.10	86.10	1291.67
Industry 17	23.73	7.05	1.09	0.00	31.87
Industry 18	6.32	0.00	0.59	0.00	6.91
Industry 19	78.92	93.92	0.05	19.50	192.38
Industry 20	24.55	6.00	0.55	0.05	31.14
Industry 21	79.01	46.19	7.86	0.09	133.15
Industry 22	12.36	594.01	1.86	91.69	699.93
Industry 23	126.79	1305.58	15.37	77.05	1524.79
Industry 24	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00
Industry 27	3.50	8238.08	7.77	1071.29	9320.64
Industry 28	0.00	0.00	0.00	0.00	0.00
Industry 29	987.16	0.00	0.00	0.00	987.16
Industry 30	0.00	0.00	0.00	0.00	0.00
TOTAL	2237.08	15211.56	235.96	1477.50	21933.79

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1972. Data were compiled from confidential individual returns. Data for the wholesale and retail trade sector were based upon "backcasting" 1976 data in Tate and Lacelle, 1976. All data used in this sector were derived from public sources.

Table A-5 Industrial Water Intake by Source, Canada, 1976
(million cubic metres)

	Public	Self-Supplied Surface Water	Self-Supplied Ground Water	Brackish	Total Intake
Industry 1	information not available				3299.60
Industry 2	0.00	0.00	0.00	0.00	0.00
Industry 3	77.19	395.08	49.32	19.96	541.55
Industry 4	0.91	37.46	0.59	0.05	39.00
Industry 5	6.27	48.73	14.23	17.55	86.78
Industry 6	156.33	119.56	31.46	51.41	358.76
Industry 7	—	—	—	—	—
Industry 8	33.78	18.91	5.82	0.95	59.46
Industry 9	0.23	0.00	0.00	0.00	0.23
Industry 10	30.82	105.87	2.00	0.00	138.70
Industry 11	26.37	231.25	5.64	68.10	331.35
Industry 12	—	—	—	—	—
Industry 13	164.20	2953.24	3.68	10.96	3132.08
Industry 14	—	—	—	—	—
Industry 15	219.39	484.73	2.82	19.50	726.43
Industry 16	42.91	1245.53	1.82	77.64	1367.91
Industry 17	2.77	4.36	1.27	0.00	8.41
Industry 18	—	—	—	—	—
Industry 19	303.98	71.64	0.05	0.05	375.72
Industry 20	—	—	—	—	—
Industry 21	24.14	57.37	11.50	1.68	94.69
Industry 22	15.87	535.60	2.14	62.14	615.74
Industry 23	98.60	1281.99	14.77	67.32	1462.69
Industry 24	—	—	—	—	—
Industry 25	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00
Industry 27	5.73	9901.88	2.41	3253.55	13163.56
Industry 28	0.00	0.00	0.00	0.00	0.00
Industry 29	1091.02	0.00	0.00	0.00	1091.02
Industry 30	0.00	0.00	0.00	0.00	0.00
TOTAL	2300.50	17493.21	149.51	3650.86	26893.68

— not surveyed in 1976

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1976. Data were compiled from confidential individual returns. Data for the wholesale and retail trade sector were based upon data in Tate and Lacelle, 1976.

Table A-6 Industrial Water Intake by Purpose, Canada, 1972
(million cubic metres)

	Process	Cooling Condensing and Steam	Sanitary Service	Other	Total
Industry 1	2854.50	0.00	0.00	0.00	2854.50
Industry 2	0.00	0.00	0.00	0.00	0.00
Industry 3	115.87	33.68	2.89	8.15	160.58
Industry 4	6.51	0.64	0.14	35.14	42.43
Industry 5	96.82	53.19	0.81	8.25	159.06
Industry 6	161.70	176.24	23.96	18.18	380.08
Industry 7	0.09	0.77	0.27	0.09	1.23
Industry 8	306.48	25.96	2.45	19.00	353.90
Industry 9	2.45	0.68	0.23	0.00	3.36
Industry 10	65.55	59.28	2.14	0.86	127.83
Industry 11	29.18	141.01	1.23	3.86	175.29
Industry 12	0.36	0.45	0.36	0.05	1.23
Industry 13	2453.92	526.05	17.18	97.10	3094.26
Industry 14	0.64	1.05	1.36	0.55	3.59
Industry 15	130.19	212.43	5.96	8.18	356.76
Industry 16	483.91	793.44	13.77	0.55	1291.67
Industry 17	13.55	12.96	4.96	0.41	31.87
Industry 18	4.00	2.23	0.59	0.09	6.91
Industry 19	58.10	88.55	25.46	20.27	192.38
Industry 20	15.87	11.86	3.05	0.36	31.14
Industry 21	36.78	75.55	4.32	16.50	133.15
Industry 22	80.33	601.06	2.05	16.50	699.93
Industry 23	219.07	1279.99	15.27	10.46	1524.79
Industry 24	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00
Industry 27	0.00	9320.64	0.00	0.00	9320.64
Industry 28	0.00	0.00	0.00	0.00	0.00
Industry 29	0.00	0.00	987.19	0.00	987.19
Industry 30	0.00	0.00	0.00	0.00	0.00
TOTAL	7135.87	13417.72	1115.63	264.55	21933.77

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1972. Data were compiled from confidential individual returns.
Data for the agriculture sector were derived from: Canada-Alberta-Saskatchewan-Manitoba, 1983.
Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1972 were "backcast" from 1975 data on the basis of average growth rates.
Data for the wholesale and retail trade sector were based upon "backcasting" 1976 data in Tate and Lacelle, 1976.

Table A-7 Industrial Water Intake by Purpose, Canada, 1976
(million cubic metres)

	Process	Cooling Condensing and Steam	Sanitary Service	Other	Total
Industry 1	3299.60	0.00	0.00	0.00	3299.60
Industry 2	0.00	0.00	0.00	0.00	0.00
Industry 3	329.40	94.28	75.83	42.05	541.55
Industry 4	7.00	1.27	0.59	30.14	39.00
Industry 5	49.32	24.91	3.91	8.64	86.78
Industry 6	116.60	198.25	24.28	19.64	358.76
Industry 7	—	—	—	—	—
Industry 8	22.55	33.55	2.82	0.55	59.46
Industry 9	0.23	0.00	0.00	0.00	0.23
Industry 10	42.60	89.92	3.27	2.91	138.70
Industry 11	103.96	209.93	7.18	10.27	331.35
Industry 12	—	—	—	—	—
Industry 13	2235.45	821.90	14.32	60.42	3132.08
Industry 14	—	—	—	—	—
Industry 15	195.97	449.62	74.13	6.73	726.44
Industry 16	429.91	917.50	18.27	2.23	1367.91
Industry 17	3.41	4.36	0.55	0.09	8.41
Industry 18	—	—	—	—	—
Industry 19	43.55	56.51	234.89	40.78	375.72
Industry 20	—	—	—	—	—
Industry 21	31.55	50.50	4.23	8.41	94.69
Industry 22	69.10	539.33	4.73	2.59	615.74
Industry 23	169.43	1258.49	12.91	21.87	1462.69
Industry 24	—	—	—	—	—
Industry 25	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00
Industry 27	0.00	13163.56	0.00	0.00	13163.56
Industry 28	0.00	0.00	0.00	0.00	0.00
Industry 29	0.00	0.00	1091.02	0.00	1091.02
Industry 30	0.00	0.00	0.00	0.00	0.00
TOTAL	7149.61	17913.87	1572.91	257.30	26893.69

— not surveyed in 1976

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1976. Data were compiled from confidential individual returns. Data for the agriculture sector were derived from: Canada-Alberta-Saskatchewan-Manitoba, 1983. Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87–107. Data for 1976 were interpolated from 1975 and 1980 data on the basis of average growth rates. Data for the wholesale and retail trade sector were based upon data in Tate and Lacelle, 1976.

Table A-8 Industrial Use Rates and Consumption Rates, Canada, 1972 and 1976

	Use Rate 1972	Use Rate 1976	Consumption Rat 1972	Consumption Rat 1976
Industry 1	1.00	1.00	0.68	0.58
Industry 2	—	—	—	—
Industry 3	10.60	3.65	0.08	0.11
Industry 4	2.62	1.76	0.90	0.98
Industry 5	2.23	4.55	0.22	0.18
Industry 6	1.42	1.45	0.07	0.09
Industry 7	6.52	—	0.26	—
Industry 8	1.32	2.35	0.01	0.09
Industry 9	1.11	1.00	0.07	0.00
Industry 10	1.36	1.72	0.04	0.05
Industry 11	1.25	1.48	0.03	0.03
Industry 12	1.33	—	—	—
Industry 13	3.13	2.83	0.04	0.05
Industry 14	12.39	—	0.00	—
Industry 15	2.42	2.50	0.02	0.05
Industry 16	1.62	1.65	0.03	0.03
Industry 17	2.19	1.34	0.04	0.02
Industry 18	1.74	—	0.07	—
Industry 19	1.45	2.14	0.04	0.01
Industry 20	2.80	—	0.03	—
Industry 21	1.92	2.60	0.04	0.16
Industry 22	2.12	2.65	0.05	0.06
Industry 23	2.20	2.06	0.06	0.07
Industry 24	—	—	—	—
Industry 25	—	—	—	—
Industry 26	—	—	—	—
Industry 27	1.00	1.00	0.01	0.01
Industry 28	—	—	—	—
Industry 29	1.00	1.00	0.00	0.00
Industry 30	—	—	—	—

— not surveyed or insignificant water use

Source calculated from Tables A-2 and A-3.

Table A-9 Industrial Water Intake by Region, 1972, million cubic metres)

	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	20.54	74.70	128.10	2160.30	470.86	2854.50
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	32.09	55.73	39.59	13.77	19.37	160.56
Industry 4	0.00	0.00	0.00	37.87	4.55	42.41
Industry 5	15.68	2.82	33.82	82.37	24.37	159.06
Industry 6	93.15	73.96	132.24	52.73	28.00	380.08
Industry 7	0.00	0.77	0.45	0.00	0.00	1.23
Industry 8	0.64	10.55	337.17	5.50	0.05	353.90
Industry 9	0.00	0.18	3.00	0.18	0.00	3.36
Industry 10	0.64	59.82	67.01	0.05	0.32	127.83
Industry 11	0.45	4.73	5.05	5.00	160.06	175.29
Industry 12	0.00	0.09	1.14	0.00	0.00	1.23
Industry 13	555.01	849.04	705.66	128.24	856.31	3094.26
Industry 14	0.05	1.59	1.82	0.14	0.00	3.59
Industry 15	58.51	192.97	58.28	17.00	30.00	356.76
Industry 16	45.19	72.83	1065.79	0.00	107.87	1291.67
Industry 17	0.64	10.32	16.73	1.73	2.45	31.87
Industry 18	0.41	1.82	3.41	0.32	0.95	6.91
Industry 19	24.91	32.09	131.65	3.18	0.55	192.38
Industry 20	0.55	10.18	19.73	0.50	0.18	31.14
Industry 21	2.45	78.33	42.10	5.82	4.45	133.15
Industry 22	102.10	160.61	310.12	46.37	80.74	699.93
Industry 23	91.46	132.10	1090.20	95.92	115.10	1524.79
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	1162.61	413.68	5629.23	2058.29	56.82	9320.64
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	73.23	339.40	355.44	110.97	108.15	987.19
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	2280.31	2578.31	10177.72	4826.24	2071.15	21933.73

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1972. Data were compiled from confidential individual returns. Data for the agriculture sector werederived from: Canada-Alberta-Saskatchewan-Manitoba, 1983. Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1972 were "backcast" from 1975 data on the basis of average growth rates. Data for the wholesale and retail trade sector were based upon "backcasting" 1976 data in Tate and Lacelle, 1976.

Table A-10 Industrial Water Intake by Region, 1974
(million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	22.25	62.73	141.88	2355.17	495.08	3077.10
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	63.95	134.58	80.04	27.18	45.30	351.06
Industry 4	0.00	0.00	0.00	36.54	3.60	40.14
Industry 5	15.00	5.96	34.28	54.82	12.88	122.94
Industry 6	86.20	78.10	128.15	47.71	29.28	369.43
Industry 7	0.00	0.39	0.23	0.00	0.00	0.61
Industry 8	2.51	13.78	187.04	3.33	0.02	206.68
Industry 9	0.00	0.09	1.50	0.21	0.00	1.80
Industry 10	0.93	54.03	77.88	0.27	0.16	133.27
Industry 11	8.77	26.43	22.64	20.36	174.61	252.81
Industry 12	0.00	0.05	0.57	0.00	0.00	0.61
Industry 13	487.91	879.50	693.27	109.99	942.50	3113.17
Industry 14	0.03	0.80	0.91	0.07	0.00	1.80
Industry 15	57.01	245.84	181.54	37.98	19.23	541.60
Industry 16	46.53	74.99	1097.25	0.00	111.03	1329.80
Industry 17	0.32	6.66	10.89	1.05	1.23	20.14
Industry 18	0.21	0.91	0.71	0.28	0.48	2.59
Industry 19	93.41	53.89	119.88	2.32	14.55	284.04
Industry 20	0.28	5.09	9.87	0.25	0.09	15.58
Industry 21	3.05	48.75	50.31	5.96	5.86	113.93
Industry 22	90.20	142.43	315.19	35.74	74.28	657.84
Industry 23	82.69	146.22	1070.81	91.99	102.01	1493.71
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	2083.57	423.40	6157.42	2221.50	356.22	11242.11
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	77.12	357.38	373.88	116.86	113.88	1039.11
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	3221.94	2761.98	10756.13	5169.57	2502.28	24411.89

Source: Calculated by taking the average value of the corresponding 1972 and 1976 values (Tables A-9 and A-11 respectively.) For th industries not surveyed in 1976, their water intakes were considered to be zero.

Table A-11 Industrial Water Intake by Region, 1976
(million cubic metres)

	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	23.96	50.69	155.65	2550.07	519.32	3299.69
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	95.83	213.38	120.51	40.59	71.23	541.55
Industry 4	1.18	0.00	0.00	35.23	2.64	39.05
Industry 5	14.32	9.09	34.73	27.28	1.36	86.78
Industry 6	79.24	82.24	124.06	42.69	30.55	358.76
Industry 7	—	—	—	—	—	—
Industry 8	4.36	17.00	36.91	1.18	0.00	59.46
Industry 9	0.00	0.00	0.00	0.23	0.00	0.23
Industry 10	1.23	48.23	88.74	0.50	0.00	138.70
Industry 11	17.09	48.14	41.23	35.73	189.15	331.35
Industry 12	—	—	—	—	—	—
Industry 13	420.81	909.95	680.88	91.74	1028.69	3132.08
Industry 14	—	—	—	—	—	—
Industry 15	55.51	298.71	304.80	58.96	8.46	726.43
Industry 16	47.87	77.14	1128.70	0.00	114.19	1367.91
Industry 17	0.00	3.00	5.05	0.36	0.00	8.41
Industry 18	0.00	0.00	0.00	0.23	0.00	0.23
Industry 19	161.92	75.69	108.10	1.45	28.55	375.72
Industry 20	—	—	—	—	—	—
Industry 21	3.64	19.18	58.51	6.09	7.27	94.69
Industry 22	78.28	124.24	320.26	25.09	67.82	615.70
Industry 23	73.92	160.33	1051.42	88.05	88.92	1462.64
Industry 24	—	—	—	—	—	—
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	3004.52	433.13	6685.61	2384.69	655.61	13163.56
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	81.01	375.35	392.31	122.74	119.60	1091.02
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	4164.68	2945.52	11337.47	5512.90	2933.38	26893.73

— not surveyed in 1976

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1976. Data were compiled from confidential individual returns. Data for the agriculture sector were derived from: Canada-Alberta-Saskatchewan-Manitoba, 1983. Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1976 were interpolated from 1975 and 1980 data on the basis of average growth rates. Data for the wholesale and retail trade sector were based upon data in Tate and Lacelle, 1976.

Table A-12 Industrial Gross Water Use by Region, 1972
(million cubic metres)

	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	20.54	74.70	128.10	2160.30	470.86	2854.50
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	156.92	258.35	1183.02	33.89	67.67	1699.85
Industry 4	0.00	0.00	0.00	37.87	67.32	105.19
Industry 5	14.24	0.61	53.02	252.88	26.71	347.47
Industry 6	108.83	115.86	176.53	110.76	29.21	541.18
Industry 7	0.00	3.34	4.64	0.00	0.00	7.97
Industry 8	24.51	20.66	414.57	5.82	0.00	465.55
Industry 9	0.00	0.16	3.38	0.20	0.00	3.74
Industry 10	0.57	68.12	105.47	0.05	0.34	174.54
Industry 11	0.68	5.49	5.26	5.00	204.64	221.07
Industry 12	0.00	0.10	1.54	0.00	0.00	1.64
Industry 13	1421.60	2136.35	2392.09	469.18	3272.21	9691.43
Industry 14	0.06	27.31	16.97	0.16	0.00	44.50
Industry 15	61.81	311.98	102.31	240.26	42.88	759.26
Industry 16	47.74	117.75	1871.07	0.00	154.20	2190.76
Industry 17	0.68	14.35	31.15	20.40	3.34	69.92
Industry 18	0.40	1.84	8.52	0.32	0.95	12.02
Industry 19	24.93	33.83	215.13	3.83	0.55	278.27
Industry 20	3.74	31.93	49.73	1.59	0.34	87.33
Industry 21	3.00	156.11	77.57	11.36	7.19	255.23
Industry 22	134.70	465.72	468.09	191.23	221.23	1480.97
Industry 23	355.41	753.10	1478.10	569.14	199.57	3355.33
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	1162.61	413.68	5629.23	2058.29	56.82	9320.63
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	73.23	339.40	355.44	110.97	108.15	987.19
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	3616.22	5350.77	14770.94	6283.46	4934.17	34955.56

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1972. Data were compiled from confidential individual returns.
Data for the agriculture sector werederived from: Canada-Alberta-Saskatchewan-Manitoba, 1983.
Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1972 were "backcast" from 1975 data on the basis of average growth rates.
Data for the wholesale and retail trade sector were based upon "backcasting" 1976 data in Tate and Lacelle, 1976.

Table A-13 Industrial Gross Water Use by Region, 1974
(million cubic metres)

	Atlantic	Quebec	Ontario	Prairies	Columbia	Total
Industry 1	22.25	62.73	141.88	2355.17	495.08	3077.10
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	341.67	454.57	855.45	42.61	137.25	1831.54
Industry 4	0.00	0.00	0.00	36.55	34.98	71.53
Industry 5	19.98	13.54	79.61	241.48	16.47	371.07
Industry 6	100.10	124.27	182.95	91.80	31.79	530.92
Industry 7	0.00	1.67	2.32	0.00	0.00	3.99
Industry 8	18.21	29.51	248.04	6.78	0.98	303.52
Industry 9	0.00	0.08	1.69	0.22	0.00	1.99
Industry 10	1.43	94.25	111.58	0.58	0.64	208.48
Industry 11	11.87	37.77	35.84	28.90	240.45	354.83
Industry 12	0.00	0.05	0.77	0.00	0.00	0.82
Industry 13	1259.46	2092.99	2263.54	497.48	3166.03	9279.49
Industry 14	0.03	13.66	8.48	0.08	0.00	22.25
Industry 15	63.21	436.04	563.07	198.12	26.37	1286.81
Industry 16	51.70	131.62	1896.61	0.00	143.74	2223.68
Industry 17	0.34	9.06	18.76	10.73	1.67	40.56
Industry 18	0.20	0.92	4.26	0.30	0.48	6.15
Industry 19	93.64	60.22	364.39	5.26	17.34	540.84
Industry 20	1.87	15.97	24.86	0.80	0.17	43.67
Industry 21	3.82	98.96	120.65	15.02	12.46	250.91
Industry 22	164.43	480.75	479.50	214.05	217.45	1556.17
Industry 23	258.92	617.01	1474.37	659.28	173.16	3182.74
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	2083.57	423.41	6157.42	2221.49	356.22	11242.10
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	77.12	357.38	373.88	116.86	113.88	1039.10
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	4573.81	5556.40	15409.90	6743.52	5186.60	37470.23

Source: Calculated by taking the average value of the corresponding 1972 and 1976 values (Tables A-12 and A-13 respectively. For the industries not surveyed in 1976, their water intakes were considered to be zero.

Table A-14 Gross Water Use by Region, 1976
(million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	23.96	50.69	155.65	2550.07	519.32	3299.69
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	526.42	650.79	527.87	51.33	206.82	1963.22
Industry 4	1.80	0.00	0.00	35.23	2.64	39.67
Industry 5	25.71	26.46	106.20	230.08	6.23	394.67
Industry 6	91.38	132.69	189.38	72.83	34.37	520.65
Industry 7	—	—	—	—	—	—
Industry 8	11.92	38.37	81.51	7.74	1.95	141.49
Industry 9	0.00	0.00	0.00	0.23	0.00	0.00
Industry 10	2.28	120.38	117.69	1.10	0.95	242.40
Industry 11	23.07	70.05	66.42	52.79	276.25	488.58
Industry 12	—	—	—	—	—	—
Industry 13	1097.32	2049.63	2134.98	525.77	3059.85	8867.55
Industry 14	—	—	—	—	—	—
Industry 15	64.60	560.10	1023.82	155.98	9.86	1814.36
Industry 16	55.66	145.50	1922.14	0.00	133.29	2256.59
Industry 17	0.00	3.77	6.36	1.06	0.00	11.20
Industry 18	—	—	—	—	—	—
Industry 19	162.34	86.60	513.64	6.70	34.14	803.42
Industry 20	—	—	—	—	—	—
Industry 21	4.64	41.82	163.74	18.67	17.73	246.60
Industry 22	194.15	495.78	490.91	236.87	213.66	1631.36
Industry 23	162.43	480.91	1470.64	749.43	146.74	3010.15
Industry 24	—	—	—	—	—	—
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	3004.52	433.13	6685.61	2384.69	655.61	13163.56
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	81.01	375.35	392.31	122.74	119.60	1091.02
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	5533.19	5762.03	16048.88	7203.29	5439.02	39986.19

— not surveyed in 1976

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1976. Data were compiled from confidential individual returns.
Data for the agriculture sector were derived from: Canada-Alberta-Saskatchewan-Manitoba, 1983.
Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1976 were interpolated from 1975 and 1980 data on the basis of average growth rates.
Data for the wholesale and retail trade sector were based upon data in Tate and Lacelle, 1976.

Table A-15 Industrial Water Consumption by Region, 1972 (million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	20.22	74.48	101.73	1623.80	222.55	2042.78
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	2.64	7.64	0.91	0.50	1.86	13.55
Industry 4	0.00	0.00	0.00	36.32	2.00	38.32
Industry 5	0.86	0.18	1.09	31.05	2.09	35.27
Industry 6	0.00	7.41	9.00	7.09	1.55	25.05
Industry 7	0.00	0.09	0.23	0.00	0.00	0.32
Industry 8	0.36	0.36	1.95	0.09	0.00	2.76
Industry 9	0.00	0.00	0.23	0.00	0.00	0.23
Industry 10	0.00	2.95	1.55	0.00	0.00	4.50
Industry 11	0.05	2.18	0.59	0.23	2.23	5.28
Industry 12	0.00	0.00	0.05	0.00	0.00	0.05
Industry 13	18.82	21.87	27.82	4.45	48.87	121.83
Industry 14	0.00	0.00	0.00	0.00	0.00	0.00
Industry 15	1.41	4.59	1.36	0.41	0.73	8.50
Industry 16	1.23	2.00	29.28	0.00	2.95	35.46
Industry 17	0.09	0.05	0.86	0.41	0.05	1.46
Industry 18	0.18	0.00	0.18	0.14	0.00	0.50
Industry 19	1.36	2.82	3.68	0.05	0.09	8.00
Industry 20	0.09	0.09	0.64	0.00	0.00	0.82
Industry 21	0.50	0.00	3.14	1.32	0.91	5.87
Industry 22	0.05	12.14	14.29	6.50	2.55	35.53
Industry 23	10.91	9.63	53.82	13.91	6.55	94.82
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	1.40	0.00	98.27	1.31	0.31	101.29
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.00	0.00	0.00	0.00	0.00	0.00
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
						0.00
TOTAL	60.17	148.48	350.67	1727.57	295.29	2582.18

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1972. Data were compiled from confidential individual returns. Data for the agriculture sector were derived from: Canada-Alberta-Saskatchewan-Manitoba, 1983; and Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1972 were "backcast" from 1975 data on the basis of average growth rates.
Data for the wholesale and retail trade sector were based upon "backcasting 1976 data in Tate and Lacelle, 1976.

Table A-16 Industrial Water Consumption by Region, 1974
(million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	21.90	62.50	112.55	1775.90	233.52	2205.49
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	6.93	12.86	10.21	1.32	4.71	36.03
Industry 4	0.00	0.00	0.00	33.46	1.34	34.80
Industry 5	0.89	0.61	2.82	19.80	1.20	25.32
Industry 6	1.75	7.96	10.11	6.30	1.89	28.00
Industry 7	0.00	0.05	0.11	0.00	0.00	0.16
Industry 8	0.43	0.86	2.66	0.09	0.02	4.07
Industry 9	0.00	0.00	0.11	0.00	0.00	0.11
Industry 10	0.05	3.84	1.98	0.00	0.00	5.86
Industry 11	0.20	1.91	0.59	1.09	3.16	6.96
Industry 12	0.00	0.00	0.02	0.00	0.00	0.02
Industry 13	25.66	31.64	28.53	6.27	48.98	141.08
Industry 14	0.00	0.00	0.00	0.00	0.00	0.00
Industry 15	3.68	12.21	3.59	1.07	1.89	22.43
Industry 16	1.32	2.14	31.28	0.00	3.16	37.89
Industry 17	0.05	0.02	0.50	0.20	0.02	0.80
Industry 18	0.09	0.00	0.09	0.07	0.00	0.25
Industry 19	0.77	1.55	2.64	0.07	0.09	5.11
Industry 20	0.05	0.05	0.32	0.00	0.00	0.41
Industry 21	0.45	2.16	3.98	2.02	2.09	10.71
Industry 22	1.20	12.98	8.43	9.34	3.39	35.34
Industry 23	7.43	11.46	58.94	14.23	6.93	98.99
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	8.20	8.69	107.49	3.86	2.62	130.85
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.00	0.00	0.00	0.00	0.00	0.00
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	81.08	173.93	387.05	1875.08	315.01	2831.27

Source: Calculated by taking the average of the corresponding 1972 and 1976 values (Tables A-12 and A-14 respectively). For t industries not surveyed in 1976, their water intakes were considered to be zero.

Table A-17 **Industrial Water Consumption by Region, 1976**
(million cubic metres)

Sector	Atlantic	Quebec	Ontario	Prairies	British Columbia	Total
Industry 1	23.60	50.50	123.40	1928.00	244.50	2369.00
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	11.23	18.09	19.50	2.14	7.55	58.51
Industry 4	0.00	0.00	0.00	30.59	0.68	31.28
Industry 5	0.91	1.05	4.55	8.55	0.32	15.37
Industry 6	3.50	8.50	11.23	5.50	2.23	30.96
Industry 7	—	—	—	—	—	—
Industry 8	0.50	1.36	3.36	0.09	0.05	5.36
Industry 9	0.00	0.00	0.00	0.00	0.00	0.00
Industry 10	0.09	4.73	2.41	0.00	0.00	7.23
Industry 11	0.36	1.64	0.59	1.95	4.09	8.64
Industry 12	—	—	—	—	—	—
Industry 13	32.50	41.41	29.23	8.09	59.10	170.33
Industry 14	—	—	—	—	—	—
Industry 15	5.96	19.82	5.82	1.73	3.05	36.37
Industry 16	1.41	2.27	32.28	0.00	3.36	40.32
Industry 17	0.05	0.00	0.14	0.00	0.00	0.14
Industry 18	—	—	—	—	—	—
Industry 19	0.18	0.27	1.59	0.09	0.09	2.23
Industry 20	—	—	—	—	—	—
Industry 21	0.49	4.32	4.82	2.73	3.27	15.55
Industry 22	2.36	13.82	2.77	12.18	4.23	35.37
Industry 23	3.95	14.18	64.05	14.55	7.32	104.06
Industry 24	—	—	—	—	—	—
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	15.00	17.38	116.70	6.40	4.92	160.40
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.00	0.00	0.00	0.00	0.00	0.00
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	102.12	199.36	422.41	2022.59	344.75	3091.13

— not surveyed in 1976

Source: Canada, Department of the Environment, Inland Waters Directorate, Industrial Water Use Survey: 1976. Data were compiled from confidential individual returns.
Data for the agriculture sector were derived from: Canada-Alberta-Saskatchewan-Manitoba, 1983.
Canada, Department of the Environment, Inland Waters Directorate, 1979, Chapter 4, pp. 87-107. Data for 1976 were interpolated from 1975 and 1980 data on the basis of average growth rates.
Data for the wholesale and retail trade sector were based upon data in Tate and Lacelle, 1976.

Appendix B

Calculation of Industrial Water Uses for 1966

Table B-1 Basic Data for Calculation of Water Uses for 1966, Canada

	Water Use Data, 1972		Employment Related Data ('000 persons)					Output Related Dat ($ million, 1971)	
	Intake	Gross Use	Employment, 1972		Ratio	Employment, 1966		1972	1966
	million cubic metres (MCM)		In firms surveyed	In total group	(3)/(4)	In total group	estimated for firms surveyed (5)*(6)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry 1	2854.60	2854.60	472.30	472.30	1.00	531.40	531.40	4366.13	4855.86
Industry 2	0.00	0.00	76.50	76.50	1.00	102.80	102.80	1354.07	1525.60
Industry 3	160.56	1701.53	57.70	57.70	1.00	60.20	60.20	1642.62	1768.18
Industry 4	42.41	110.97	22.30	22.80	1.00	21.10	21.10	1193.92	1259.58
Industry 5	159.06	355.26	37.60	37.60	1.00	33.00	33.00	320.20	852.84
Industry 6	380.03	541.01	105.01	220.48	0.43	227.22	109.04	10015.66	8116.50
Industry 7	1.23	8.00	5.41	9.53	1.00	10.18	10.18	551.15	464.05
Industry 8	353.90	465.59	28.73	49.10	0.59	27.82	16.28	916.23	840.41
Industry 9	3.36	3.73	3.97	27.28	0.15	32.59	4.74	361.45	429.87
Industry 10	127.83	174.47	48.21	201.02	0.24	100.86	24.19	2990.99	2938.60
Industry 11	175.29	218.70	23.22	102.70	0.23	91.94	20.78	2345.28	1973.24
Industry 12	1.23	1.64	4.01	46.94	0.09	43.60	3.72	950.22	712.86
Industry 13	3094.26	9688.72	79.01	120.76	0.65	116.84	76.44	4233.57	3596.93
Industry 14	3.59	44.50	18.22	86.07	0.21	82.00	17.36	2400.77	1490.88
Industry 15	356.76	361.90	54.64	64.51	0.85	68.82	58.28	2689.78	2928.74
Industry 16	1291.67	2087.84	40.84	73.80	0.55	44.83	24.81	966.37	1471.25
Industry 17	31.87	69.92	34.45	133.31	0.25	143.31	35.70	2769.16	3285.18
Industry 18	6.91	12.05	21.96	77.44	0.28	75.45	21.39	1365.60	1989.38
Industry 19	192.33	278.30	100.41	159.11	0.64	146.90	93.29	5289.40	4924.97
Industry 20	31.14	87.33	55.08	121.18	0.46	124.50	57.41	2905.33	2626.95
Industry 21	133.15	255.71	32.62	53.09	0.61	53.20	32.69	1333.05	1346.05
Industry 22	699.93	1430.96	8.18	15.41	0.53	15.40	8.17	2328.02	1725.04
Industry 23	1524.79	3355.33	39.15	74.73	0.52	74.50	39.03	2196.47	2472.16
Industry 24	0.00	0.00	--	--	--	--	--	1043.13	--
Industry 25	0.00	0.00	570.00	570.00	1.00	580.30	580.30	17669.72	14029.48
Industry 26	0.00	0.00	533.10	533.10	1.00	464.60	464.60	14161.53	7994.26
Industry 27	9320.64	9320.64	55.80	55.80	1.00	38.70	38.70	2218.84	1584.06
Industry 28	0.00	0.00	9.30	9.30	1.00	8.70	8.70	807.79	250.72
Industry 29	937.19	937.19	1340.70	1340.70	1.00	1107.10	1107.10	16183.51	11927.97
Industry 30	0.00	0.00	1261.70	1261.70	1.00	954.90	954.90	67109.56	32282.98
TOTAL	21933.83	34913.20	5142.18	66102.94		5342.75	4556.30	175229.6	121664.6

-- Figure not available

Table 8-2. Calculation of Water Uses for 1966 by Industry Group, Canada

	Water Use Coefficients: Employment-based (MCM/'000 persons) Intake (1)/(7) (10)	Employment-based Gross Use (2)/(7) (11)	Output-based (MCM/$million) Intake (1)/(8) (12)	Output-based Gross Use (2)/(8) (13)	1966 Water Intake Calculations (million cubic metres) (employ't-based) (10)*(7) (14)	(output-based) (12)*(9) (15)	(average) (14)+(15)/2 (16	Gross Use Calculations (million cubic metres) (employ't-based) (11)*(7) (17)	(output-based) (13)*(9) (18)	(average) (17)+(18)/2 (19)
Industry 1	6.04	6.04	0.65	0.65	3211.69	3174.68	3193.18	3211.70	3174.69	3193.19
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	2.78	29.49	0.10	1.04	167.52	172.83	170.17	1775.25	1831.59	1803.42
Industry 4	1.86	4.87	0.04	0.09	39.25	44.74	42.00	102.70	117.07	109.88
Industry 5	4.23	9.45	0.19	0.43	139.60	165.39	152.50	311.80	369.40	340.60
Industry 6	3.59	5.11	0.04	0.05	391.70	308.01	349.85	557.54	438.42	497.98
Industry 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 8	12.32	16.21	0.39	0.51	200.53	324.62	262.57	263.81	427.07	345.44
Industry 9	0.85	0.94	0.01	0.01	4.01	4.00	4.01	4.46	4.44	4.45
Industry 10	2.65	3.62	0.04	0.06	64.14	125.59	94.86	87.54	171.41	129.48
Industry 11	7.55	9.42	0.07	0.09	156.92	147.48	152.20	195.78	184.01	189.89
Industry 12	0.00	0.00	0.00	0.00	0.00	0.92	0.46	0.00	1.23	0.62
Industry 13	39.16	122.63	0.73	2.29	2993.87	2623.95	2811.41	9374.37	9231.73	8803.05
Industry 14	0.20	2.44	0.00	0.02	3.42	2.23	2.82	42.39	27.63	35.01
Industry 15	6.53	15.78	0.13	0.32	380.58	383.45	384.52	919.46	938.47	928.96
Industry 16	31.63	51.13	1.34	2.16	784.65	1966.51	1375.58	1268.30	3178.64	2223.47
Industry 17	0.93	2.03	0.01	0.03	33.02	37.81	35.42	72.45	82.95	77.70
Industry 18	0.31	0.55	0.01	0.01	6.73	10.07	8.40	11.74	17.55	14.65
Industry 19	1.92	2.77	0.04	0.05	178.75	179.13	178.94	258.58	259.13	258.85
Industry 20	0.56	1.56	0.01	0.03	31.99	28.16	30.07	89.72	78.96	84.34
Industry 21	4.03	7.84	0.10	0.18	133.43	129.59	131.51	256.25	248.87	252.56
Industry 22	35.60	181.11	0.30	0.64	699.52	518.64	609.08	1480.10	1097.38	1288.74
Industry 23	33.95	35.70	0.69	1.53	1520.08	1716.17	1618.12	3344.96	3776.47	3560.71
Industry 24	--	--	--	--	--	--	--	--	--	--
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	167.04	167.04	4.20	4.20	6464.31	6654.14	6559.23	6464.31	6654.14	6559.23
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.74	0.74	0.06	0.06	815.18	727.60	771.39	815.18	727.60	771.39
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL					18420.89	19455.71	18938.30	30908.38	32038.07	31923.62

Note: The bracketed numbers below 9 in the column headings refer to the respective columns of Table 8-1.

-- Figures not available

Table B-3 Basic Data for Calculation of Water Uses for 1966, Atlantic Region

	Water Use Data, 1974		Employment Related Data ('000 persons)					Output Related Dat ($ million, 1974)	
	Intake million cubic metres (MCM)	Gross Use	Employment, 1974 in firms surveyed	in total group	Ratio (3)/(4)	Employment, 1966 in total group	estimated for firms surveyed (5)*(6)	1974	1966
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry 1	22.26	22.26	20.21	20.21	1.00	30.69	30.69	288.98	296.25
Industry 2	0.00	0.00	18.95	18.95	1.00	24.19	24.19	437.28	363.41
Industry 3	63.95	341.67	6.43	6.43	1.00	6.03	6.03	496.92	498.56
Industry 4	0.00	0.00	0.00	0.00	1.00	0.00	0.00	44.96	57.42
Industry 5	15.00	19.97	5.80	5.80	1.00	6.26	6.26	214.93	75.96
Industry 6	86.20	100.10	13.66	26.86	0.51	26.55	13.50	1038.51	835.48
Industry 7	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Industry 8	2.51	18.21	0.84	2.51	0.33	0.06	0.02	65.77	0.19
Industry 9	0.18	0.00	0.00	0.00	1.00	0.55	0.55	3.17	5.56
Industry 10	0.93	1.43	1.52	3.42	0.44	3.26	1.45	65.08	43.17
Industry 11	8.77	11.87	1.46	6.96	0.21	6.30	1.32	205.43	56.06
Industry 12	0.00	0.00	0.00	18.90	0.00	0.54	0.00	18.76	8.09
Industry 13	487.91	1259.46	6.85	12.40	0.55	10.65	5.88	910.11	497.83
Industry 14	0.03	0.03	0.62	3.14	0.20	3.15	0.63	63.73	51.02
Industry 15	57.01	63.21	1.91	2.78	0.69	2.07	1.42	93.61	56.80
Industry 16	46.53	51.70	1.54	2.25	0.69	1.73	1.19	151.64	40.33
Industry 17	0.32	0.34	0.82	2.77	0.29	3.80	1.12	92.89	94.56
Industry 18	0.21	0.21	0.20	0.76	0.26	0.75	0.20	15.36	6.53
Industry 19	93.41	93.63	4.70	8.09	0.58	7.16	4.16	279.49	130.20
Industry 20	0.28	1.87	1.33	2.42	0.55	2.00	1.10	54.86	42.16
Industry 21	3.05	3.82	4.29	2.47	1.74	2.11	3.67	112.79	184.24
Industry 22	90.20	164.42	0.49	1.36	0.36	1.00	0.36	907.87	296.95
Industry 23	82.70	258.92	0.88	1.76	0.50	0.79	0.39	137.99	41.50
Industry 24	--	--	--	--	--	--	--	--	--
Industry 25	0.00	0.00	49.92	49.92	1.00	57.65	57.65	2153.48	1505.78
Industry 26	0.00	0.00	0.89	50.56	0.02	46.96	0.83	789.65	572.32
Industry 27	2083.57	2083.57	6.76	6.76	1.00	3.68	3.68	346.32	148.11
Industry 28	0.00	0.00	0.50	0.50	1.00	0.37	0.37	5.93	10.46
Industry 29	77.12	77.12	107.32	107.32	1.00	81.08	81.08	1498.87	1142.65
Industry 30	0.00	0.00	62.56	62.56	1.00	49.89	49.89	3311.16	1764.41
TOTAL Total	3222.14	4573.31	320.44	427.85	19.92	379.26	297.63	13805.53	8825.99

-- Figure not available

Table B-4 Calculation of Water Uses for 1966 by Industry Group, Atlantic Region

	Water Use Coefficients Employment-based (MCM/'000 persons) Intake (1)/(7) (10)	Gross Use (2)/(7) (11)	Output-based (MCM/$million) Intake (1)/(8) (12)	Gross Use (2)/(8) (13)	Preliminary Water Uses (million cubic metres) Intake	Gross Use	Proportion of National Total Intake	Gross Use	Regional Water Use Intake	Gross Use
Industry 1	1.10	1.10	0.08	0.08	28.31	28.31	0.01	0.01	28.37	28.37
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	9.95	53.14	0.13	0.69	62.07	331.61	0.22	0.21	38.07	387.45
Industry 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 5	2.59	3.44	0.07	0.09	10.75	14.31	0.12	0.06	18.21	19.60
Industry 6	6.31	7.33	0.08	0.10	77.28	89.74	0.23	0.18	79.23	91.30
Industry 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 8	3.00	21.78	0.04	0.28	0.03	0.24	0.00	0.00	0.13	0.96
Industry 9	0.00	0.00	0.06	0.00	0.16	0.00	0.15	0.14	0.61	0.61
Industry 10	0.61	0.94	0.01	0.02	0.75	1.16	0.01	0.01	0.61	0.83
Industry 11	6.00	8.12	0.04	0.06	5.16	6.99	0.03	0.03	4.42	5.30
Industry 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 13	71.24	183.89	0.54	1.38	342.98	885.35	0.14	0.13	403.47	1108.33
Industry 14	0.05	0.05	0.00	0.00	0.03	0.03	0.02	0.00	0.06	0.06
Industry 15	29.90	33.15	0.61	0.68	38.51	42.70	0.09	0.04	33.20	37.10
Industry 16	30.21	33.57	0.31	0.34	24.12	26.80	0.02	0.01	27.62	30.50
Industry 17	0.39	0.42	0.00	0.00	0.38	0.41	0.02	0.00	0.78	0.93
Industry 18	1.00	1.00	0.01	0.01	0.14	0.14	0.05	0.03	0.42	0.42
Industry 19	19.86	19.91	0.33	0.34	63.05	63.19	0.31	0.22	56.11	58.00
Industry 20	0.21	1.41	0.01	0.03	0.22	1.49	0.02	0.04	0.40	2.86
Industry 21	0.71	0.89	0.03	0.03	3.80	4.75	0.04	0.02	5.15	5.67
Industry 22	184.03	335.55	0.10	0.18	48.00	87.50	0.10	0.07	59.15	94.07
Industry 23	93.98	294.23	0.60	1.88	30.93	96.83	0.03	0.04	41.79	134.23
Industry 24	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	308.45	308.45	6.02	6.02	1013.08	1013.08	0.16	0.16	1034.03	1034.03
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.72	0.72	0.05	0.05	58.53	58.53	0.08	0.08	62.92	62.92
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL					1808.27	2753.14			1894.75	3103.54

Note: The bracketed numbers below 9 in the column headings refer to the respective columns of Table B-3.

The preliminary water use calculations were made by "backcasting" the 1974 water uses on the basis of both employment and output trends, in a manner similar to that described for the corresponding columns of Table B-2. These preliminary water uses were used to calculate the proportion of each industry's water use accounted for in the region. These proportions were then used to pro-rate the corresponding national water uses to the region. All numbers have been rounded off to two significant figures.

Table B-5 **Basic Data for Calculation of Water Uses for 1966, Quebec Region, 1974**

	Water Use Data, 1974		Employment Related Data ('000 persons)					Output Related Dat ($ million, 1971)	
	Intake million cubic metres (HCM)	Gross Use	Employment, 1974 In firms surveyed	Employment, 1974 In total group	Ratio (3)/(4)	Employment, 1966 In total group	Employment, 1966 estimated for firms surveyed (5)*(6)	$million)(StatCan) 1974	1966 1974)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry 1	62.73	62.73	85.40	85.40	1.00	107.16	107.16	1151.15	1187.07
Industry 2	0.00	0.00	5.96	5.96	1.00	18.44	18.44	525.79	498.08
Industry 3	134.58	454.57	13.60	13.60	1.00	15.43	15.43	589.67	21.93
Industry 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
Industry 5	5.96	13.53	12.49	12.49	1.00	14.27	14.27	400.25	385.59
Industry 6	78.10	124.27	22.43	56.84	0.39	59.97	23.66	3914.04	3283.13
Industry 7	0.39	1.66	4.67	5.82	0.80	6.77	5.42	317.31	267.22
Industry 8	13.78	29.51	7.13	13.82	0.52	7.68	3.96	433.40	25.87
Industry 9	0.09	0.09	0.00	12.56	0.00	16.18	0.02	253.59	265.45
Industry 10	54.03	94.25	27.08	122.21	0.22	119.04	26.38	3063.30	2151.35
Industry 11	26.44	37.80	2.21	24.77	0.09	19.42	1.74	785.12	2000.99
Industry 12	0.05	0.05	0.00	20.05	0.00	16.55	0.00	490.78	359.56
Industry 13	379.50	2092.99	29.05	45.37	0.64	42.50	27.22	2448.59	1957.43
Industry 14	0.80	13.66	1.72	25.29	0.07	22.03	1.50	830.25	546.11
Industry 15	245.84	436.04	15.73	22.28	0.71	19.55	13.81	2075.46	1625.14
Industry 16	74.99	131.62	4.81	7.99	0.60	6.03	3.63	439.96	425.63
Industry 17	6.66	9.06	5.99	39.16	0.15	37.09	5.67	1346.77	1077.85
Industry 18	0.91	0.92	0.40	17.49	0.02	14.68	0.34	490.82	372.47
Industry 19	53.09	60.22	19.81	30.01	0.66	30.31	20.01	1281.85	760.25
Industry 20	5.09	15.97	16.81	33.69	0.50	35.19	17.55	1115.41	850.88
Industry 21	48.75	98.96	8.51	15.55	0.55	15.60	8.54	*541.38	447.46
Industry 22	142.43	480.75	2.95	3.25	0.91	2.98	2.71	1570.73	877.33
Industry 23	146.22	617.05	14.16	26.78	0.53	25.99	13.74	1226.11	917.61
Industry 24	0.00	0.00	--	--	--	--	--	--	--
Industry 25	0.00	0.00	148.16	148.16	1.00	159.42	159.42	5606.05	4692.94
Industry 26	0.00	0.00	156.48	156.48	1.00	129.54	129.54	4095.32	2558.02
Industry 27	423.41	423.41	13.77	13.77	1.00	8.95	8.95	751.65	507.53
Industry 28	0.00	0.00	1.22	1.22	1.00	0.86	0.86	123.96	34.90
Industry 29	357.38	357.38	323.78	323.78	1.00	253.25	253.25	6429.74	3897.53
Industry 30	0.00	0.00	344.64	344.64	1.00	277.77	277.77	15268.83	8604.49
TOTAL	2163.47[3]	5556.48	1288.94	1628.41		1504.18	1163.90	57567.31	40599.77

— Figure not available

Table B-6. Calculation of Water Uses for 1966 by Industry Group, Quebec Region

	Water Use Coefficients Employment-based (MCM/'000 persons)		Water Use Coefficients Output-based (MCM/$million)		Preliminary Water Uses (million cubic metres)		Proportion of National Total		Regional Water Use (million cubic metres)	
	Intake	Gross Use	Intake	Gross Use	Intake	Gross Use	Intake	Gross Use	Intake	Gross Use
	(1)/(7)	(2)/(7)	(1)/(8)	(2)/(8)						
Industry 1	0.73	0.73	0.05	0.05	71.70	71.70	0.02	0.02	71.86	71.86
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	9.90	33.42	0.23	0.77	78.85	266.32	0.28	0.17	48.36	311.32
Industry 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 5	0.48	1.08	0.01	0.03	6.28	14.25	0.07	0.06	10.64	19.52
Industry 6	3.48	5.54	0.02	0.03	73.95	117.67	0.22	0.24	75.81	119.47
Industry 7	0.08	0.36	0.00	0.01	0.39	1.65	1.00	1.00	0.39	1.66
Industry 8	1.93	4.14	0.03	0.07	4.24	9.08	0.07	0.10	17.93	36.19
Industry 9	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.04	0.19	0.19
Industry 10	2.00	3.48	0.02	0.03	45.29	79.00	0.39	0.44	37.07	56.63
Industry 11	11.94	17.07	0.03	0.05	44.06	62.99	0.25	0.25	37.74	47.81
Industry 12	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.02
Industry 13	30.28	72.05	0.36	0.85	763.54	1817.03	0.32	0.26	897.84	2274.65
Industry 14	0.46	7.93	0.00	0.02	0.61	10.44	0.42	0.60	1.19	20.97
Industry 15	15.63	27.72	0.12	0.21	204.13	362.06	0.46	0.34	175.98	314.65
Industry 16	15.59	27.36	0.17	0.30	64.56	113.31	0.05	0.06	73.94	128.99
Industry 17	1.11	1.51	0.00	0.01	5.82	7.92	0.34	0.07	12.01	18.02
Industry 18	2.25	2.28	0.00	0.00	0.73	0.74	0.26	0.13	2.19	2.20
Industry 19	2.68	3.04	0.04	0.05	42.55	48.27	0.21	0.16	37.86	42.71
Industry 20	0.30	0.95	0.00	0.01	4.60	14.43	0.35	0.39	8.39	26.35
Industry 21	5.73	11.63	0.09	0.18	44.60	90.54	0.46	0.42	60.44	108.09
Industry 22	48.23	162.80	0.09	0.31	105.08	354.69	0.21	0.30	129.50	381.24
Industry 23	10.33	43.58	0.12	0.50	125.67	530.32	0.10	0.21	169.79	735.15
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	30.76	30.76	0.56	0.56	280.60	280.60	0.04	0.04	286.41	286.41
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	1.10	1.10	0.06	0.06	250.84	250.84	0.35	0.35	269.67	269.67
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL					2218.15	4503.92			2425.20	5273.77

Note: The bracketed numbers below 9 in the column headings refer to the respective columns of Table B-5.

The preliminary water use calculations were made by "backcasting" the 1974 water uses on the basis of both employment and output trends, in a manner similar to that described for the corresponding columns of Table B-2. These preliminary water uses were used to calculate the proportion of each industry's water use accounted for in the region. These proportions were then, used to pro-rate the corresponding national water uses to the region. All numbers have been rounded off to two significant figures.

Table B-7 **Basic Data for Calculation of Water Uses for 1966, Ontario Region**

Sector	Water Use Data, 1974: Intake, million cubic metres (MCM) (1)	Water Use Data, 1974: Gross Use, million cubic metres (MCM) (2)	Employment Related Data ('000 persons): Employment, 1974, in firms surveyed (3)	Employment, 1974, in total group (4)	Ratio (3)/(4) (5)	Employment, 1966, in total group ('000's) (6)	Employment, 1966, estimated for firms surveyed (5)*(6) (7)	Output Related Data ($ million, 1974): 1974 (8)	1966 (9)
Industry 1	141.89	141.89	122.44	122.44	1.00	133.46	133.46	2497.66	2556.90
Industry 2	0.00	0.00	20.37	20.37	1.00	23.78	23.78	339.59	328.53
Industry 3	80.04	855.45	26.07	26.07	1.00	27.80	27.80	1617.24	1272.57
Industry 4	0.00	0.00	0.00	1.00	1.00	0.00	0.00	7.77	22.68
Industry 5	34.28	79.61	6.05	6.05	1.00	7.21	7.21	245.41	197.28
Industry 6	128.02	182.95	39.42	87.10	0.45	90.93	41.15	5962.81	5096.22
Industry 7	0.23	2.32	0.72	3.55	1.00	3.20	3.20	416.16	263.89
Industry 8	187.04	248.04	19.58	34.72	0.56	18.96	10.69	1210.41	76.83
Industry 9	1.50	1.69	0.00	12.33	1.00	14.64	14.64	282.23	285.07
Industry 10	77.88	111.57	18.99	61.54	0.31	64.29	19.84	1672.22	1245.91
Industry 11	22.64	35.84	1.78	20.51	0.09	19.21	1.67	694.36	199.25
Industry 12	0.57	0.77	0.00	24.69	0.00	20.72	0.00	660.23	479.17
Industry 13	693.27	2263.53	29.62	47.40	0.62	44.41	27.75	2494.06	1919.04
Industry 14	0.91	8.48	11.28	47.43	0.24	42.58	10.12	1423.46	1033.70
Industry 15	181.54	563.07	32.40	37.12	0.87	37.22	32.48	2394.50	1834.96
Industry 16	1097.25	1896.61	30.00	34.37	0.87	32.65	28.50	2215.51	1367.86
Industry 17	10.89	18.75	18.72	89.24	0.21	82.71	17.35	3503.27	2621.93
Industry 18	1.71	4.26	17.10	56.78	0.30	51.22	15.43	2215.09	1854.40
Industry 19	119.88	364.39	68.12	114.12	0.60	98.03	58.51	7795.38	4593.06
Industry 20	9.87	24.86	36.34	90.41	0.40	82.53	33.17	3093.24	2208.42
Industry 21	50.31	120.65	16.58	28.73	0.58	26.35	15.21	1110.58	761.35
Industry 22	315.19	479.50	2.15	9.44	0.23	7.96	1.81	1593.39	1141.10
Industry 23	1070.81	1474.37	20.22	44.34	0.46	39.57	18.04	2822.63	2012.39
Industry 24	0.00	0.00	—	—	—	—	—	—	—
Industry 25	0.00	0.00	237.48	237.48	1.00	223.03	223.03	9382.79	6607.52
Industry 26	0.00	0.00	174.32	174.32	1.00	141.98	141.98	7268.03	3415.70
Industry 27	6157.43	6157.43	23.67	23.67	1.00	13.94	13.94	1155.35	634.63
Industry 28	0.00	0.00	5.59	5.59	1.00	4.26	4.26	415.09	136.21
Industry 29	373.88	373.88	613.23	613.23	1.00	449.34	449.34	10899.23	5734.36
Industry 30	0.00	0.00	638.21	638.21	1.00	443.43	443.43	26910.13	21001.40
TOTAL	10757.03	15409.91	2230.42	2712.22	19.79	2245.40	1817.02	103518.5	70902.31

— Figure not available

Table B-8 **Calculation of Water Uses for 1966 by Industry Group, Ontario Region**

	Water Use Coefficients: Employment-based (MCM/'000 persons) Intake (1)/(7)	Employment-based Gross Use (2)/(7)	Output-based (MCM/$million) Intake (1)/(8)	Output-based Gross Use (2)/(8)	Preliminary Water Uses (million cubic metres) Intake	Preliminary Water Uses Gross Use	Proportion of National Total Intake	Proportion of National Total Gross Use	Regional Water Use (million cubic metres) Intake	Regional Water Use Gross Use
Industry 1	1.16	1.16	0.06	0.06	149.96	149.96	0.05	0.05	150.29	150.29
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	3.07	32.82	0.05	0.53	74.17	792.76	0.27	0.31	45.50	926.25
Industry 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 5	5.67	13.16	0.14	0.32	34.20	79.44	0.38	0.32	57.92	108.85
Industry 6	3.23	4.64	0.02	0.03	121.52	173.67	0.36	0.35	124.59	176.36
Industry 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 8	9.55	12.67	0.15	0.20	57.00	75.59	0.92	0.87	241.26	301.24
Industry 9	0.00	0.00	0.01	0.01	0.76	0.85	0.72	0.75	2.90	3.34
Industry 10	4.10	5.87	0.05	0.07	69.69	99.84	0.60	0.55	57.05	71.56
Industry 11	12.69	20.09	0.03	0.05	13.85	21.93	0.08	0.09	11.86	16.64
Industry 12	0.00	0.00	0.00	0.00	0.21	0.28	0.00	0.00	0.00	0.00
Industry 13	23.40	76.41	0.28	0.91	591.44	1931.06	0.25	0.27	695.75	2417.40
Industry 14	0.08	0.75	0.00	0.01	0.74	6.89	0.51	0.40	1.45	13.84
Industry 15	5.60	17.38	0.08	0.24	160.56	498.00	0.36	0.47	138.42	432.79
Industry 16	36.58	63.23	0.50	0.86	859.95	1486.44	0.72	0.76	984.83	1691.91
Industry 17	0.58	1.00	0.00	0.01	9.12	15.71	0.53	0.14	18.61	35.74
Industry 18	0.10	0.25	0.00	0.00	1.49	3.70	0.53	0.73	4.47	10.69
Industry 19	1.76	5.35	0.02	0.05	86.81	263.86	0.43	0.57	77.25	148.39
Industry 20	0.27	0.68	0.00	0.01	8.03	20.22	0.61	0.55	14.66	36.91
Industry 21	3.03	7.28	0.05	0.11	40.31	96.67	0.42	0.45	54.63	115.41
Industry 22	146.53	222.92	0.20	0.30	245.68	373.75	0.50	0.31	302.77	401.83
Industry 23	52.96	72.92	0.38	0.52	859.50	1183.42	0.72	0.46	1161.27	1640.50
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	260.19	260.19	5.33	5.33	3504.66	3504.66	0.55	0.55	3577.10	3577.10
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.61	0.61	0.03	0.03	235.33	235.33	0.33	0.33	252.99	252.99
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL					7125.00	11014.06			7975.77	12530.03

Note: The bracketed numbers below 9 in the column headings refer to the respective columns of Table B-7.

The preliminary water use calculations were made by "backcasting" the 1974 water uses on the basis of both employment and output trends, in a manner similar to that described for the corresponding columns of Table B-2. These preliminary water uses were used to calculate the proportion of each industry's water use accounted for in the region. These proportions were then used to pro-rate the corresponding national water uses to the region. All numbers have been rounded off to two significant figures.

Table B-9 **Basic Data for Calculation of Water Uses for 1966, Prairie Region**

	Water Use Data, 1974		Employment Related Data ('000 persons)					Output Related Data ($ million, 1974)	
	Intake million cubic metres (MCM)	Gross Use million cubic metres (MCM)	Employment, 1974 in firms surveyed	Employment, 1974 in total group	Ratio (3)/(4)	Employment, 1966 in total group	Employment, 1966 estimated for firms surveyed (5)*(6)	1974	1966
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry 1	2355.17	2355.17	229.90	229.90	1.00	235.26	235.26	4703.10	4728.45
Industry 2	0.00	0.00	11.52	11.52	1.00	16.15	16.15	117.61	90.96
Industry 3	27.18	42.61	6.39	6.39	1.00	5.31	5.31	310.03	304.12
Industry 4	36.54	36.55	19.42	19.42	1.00	14.84	14.84	4846.81	2318.71
Industry 5	54.82	241.48	14.12	14.12	1.00	7.21	7.21	708.54	390.04
Industry 6	47.71	91.80	22.40	31.77	0.71	31.43	22.16	2703.98	2050.91
Industry 7	0.00	0.00	0.00	0.11	1.00	0.10	0.10	0.00	0.00
Industry 8	3.33	6.78	1.11	1.93	0.58	0.83	0.48	76.03	2.92
Industry 9	0.21	0.21	0.24	0.97	1.00	0.95	0.95	28.23	21.82
Industry 10	0.28	0.58	0.62	11.69	0.05	10.78	0.57	261.83	175.99
Industry 11	20.36	28.90	5.72	9.46	0.60	7.27	4.39	299.88	85.18
Industry 12	0.00	0.00	0.00	3.82	0.00	3.25	0.00	106.38	74.27
Industry 13	109.99	497.47	2.92	5.33	0.55	3.50	1.91	364.28	183.52
Industry 14	0.07	0.08	4.60	10.02	0.46	8.73	4.00	239.82	181.92
Industry 15	37.98	193.12	5.04	7.76	0.65	6.11	3.97	632.81	409.91
Industry 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 17	1.05	10.73	6.61	11.70	0.57	10.86	6.14	456.67	322.78
Industry 18	0.28	0.30	2.25	8.68	0.26	5.24	1.36	296.96	131.83
Industry 19	2.32	5.26	6.80	11.09	0.61	5.46	3.35	330.23	100.22
Industry 20	0.25	0.00	1.40	3.47	0.40	2.38	0.96	122.52	70.97
Industry 21	5.96	15.01	4.55	6.44	0.71	6.20	4.37	307.19	205.24
Industry 22	35.74	214.05	1.76	2.23	0.79	2.49	1.96	817.89	630.85
Industry 23	91.99	659.28	2.84	3.82	0.74	3.76	2.79	277.68	223.52
Industry 24	--	--	--	--	—	—	—	—	—
Industry 25	0.00	0.00	117.39	117.39	1.00	91.75	91.75	4942.17	4058.48
Industry 26	0.00	0.00	99.24	99.24	1.00	87.17	87.17	2631.53	1702.20
Industry 27	2221.50	2221.50	8.07	8.87	1.00	5.69	5.69	469.03	285.21
Industry 28	0.00	0.00	2.53	2.53	1.00	2.28	2.28	157.26	80.32
Industry 29	116.86	116.86	252.69	252.69	1.00	201.63	201.63	3328.41	2697.49
Industry 30	0.00	0.00	226.95	226.95	1.00	158.32	158.32	9265.04	5266.29
TOTAL	5169.59	6743.54	1057.84	1119.23		934.92	885.08	38801.89	26794.14

— Figure not available

Table B-10 Calculation of Water Uses for 1966 by Industry Group, Prairie Region

	Water Use Coefficients: Employment-based (MCM/'000 persons)		Output-based (MCM/$million)		Preliminary Water Uses (million cubic metres)		Proportion of National Total		Regional Water Use (million cubic metres)	
	Intake	Gross Use	Intake	Gross Use	Intake	Gross Use	Intake	Gross Use	Intake	Gross Use
	(1)/(7)	(2)/(7)	(1)/(8)	(2)/(8)						
Industry 1	10.24	10.24	0.50	0.50	2389.00	2389.00	0.75	0.75	2394.36	2394.36
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	4.25	6.67	0.09	0.14	24.62	38.60	0.09	0.03	15.10	45.10
Industry 4	1.88	1.88	0.01	0.01	22.70	22.71	0.88	0.36	37.00	39.55
Industry 5	3.88	17.10	0.08	0.34	29.08	128.12	0.32	0.52	49.25	175.55
Industry 6	2.13	4.10	0.02	0.03	41.69	80.22	0.12	0.16	42.74	81.46
Industry 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 8	2.99	6.10	0.04	0.09	0.78	1.59	0.01	0.02	3.30	6.37
Industry 9	0.00	0.00	0.01	0.01	0.08	0.08	0.08	0.07	0.31	0.31
Industry 10	0.45	0.93	0.00	0.00	0.22	0.46	0.00	0.00	0.18	0.33
Industry 11	3.56	5.06	0.07	0.10	10.71	15.20	0.06	0.06	9.17	11.54
Industry 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 13	37.69	170.48	0.30	1.37	63.75	288.35	0.03	0.04	75.00	360.97
Industry 14	0.02	0.02	0.00	0.00	0.06	0.07	0.04	0.00	0.12	0.14
Industry 15	8.98	46.83	0.07	0.37	27.94	145.75	0.06	0.14	23.31	126.67
Industry 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 17	0.16	1.62	0.00	0.02	0.86	8.77	0.05	0.77	1.77	190.95
Industry 18	0.12	0.13	0.00	0.00	0.15	0.16	0.05	0.03	0.45	0.47
Industry 19	0.34	0.77	0.01	0.02	0.92	2.09	0.00	0.01	0.82	1.75
Industry 20	0.18	0.57	0.00	0.01	0.16	0.51	0.01	0.01	0.29	0.98
Industry 21	1.31	3.30	0.02	0.05	4.86	12.23	0.05	0.07	6.59	16.58
Industry 22	20.33	121.76	0.04	0.26	33.74	202.07	0.07	0.17	41.57	217.25
Industry 23	32.43	232.39	0.33	2.37	82.26	589.54	0.07	0.83	111.14	817.24
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	250.59	250.59	4.74	4.74	1388.37	1388.37	0.22	0.22	1417.09	1417.09
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.46	0.46	0.04	0.04	93.98	93.98	0.13	0.13	101.83	101.03
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL					4215.94	5407.87			4331.39	6005.69

Note: The bracketed numbers below 9 in the column headings refer to the respective columns of Table B-9.

The preliminary water use calculations were made by "backcasting" the 1974 water uses on the basis of both employment and output trends, in a manner similar to that described for the corresponding columns of Table B-2. These preliminary water uses were used to calculate the proportion of each industry's water use accounted for in the region. These proportions were then used to pro-rate the corresponding national water uses to the region. All numbers have been rounded off to two significant figures.

Table B-11 **Basic Data for Calculation of Water Uses for 1966, B.C. Region**

	Water Use Data, 1972 ----'000 cubic dec		Emp't'74 ('000's)	Employment Related Data ('000 persons) ('000's)				Output Related Data ($ million, 1974) $million)(StatCan)	
	Intake million cubic metres (MCM)	Gross Use	Employment, 1974 in firms surveyed	in total group	Ratio (3)/(4)	Employment, 1966 in total group	estimated for firms surveyed (5)*(6)	1974	1966
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry 1	495.10	495.10	19.86	19.86	1.00	24.84	24.84	399.00	382.69
Industry 2	0.00	0.00	19.77	19.77	1.00	20.24	20.24	1340.18	986.98
Industry 3	45.30	137.25	7.07	7.07	1.00	5.62	5.62	600.58	522.20
Industry 4	3.60	34.90	0.00	0.00	1.00	0.00	0.00	375.66	144.90
Industry 5	12.88	16.47	7.85	7.85	1.00	4.30	4.30	124.09	119.61
Industry 6	29.28	31.78	7.91	18.36	0.43	18.35	7.90	1200.71	997.48
Industry 7	0.00	0.00	0.00	0.07	1.00	0.07	0.07	0.00	0.00
Industry 8	0.03	0.98	0.10	1.19	0.08	0.29	0.02	33.96	3.90
Industry 9	0.00	0.00	0.00	0.36	1.00	0.30	0.30	5.93	5.31
Industry 10	0.16	0.64	0.00	4.03	0.00	3.19	0.00	93.42	51.85
Industry 11	174.61	240.45	12.06	44.92	0.27	39.74	10.65	2025.24	618.57
Industry 12	0.00	0.00	0.00	2.04	0.00	2.54	0.00	59.09	61.66
Industry 13	942.50	3166.03	10.57	20.77	0.51	15.78	8.03	1565.18	897.29
Industry 14	0.00	0.00	0.00	6.55	0.00	5.50	0.00	175.74	128.52
Industry 15	19.23	26.37	3.40	3.96	0.86	4.27	3.67	427.95	200.88
Industry 16	111.03	143.74	0.66	3.73	0.18	4.02	0.71	46.29	160.64
Industry 17	1.23	1.67	2.32	9.90	0.23	8.85	2.07	398.27	282.72
Industry 18	0.48	0.48	2.00	5.45	0.37	3.56	1.31	184.96	99.62
Industry 19	14.55	17.34	0.97	8.66	0.11	5.98	0.67	356.70	133.67
Industry 20	0.09	0.17	0.00	3.22	0.00	2.40	0.00	102.22	66.86
Industry 21	5.86	12.45	1.69	4.37	0.39	2.94	1.13	191.07	97.70
Industry 22	74.28	217.45	0.82	1.16	0.71	0.98	0.69	407.73	333.95
Industry 23	102.01	173.16	1.05	3.10	0.34	3.22	1.09	176.63	160.19
Industry 24	--	--	--	--	--	--	--	--	--
Industry 25	0.00	0.00	59.01	59.01	1.00	48.45	48.45	3400.36	2493.14
Industry 26	0.00	0.00	84.76	84.76	1.00	58.95	58.95	1710.64	1120.24
Industry 27	356.22	356.22	9.20	9.20	1.00	6.46	6.46	322.68	207.68
Industry 28	0.00	0.00	1.01	1.01	1.00	0.93	0.93	91.90	21.03
Industry 29	113.88	113.88	154.79	154.79	1.00	116.80	116.80	2543.95	1603.74
Industry 30	0.00	0.00	159.61	159.61	1.00	25.49	25.49	6416.89	3807.53
TOTAL	2502.32	5106.61	566.43	664.75	17.47	434.04	350.39	24777.01	15710.54

-- Figure not available

Table B-12 Calculation of Water Uses for 1966 by Industry Group, B.C. Region

Sector	Water Use Coefficients: Employment-based (MCM/'000 persons) Intake (1)/(7)	Employment-based Gross Use (2)/(7)	Output-based (MCM/$million) Intake (1)/(8)	Output-based Gross Use (2)/(8)	Preliminary Water Uses (million cubic metres) Intake	Preliminary Gross Use	Proportion of National Total Intake	Proportion Gross Use	Regional Water Use (million cubic metres) Intake	Regional Gross Use
Industry 1	24.93	24.93	1.24	1.24	547.06	547.06	0.17	0.17	548.28	548.28
Industry 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 3	6.41	19.41	0.08	0.23	37.70	114.22	0.14	0.07	23.12	133.45
Industry 4	0.00	0.00	0.01	0.09	0.69	6.75	0.12	0.64	5.00	70.32
Industry 5	1.64	2.10	0.10	0.13	9.74	12.45	0.11	0.05	16.49	17.06
Industry 6	3.70	4.02	0.02	0.03	26.79	29.08	0.08	0.06	27.47	29.53
Industry 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 8	0.31	10.10	0.00	0.03	0.01	0.18	0.00	0.00	0.04	0.72
Industry 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 10	0.00	0.00	0.00	0.01	0.04	0.18	0.00	0.00	0.03	0.13
Industry 11	14.50	19.97	0.09	0.12	103.90	143.08	0.58	0.57	89.00	108.39
Industry 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 13	89.19	299.61	0.60	2.02	628.20	2110.24	0.26	0.30	739.00	2641.70
Industry 14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 15	5.65	7.75	0.04	0.06	14.88	20.41	0.03	0.02	12.82	17.74
Industry 16	168.74	218.45	2.40	3.11	252.51	326.90	0.21	0.17	289.18	372.09
Industry 17	0.53	0.72	0.00	0.00	0.99	1.34	0.06	0.01	2.04	3.05
Industry 18	0.24	0.24	0.00	0.00	0.29	0.29	0.10	0.06	0.87	0.87
Industry 19	14.95	17.82	0.04	0.05	7.75	9.24	0.04	0.03	6.90	8.00
Industry 20	0.00	0.00	0.00	0.00	0.03	0.06	0.01	0.00	0.31	0.12
Industry 21	3.47	7.[illegible]	0.03	0.07	3.46	7.36	0.04	0.03	4.68	8.78
Industry 22	90.36	264.54	0.18	0.53	61.74	180.75	0.12	0.15	76.08	194.33
Industry 23	96.88	164.44	0.58	0.98	99.27	168.51	0.08	0.07	134.12	233.59
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 27	38.72	38.72	1.10	1.10	239.63	239.63	0.04	0.04	244.59	244.59
Industry 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry 29	0.74	0.74	0.04	0.04	78.86	78.86	0.11	0.11	84.77	84.77
Industry 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL					2113.55	3996.57			2304.79	4717.31

Note: The bracketed numbers below 9 in the column headings refer to the respective colable B-11.

The preliminary water use calculations were made by "backcasting" the 1974 water uses on the basis of both employment and output trends, in a manner similar to that described for the corresponding columns of Table B-2. These preliminary water uses were used to calculate the proportion of each industry's water use accounted for in the region. These proportions were then used to pro-rate the corresponding national water uses to the region. All numbers have been rounded off to two significant figures.

Appendix C

Industrial Water Use Coefficients

Table C-1 Water Use Coefficients by Industry Group, Canada, 1966-1976 (million cubic metres/$million output)

	Water Intake			Gross Water Use		
	1966	1972	1976	1966	1972	1976
Industry 1	.65759	.65378	.65289	.65759	.65378	.65289
Industry 2	0	0	0	0	0	0
Industry 3	.09624	.09775	.29797	1.01993	1.03586	1.08021
Industry 4	.03334	.03552	.03653	.08724	.09295	.03713
Industry 5	.07881	.19393	.09269	.39937	.43314	.42154
Industry 6	.04311	.03795	.03334	.06135	.05402	.04839
Industry 7	0	0	0	0	0	0
Industry 8	.61243	.38626	.04734	.41103	.50816	.11266
Industry 9	.00932	.0093	.00491	.01034	.01032	.00491
Industry 10	.03228	.04274	.04344	.04406	.05833	.07592
Industry 11	.07713	.07474	.12386	.09624	.09325	.18264
Industry 12	.00065	.00129	0	.00086	.00173	0
Industry 13	.78161	.73089	.72219	2.44738	2.28855	2.04468
Industry 14	.0019	.0015	0	.02349	.01854	0
Industry 15	.13129	.13264	.29382	.31719	.32043	.70889
Industry 16	.93497	1.33662	1.12058	1.51128	2.1605	1.84852
Industry 17	.01078	.01151	.00259	.02365	.02525	.00345
Industry 18	.00422	.00506	.00013	.00736	.00882	.00015
Industry 19	.03633	.03637	.05992	.05256	.05261	.12579
Industry 20	.01145	.01071	0	.03211	.03006	0
Industry 21	.09771	.09273	.08332	.18763	.18489	.16491
Industry 22	.35308	.30086	.21638	.74708	.63615	.5733
Industry 23	.65454	.6942	.58002	1.44033	1.5276	1.19367
Industry 24	0	0	0	0	0	0
Industry 25	0	0	0	0	0	0
Industry 26	0	0	0	0	0	0
Industry 27	4.14077	4.20069	4.59471	4.14076	4.20069	4.59471
Industry 28	0	0	0	0	0	0
Industry 29	.06467	.061	.05079	.06467	.061	.05079
Industry 30	0	0	0	0	0	0

Source: Water use data for 1966 were taken from Appedix table B-2. Water use data for 1972 and 1976 were taken from Appendix tables A-2 and A-3. Output data for 1966 were taken from Appendix table B-1. Output data for 1972 and 1976 were derived by solving the basic input-output algorithm for these years.

Table C-2 Water Use Coefficients by Industry Group, Atlantic and Quebec Regions, 1966 and 1974
(million cubic metres/$million output)

	Atlantic Region				Quebec Region			
	Intake		Gross Use		Intake		Gross Use	
	1966	1974	1966	1974	1966	1974	1966	1974
Industry 1	.09578	.07703	.09578	.07703	.06054	.05449	.06054	.05449
Industry 2	0	0	0	0	0	0	0	0
Industry 3	.01636	.12869	.77714	.68758	2.20519	.22823	14.20501	.7709
Industry 4	0	0	0	0	0	0	0	0
Industry 5	.23966	.06979	.25803	.09291	.02758	.01489	.03062	.0338
Industry 6	.09483	.08301	.10906	.09639	.02309	.01995	.0364	.0317
Industry 7	0	0	0	0	.00146	.00123	.00623	.00523
Industry 8	.68421	.03816	5.05263	.27686	.69343	.0318	1.39876	.06809
Industry 9	.1099	.05675	.1099	.05675	.00072	.00035	.00072	.00035
Industry 10	.01422	.01429	.01923	.02197	.01724	.01763	.02632	.03077
Industry 11	.07884	.04269	.09447	.05778	.01886	.03367	.02389	.04815
Industry 12	0	0	0	0	0	.0001	.00005	.0001
Industry 13	.81046	.53611	2.22631	1.38385	.45869	.35919	1.16206	.85477
Industry 14	.00115	.00047	.00115	.00047	.00219	.00096	.0384	.01644
Industry 15	.58451	.60903	.65333	.67526	.10829	.11845	.19362	.21009
Industry 16	.68492	.30685	.75637	.34094	.17371	.17045	.303	.29916
Industry 17	.00829	.00344	.00987	.00366	.00111	.00495	.01672	.00673
Industry 18	.06432	.01367	.06432	.01302	.00588	.00185	.00591	.00187
Industry 19	.43094	.33423	.44547	.33501	.04981	.04142	.05618	.04698
Industry 20	.00953	.00511	.06773	.03408	.00987	.00456	.03096	.01432
Industry 21	.02795	.02704	.03078	.03387	.13509	.09005	.24154	.18279
Industry 22	.1992	.09935	.3168	.1811	.1476	.09068	.42965	.30607
Industry 23	1.00698	.59934	3.23444	1.87643	.18505	.11925	.80116	.50326
Industry 24	0	0	0	0	0	0	0	0
Industry 25	0	0	0	0	0	0	0	0
Industry 26	0	0	0	0	0	0	0	0
Industry 27	6.98156	6.01628	6.98156	6.01628	.56451	.5633	.56451	.56331
Industry 28	0	0	0	0	0	0	0	0
Industry 29	.05507	.05145	.05507	.05145	.06919	.05558	.06919	.05558
Industry 30	0	0	0	0	0	0	0	0

Source: Water use data for 1966 were taken from Appendix tables B-4 and B-6.
Water use data for 1974 were taken from Appendix tables A-10 and A-13.
Output data for 1966 were taken from Appendix tables B-3 and B-5. Output

Table C-3 Water Use Coefficients by Industry Group, Ontario and Prairie Regions, 1966 and 1974 (million cubic metres/$million output)

	Ontario Region				Prairie Region			
	Intake		Gross Use		Intake		Gross Use	
	1966	1974	1966	1974	1966	1974	1966	1974
Industry 1	.05878	.03681	.05878	.03681	.50637	.50077	.50637	.50077
Industry 2	0	0	0	0	0	0	0	0
Industry 3	.03575	.04949	.72786	.52896	.04966	.08767	.1483	.13744
Industry 4	0	0	0	0	.01599	.00754	.01706	.00754
Industry 5	.29358	.13969	.55176	.3244	.12626	.07737	.45009	.34081
Industry 6	.02445	.02147	.03461	.03068	.02084	.01764	.03972	.03395
Industry 7	0	.0	0	0	0	0	0	0
Industry 8	3.1389	.15453	3.92091	.20492	1.13017	.0438	2.17004	.08918
Industry 9	.01018	.005314	.01172	.00599	.014	.00744	.014	.00744
Industry 10	.04579	.04657	.05744	.06672	.00102	.00107	.00187	.00222
Industry 11	.05954	.03261	.08354	.05162	.1077	.06789	.13544	.09637
Industry 12	0	0	0	0	0	0	0	0
Industry 13	.36255	.27797	1.25969	.90757	.40867	.30194	1.96893	1.38363
Industry 14	.0014	.00064	.01339	.00596	.00065	.00029	.00077	.00033
Industry 15	.07544	.07578	.23586	.23515	.06524	.07143	.35452	.37263
Industry 16	.7201	.49526	1.3269	.85606	0	0	0	0
Industry 17	.00718	.00311	.01363	.00535	.3035	.0023	.36182	.0235
Industry 18	.00241	.00077	.00576	.00192	.00341	.00094	.00357	.00101
Industry 19	.01682	.01538	.0318	.04674	.00817	.00703	.01746	.01593
Industry 20	.00664	.00319	.01672	.00803	.00412	.00204	.01377	.00653
Industry 21	.07176	.0453	.15159	.10864	.03209	.0194	.08764	.04886
Industry 22	.26533	.19781	.35215	.30093	.06591	.0437	.34438	.26171
Industry 23	.57706	.37937	.79454	.52234	.49723	.33128	3.65623	2.37423
Industry 24	0	0	0	0	0	.00215	0	0
Industry 25	0	0	0	0	0	0	0	0
Industry 26	0	0	0	0	0	0	0	0
Industry 27	5.63652	5.32949	5.63652	5.32949	4.9679	4.73641	4.9679	4.73641
Industry 28	0	0	0	0	0	0	0	0
Industry 29	.04412	.0343	.04412	.0343	.03745	.03511	.03745	.03511
Industry 30	0	0	0	0	0	0	0	0

Source: Water use data for 1966 were taken from Appendix tables B-4 and B-6. Water use data for 1974 were taken from Appendix tables A-10 and A-13. Output data for 1966 were taken from Appendix table B-1. Output data for 1974 were derived by solving the basic input-output algorithm for that year.

Table C-4 Water Use Coefficients by Industry Group, B.C. Region, 1966-1974 (million cubic metres/$million output)

	Intake 1966	Intake 1974	Gross Use 1966	Gross Use 1974
Industry 1	.50637	1.24086	.50637	1.24086
Industry 2	0	0	0	0
Industry 3	.04428	.07543	.25556	.22853
Industry 4	.03451	.00958	.4853	.00356
Industry 5	.1379	.10379	.14683	.13273
Industry 6	.02754	.02439	.02961	.02647
Industry 7	0	0	0	0
Industry 8	.01084	.00088	.18393	.02886
Industry 9	0	0	0	0
Industry 10	.00038	.00171	.00151	.00685
Industry 11	.14388	.08622	.17556	.00872
Industry 12	0	0	0	0
Industry 13	.82358	.60216	2.94409	2.02279
Industry 14	0	0	0	0
Industry 15	.06386	.04494	.0883	.06162
Industry 16	1.80018	2.39841	2.31628	3.10501
Industry 17	.00722	.00309	.01078	.00419
Industry 18	.00873	.00259	.00873	.00259
Industry 19	.05159	.04079	.05985	.04812
Industry 20	.09448	.00088	.21096	.00166
Industry 21	.05003	.03067	.09374	.06516
Industry 22	.22784	.18218	.58192	.53332
Industry 23	.83728	.57753	1.45851	.98035
Industry 24	0	0	0	0
Industry 25	0	0	0	0
Industry 26	0	0	0	0
Industry 27	1.17771	1.10397	1.17771	1.10397
Industry 28	0	0	0	0
Industry 29	.05286	.04477	.05286	.04477
Industry 30	0	0	0	0

Source: Water use data for 1966 were taken from Appendix table B-12 Water use data for 1974 were taken from Appendix tables A-10 and A-13. Output data for 1966 were taken from Appendix table B-11. Output data for 1974 were derived by solving the input-output algorithm for that year.

Appendix D

Detailed Results of Industrial Water Shift Calculations

Table D-1 Water Intake Shifts by Industry Group, Canada, 1966-1972 (million cubic metres)

		Structural Change Factors			
		Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-16.63	541.61	-863.68	-338.70
Industry	2	0.00	0.00	0.00	0.00
Industry	3	2.48	53.23	-65.32	-9.61
Industry	4	2.60	27.79	-29.98	0.41
Industry	5	12.40	57.56	-63.39	6.56
Industry	6	-51.58	165.85	-84.03	30.24
Industry	7	0.00	0.00	0.00	0.00
Industry	8	67.64	125.49	-101.84	91.29
Industry	9	-0.01	0.78	-1.41	-0.64
Industry	10	31.29	40.50	-38.82	32.97
Industry	11	-5.61	83.22	-54.53	23.08
Industry	12	0.61	0.27	0.35	1.23
Industry	13	-214.73	1337.68	-840.08	282.87
Industry	14	-0.94	2.92	-1.21	0.78
Industry	15	3.63	156.74	-188.11	-27.75
Industry	16	388.14	333.96	-806.01	-83.90
Industry	17	2.02	13.68	-19.24	-3.54
Industry	18	1.15	1.93	-4.57	-1.49
Industry	19	0.21	90.43	-77.20	13.44
Industry	20	-2.12	15.42	-12.23	1.07
Industry	21	-1.98	67.21	-63.60	1.63
Industry	22	-122.03	396.43	-183.54	90.86
Industry	23	87.11	671.04	-851.49	-93.34
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	132.95	4343.25	-1714.79	2761.42
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-59.39	476.24	-201.05	215.80
Industry	30	0.00	0.00	0.00	0.00
TOTAL		257.22	9003.23	-6265.77	2994.68

Table D-2 Water Intake Shifts by Industry Group, Canada, 1972-1976 (million cubic metres)

		Structural Change Factors			
		Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-4.47	466.65	-17.01	445.17
Industry	2	0.00	0.00	0.00	0.00
Industry	3	363.89	16.79	0.30	380.98
Industry	4	1.07	-5.35	0.88	-3.39
Industry	5	-94.79	21.16	1.35	-72.28
Industry	6	-49.56	26.97	1.26	-21.33
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-425.66	181.73	-50.49	-294.41
Industry	9	-0.21	-2.93	0.01	-3.13
Industry	10	2.22	17.48	-8.86	10.84
Industry	11	131.39	19.82	4.83	156.04
Industry	12	-1.29	0.08	-0.02	-1.23
Industry	13	-37.71	299.14	-223.63	37.81
Industry	14	-4.18	0.77	-0.19	-3.60
Industry	15	386.95	8.69	-25.98	369.66
Industry	16	-263.73	585.41	-245.45	76.24
Industry	17	-28.95	7.80	-2.31	-23.46
Industry	18	-8.99	2.87	-0.57	-6.68
Industry	19	143.41	46.74	-6.82	183.32
Industry	20	-34.61	5.36	-1.89	-31.15
Industry	21	-43.98	14.10	-8.58	-38.47
Industry	22	-239.81	166.71	-11.11	-84.21
Industry	23	-287.93	300.86	-75.03	-62.10
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	1128.84	2646.53	67.57	3842.93
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-219.34	358.81	-35.65	103.83
Industry	30	0.00	0.00	0.00	0.00
TOTAL		412.57	5186.20	-637.38	4961.39

Table D-3 Water Intake Shifts by Industry Group, Canada, 1966-1976 (million cubic metres)

Structural Change Factors

	Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry 1	-23.75	999.59	-869.36	106.48
Industry 2	0.00	0.00	0.00	0.00
Industry 3	366.63	69.31	-65.18	370.76
Industry 4	3.40	23.20	-29.58	-2.98
Industry 5	-80.63	77.85	-62.94	-65.72
Industry 6	-105.01	196.88	-82.96	8.91
Industry 7	0.00	0.00	0.00	0.00
Industry 8	-332.94	245.62	-115.80	-203.12
Industry 9	-0.21	-2.16	-1.41	-3.78
Industry 10	35.61	50.38	-42.17	43.82
Industry 11	124.99	105.39	-51.26	179.13
Industry 12	-0.65	0.30	0.35	0.00
Industry 13	-257.69	1518.98	-940.61	320.67
Industry 14	-5.29	3.74	-1.27	-2.83
Industry 15	390.40	151.79	-200.28	341.91
Industry 16	226.57	656.45	-890.69	-7.67
Industry 17	-26.58	19.62	-20.05	-27.01
Industry 18	-7.46	4.03	-4.74	-8.17
Industry 19	143.65	133.17	-80.06	196.76
Industry 20	-37.00	20.00	-13.07	-30.07
Industry 21	-51.41	80.08	-65.49	-36.83
Industry 22	-388.98	586.55	-190.93	6.65
Industry 23	-187.91	891.17	-858.71	-155.45
Industry 24	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00
Industry 27	1300.51	6983.55	-1679.71	6604.35
Industry 28	0.00	0.00	0.00	0.00
Industry 29	-298.20	831.45	-213.63	319.63
Industry 30	0.00	0.00	0.00	0.00
TOTAL	788.05	13646.95	-6479.55	7955.45

Table D-4 Gross Water Use Shifts by Industry Group, Canada, 1966-1972
(million cubic metres)

	Structural Change Factors			
	Gross Use Coefficient	Final Demand	Production Technology	Total Shift
Industry 1	-16.63	541.61	-863.68	-338.70
Industry 2	0.00	0.00	0.00	0.00
Industry 3	26.17	564.09	-692.15	-101.90
Industry 4	6.82	72.72	-78.45	1.09
Industry 5	27.70	128.55	-141.59	14.66
Industry 6	-73.41	236.08	-119.61	43.06
Industry 7	0.00	0.00	0.00	0.00
Industry 8	88.98	165.10	-133.98	120.10
Industry 9	-0.01	0.86	-1.57	-0.72
Industry 10	42.68	55.29	-52.98	44.99
Industry 11	-7.01	103.84	-68.03	28.80
Industry 12	0.83	0.35	-0.15	1.03
Industry 13	-672.42	4188.55	-2630.44	885.68
Industry 14	-11.88	36.26	-14.88	9.50
Industry 15	8.71	378.66	-454.46	-67.08
Industry 16	627.39	539.81	-1302.82	-135.62
Industry 17	4.43	30.01	-42.21	-7.78
Industry 18	1.99	3.37	-7.96	-2.60
Industry 19	0.26	130.83	-111.67	19.42
Industry 20	-5.96	43.25	-34.30	2.99
Industry 21	-3.79	129.08	-122.14	3.15
Industry 22	-258.25	838.80	-388.33	192.23
Industry 23	191.68	1476.63	-1873.72	-205.40
Industry 24	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00
Industry 27	132.97	4343.24	-1714.80	2761.42
Industry 28	0.00	0.00	0.00	0.00
Industry 29	-59.39	476.24	-201.05	215.80
Industry 30	0.00	0.00	0.00	0.00
TOTAL	51.87	14483.23	-11051.00	3484.13

Table D-5 **Gross Water Use Shifts by Industry Group, Canada, 1972-1976**
(million cubic metres)

	Structural Change Factors			
	Gross Use Coefficient	Final Demand	Production Technology	Total Shift
Industry 1	-4.50	466.65	-17.01	445.15
Industry 2	0.00	0.00	0.00	0.00
Industry 3	80.60	177.90	3.19	261.70
Industry 4	-59.63	-13.99	2.32	-71.31
Industry 5	-10.86	47.26	3.01	39.41
Industry 6	-60.58	38.39	1.79	-20.40
Industry 7	0.00	0.00	0.00	0.00
Industry 8	-496.71	239.09	-66.42	-324.05
Industry 9	-0.25	-3.26	0.01	-3.50
Industry 10	56.16	23.86	-12.09	67.93
Industry 11	239.13	24.73	6.02	269.88
Industry 12	-1.73	0.11	-0.03	-1.64
Industry 13	-1057.64	936.67	-700.22	-821.19
Industry 14	-51.66	9.46	-2.32	-44.51
Industry 15	994.24	20.99	-62.76	952.47
Industry 16	-380.84	946.26	-396.74	168.68
Industry 17	-70.77	17.11	-5.07	-58.72
Industry 18	-15.79	5.01	-0.99	-11.77
Industry 19	467.39	67.61	-9.87	525.12
Industry 20	-97.15	15.05	-5.23	-87.33
Industry 21	-29.88	28.11	-7.35	-9.12
Industry 22	-178.84	352.73	23.51	150.38
Industry 23	-842.09	662.04	-165.11	-345.16
Industry 24	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00
Industry 27	1128.85	2646.53	67.57	3842.94
Industry 28	0.00	0.00	0.00	0.00
Industry 29	-219.32	358.81	-35.65	103.84
Industry 30	0.00	0.00	0.00	0.00
TOTAL	-611.89	7067.12	-1426.44	5028.80

Table D-6 Gross Water Use Shifts by Industry Group, Canada, 1966-1976 (million cubic metres)

		Structural Change Factors			
		Gross Use Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-23.75	999.58	-869.38	106.45
Industry	2	0.00	0.00	0.00	0.00
Industry	3	109.56	734.50	-684.26	159.80
Industry	4	-53.53	60.71	-77.40	-70.22
Industry	5	20.76	173.89	-140.58	54.07
Industry	6	-139.44	280.22	-118.12	22.66
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-374.73	323.13	-152.35	-203.95
Industry	9	-0.25	-2.40	-1.56	-4.22
Industry	10	101.72	68.76	-57.56	112.91
Industry	11	231.13	131.50	-63.94	298.68
Industry	12	-0.86	0.40	-0.16	-0.62
Industry	13	-1746.46	4756.20	-2945.24	64.50
Industry	14	-65.45	46.25	-15.81	-35.01
Industry	15	1002.53	366.71	-483.85	885.39
Industry	16	411.68	1061.08	-1439.70	33.06
Industry	17	-65.57	43.05	-43.98	-66.50
Industry	18	-13.13	7.03	-8.27	-14.37
Industry	19	467.71	192.65	-115.81	544.55
Industry	20	-103.78	56.09	-36.65	-84.34
Industry	21	-33.97	153.78	-125.78	-5.97
Industry	22	-494.50	1241.08	-403.98	342.61
Industry	23	-622.02	1961.05	-1889.60	-550.56
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	1300.54	6983.54	-1679.72	6604.36
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-298.16	831.44	-213.64	319.64
Industry	30	0.00	0.00	0.00	0.00
TOTAL		-390.00	20470.24	-11567.31	8512.93

Table D-7 Water Intake Shifts by Industry Group, Atlantic Region, 1966-1974
(million cubic metres)

	Structural Change Factors			
	Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry 1	-5.42	15.39	-16.08	-6.11
Industry 2	0.00	0.00	0.00	0.00
Industry 3	55.82	5.11	-35.06	25.88
Industry 4	0.00	0.00	0.00	0.00
Industry 5	-36.51	20.58	12.72	-3.21
Industry 6	-12.28	74.24	-54.99	6.97
Industry 7	0.00	0.00	0.00	0.00
Industry 8	-42.49	45.82	-0.95	2.38
Industry 9	-0.17	0.06	-0.32	-0.43
Industry 10	0.00	0.84	-0.53	0.32
Industry 11	-7.43	12.01	-0.23	4.35
Industry 12	0.00	0.00	0.00	0.00
Industry 13	-249.70	501.69	-167.55	84.44
Industry 14	-0.04	0.06	-0.05	-0.03
Industry 15	2.29	24.90	-3.38	23.81
Industry 16	-57.33	101.26	-25.02	18.91
Industry 17	-0.45	0.57	-0.58	-0.46
Industry 18	-0.78	2.21	-1.64	-0.21
Industry 19	-27.03	93.94	-29.61	37.30
Industry 20	-0.24	0.69	-0.57	-0.12
Industry 21	-0.10	-1.27	-0.73	-2.10
Industry 22	-90.65	145.19	-23.49	31.05
Industry 23	-56.25	152.18	-55.03	40.91
Industry 24	0.03	0.00	0.00	0.03
Industry 25	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00
Industry 27	-334.29	1671.55	-287.71	1049.55
Industry 28	0.00	0.00	0.00	0.00
Industry 29	-5.42	41.12	-21.49	14.20
Industry 30	0.00	0.00	0.00	0.00
TOTAL	-868.43	2908.14	-712.28	1327.43

Table D-8 Gross Water Use Shifts by Industry Group, Atlantic Region, 1966-1974
(million cubic metres)

		Structural Change Factors			
		Gross Use Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-5.42	15.39	-16.08	-6.11
Industry	2	0.00	0.00	0.00	0.00
Industry	3	-44.50	242.97	-244.24	-45.77
Industry	4	0.00	0.00	0.00	0.00
Industry	5	-35.49	22.16	13.70	0.37
Industry	6	-13.16	85.38	-63.42	8.80
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-314.12	338.40	-7.02	17.25
Industry	9	-0.17	0.06	-0.32	-0.43
Industry	10	0.18	1.14	-0.72	0.60
Industry	11	-7.54	14.39	-0.28	6.57
Industry	12	0.00	0.00	0.00	0.00
Industry	13	-766.73	1378.13	-460.28	151.12
Industry	14	-0.04	0.06	-0.05	-0.03
Industry	15	2.05	27.83	-3.77	26.11
Industry	16	-62.99	111.82	-27.63	21.20
Industry	17	-0.58	0.68	-0.70	-0.59
Industry	18	-0.79	2.21	-1.64	-0.22
Industry	19	-30.87	97.11	-30.60	35.63
Industry	20	-1.85	4.91	-4.06	-0.99
Industry	21	0.35	-1.40	-0.80	-1.85
Industry	22	-123.20	230.90	-37.35	70.35
Industry	23	-187.38	488.81	-176.74	124.69
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-334.30	1671.55	-287.71	1049.54
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-5.43	41.12	-21.49	14.20
Industry	30	0.00	0.00	0.00	0.00
TOTAL		-1931.98	4773.62	-1371.21	1470.43

Table D-9 Water Intake Shifts by Industry Group, Quebec Region, 1966-1974
(million cubic metres)

		Structural Change Factors			
		Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-6.96	44.08	-46.25	-9.13
Industry	2	0.00	0.00	0.00	0.00
Industry	3	-1985.59	1714.58	357.23	86.21
Industry	4	0.00	0.00	0.00	0.00
Industry	5	-0.56	15.65	-19.78	-4.68
Industry	6	-10.10	38.93	-26.55	2.28
Industry	7	-0.07	0.24	-0.17	0.00
Industry	8	-57.29	57.42	-4.28	-4.15
Industry	9	0.04	0.02	-0.16	-0.10
Industry	10	-10.48	39.82	-12.40	16.94
Industry	11	9.15	12.65	-33.11	-11.31
Industry	12	0.05	0.00	0.00	0.05
Industry	13	-75.61	498.05	-440.76	-18.33
Industry	14	-0.13	0.65	-0.91	-0.39
Industry	15	-15.00	175.91	-91.04	69.86
Industry	16	8.16	63.05	-70.16	1.05
Industry	17	-0.57	5.67	-10.44	-5.34
Industry	18	-0.05	0.68	-1.91	-1.28
Industry	19	-18.59	51.84	-18.01	15.23
Industry	20	-0.94	3.76	-6.12	-3.30
Industry	21	-4.92	52.46	-59.22	-11.69
Industry	22	-43.35	128.39	-72.11	12.93
Industry	23	-20.23	139.64	-142.98	-23.58
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-0.90	298.75	-160.85	137.00
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-54.29	222.66	-80.68	87.70
Industry	30	0.00	0.00	0.00	0.00
TOTAL		-2288.24	3564.87	-940.67	335.96

Table D-10 Gross Water Use Shifts by Industry Group, Quebec Region, 1966-1974
(million cubic metres)

		Structural Change Factors			
		Gross Use Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-6.96	44.08	-46.25	-9.13
Industry	2	0.00	0.00	0.00	0.00
Industry	3	-7921.62	6773.81	1291.06	143.25
Industry	4	0.00	0.00	0.00	0.00
Industry	5	-6.73	48.67	-47.93	-5.99
Industry	6	-18.40	62.89	-39.91	4.58
Industry	7	-0.32	1.02	-0.71	0.00
Industry	8	-576.71	489.79	80.25	-6.69
Industry	9	-0.09	0.08	-0.09	-0.10
Industry	10	13.63	49.78	-25.79	37.63
Industry	11	19.05	13.73	-42.78	-10.01
Industry	12	0.02	0.01	0.00	0.03
Industry	13	-752.43	1483.73	-912.97	-181.67
Industry	14	-18.23	22.38	-11.47	-7.32
Industry	15	34.18	270.93	-183.73	121.38
Industry	16	-1.69	125.75	-121.43	2.63
Industry	17	-13.45	17.66	-13.16	-8.96
Industry	18	-1.98	2.05	-1.35	-1.28
Industry	19	-11.79	52.09	-22.79	17.51
Industry	20	-18.56	21.56	-13.38	-10.38
Industry	21	-31.81	127.81	-105.14	-9.13
Industry	22	-194.11	469.00	-175.37	99.51
Industry	23	-365.26	825.48	-578.31	-118.10
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-0.90	298.75	-160.85	137.00
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-87.51	241.70	-66.49	87.69
Industry	30	0.00	0.00	0.00	0.00
TOTAL		-9961.68	11442.75	-1198.59	282.48

Table D-11 **Water Intake Shifts by Industry Group, Ontario Region, 1966-1974**
(million cubic metres)

		Structural Change Factors			
		Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-4.92	74.39	-77.87	-8.40
Industry	2	0.00	0.00	0.00	0.00
Industry	3	22.22	33.95	-21.63	34.54
Industry	4	0.00	0.00	0.00	0.00
Industry	5	-37.77	-226.56	240.68	-23.64
Industry	6	-17.77	52.93	-31.73	3.43
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-3612.32	2933.30	624.80	-54.21
Industry	9	-1.37	0.95	-0.97	-1.40
Industry	10	1.30	53.12	-33.60	20.83
Industry	11	-18.70	36.23	-6.75	10.78
Industry	12	0.00	0.00	0.00	0.00
Industry	13	-210.95	523.10	-314.63	-2.48
Industry	14	-1.08	1.21	-0.67	-0.54
Industry	15	0.81	125.76	-83.54	43.04
Industry	16	-498.14	1335.93	-725.37	112.42
Industry	17	-14.26	19.93	-13.59	-7.91
Industry	18	-3.63	3.22	-2.36	-2.76
Industry	19	-11.23	89.86	-35.99	42.64
Industry	20	-10.67	12.97	-7.09	-4.79
Industry	21	-29.39	71.42	-46.35	-4.32
Industry	22	-107.59	260.65	-140.65	12.42
Industry	23	-558.01	1198.82	-731.27	-90.45
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-354.73	4008.22	-1073.17	2580.32
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-105.07	289.96	-70.90	113.99
Industry	30	0.00	0.00	0.00	0.00
TOTAL		-5573.23	10899.36	-2552.62	2773.51

Table D-12 Gross Water Use Shifts by Industry Group, Ontario Region, 1966-1974
(million cubic metres)

		Structural Change Factors			
		Gross Use Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-4.92	74.39	-77.87	-8.40
Industry	2	0.00	0.00	0.00	0.00
Industry	3	-321.67	691.19	-440.32	-70.80
Industry	4	0.00	0.00	0.00	0.00
Industry	5	-55.80	-425.80	452.35	-29.24
Industry	6	-23.43	74.93	-44.91	6.58
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-4497.88	3664.09	780.59	-53.20
Industry	9	-1.62	1.09	-1.12	-1.65
Industry	10	15.52	66.64	-42.14	40.01
Industry	11	-22.16	50.84	-9.47	19.20
Industry	12	0.00	0.00	0.00	0.00
Industry	13	-878.21	1817.53	-1093.18	-153.87
Industry	14	-10.58	11.56	-6.34	-5.36
Industry	15	-1.70	393.19	-261.22	130.28
Industry	16	-1043.15	2461.66	-1213.81	204.70
Industry	17	-29.01	37.83	-25.82	-17.00
Industry	18	-8.51	7.71	-5.64	-6.44
Industry	19	116.46	169.89	-70.39	215.97
Industry	20	-26.88	32.65	-17.84	-12.07
Industry	21	-47.70	150.87	-97.93	5.24
Industry	22	-81.61	345.94	-186.66	77.67
Industry	23	-768.32	1650.63	-1048.44	-166.13
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-354.73	4008.22	-1073.17	2580.32
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-98.07	289.96	-70.90	120.99
Industry	30	0.00	0.00	0.00	0.00
TOTAL		-8143.96	15575.01	-4554.22	2876.83

Table D-13 Water Intake Shifts by Industry Group, Prairie Region, 1966-1974
(million cubic metres)

		Structural Change Factors			
		Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-26.34	578.54	-591.39	-39.19
Industry	2	0.00	0.00	0.00	0.00
Industry	3	11.90	9.33	-9.15	12.08
Industry	4	-40.96	75.66	-35.16	-0.46
Industry	5	-34.64	74.15	-33.94	5.57
Industry	6	-8.65	22.95	-9.34	4.96
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-82.55	79.11	3.47	0.03
Industry	9	-0.19	0.21	-0.13	-0.10
Industry	10	0.01	0.21	-0.13	0.10
Industry	11	-11.94	18.93	4.19	11.19
Industry	12	0.00	0.00	0.00	0.00
Industry	13	-38.88	141.10	-67.23	34.99
Industry	14	-0.09	0.11	-0.07	-0.05
Industry	15	3.33	33.11	-21.77	14.67
Industry	16	0.00	0.00	0.00	0.00
Industry	17	-138.46	102.31	35.43	-0.72
Industry	18	-0.73	0.95	-0.39	-0.17
Industry	19	-0.38	2.30	-0.42	1.50
Industry	20	-0.25	0.63	-0.42	-0.04
Industry	21	-3.90	4.10	-0.83	-0.63
Industry	22	-18.17	29.19	-16.85	-5.83
Industry	23	-46.08	81.25	-54.32	-19.15
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-108.76	1193.48	-280.31	804.41
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-7.79	56.28	-33.46	15.03
Industry	30	0.00	0.00	0.00	0.00
Total		-553.51	2503.92	-1112.21	838.20

Table D-14 Gross Water Use Shifts by Industry Group, Prairie Region, 1966-1974
(million cubic metres)

	Structural Change Factors			
	Gross Use Coefficient	Final Demand	Production Technology	Total Shift
Industry 1	-26.34	578.54	-591.39	-39.19
Industry 2	0.00	0.00	0.00	0.00
Industry 3	-3.34	27.87	-27.34	-2.81
Industry 4	-46.14	80.72	-37.59	-3.01
Industry 5	-77.43	264.33	-120.97	65.93
Industry 6	-15.60	43.74	-17.80	10.34
Industry 7	0.00	0.00	0.00	0.00
Industry 8	-158.13	151.91	6.63	0.41
Industry 9	-0.19	0.21	-0.13	-0.10
Industry 10	0.09	0.39	-0.23	0.25
Industry 11	-11.72	23.81	5.27	17.36
Industry 12	0.00	0.00	0.00	0.00
Industry 13	-219.04	679.13	-323.59	136.50
Industry 14	-0.11	0.13	-0.08	-0.06
Industry 15	9.62	179.92	-118.31	71.23
Industry 16	0.00	0.00	0.00	0.00
Industry 17	-154.50	121.17	-146.89	-180.22
Industry 18	-0.76	0.99	-0.40	-0.17
Industry 19	-0.51	4.92	-0.90	3.51
Industry 20	-0.89	2.12	-1.41	-0.18
Industry 21	-11.91	11.20	-0.86	-1.57
Industry 22	-67.62	152.54	-88.11	-3.19
Industry 23	-355.99	597.43	-399.40	-157.96
Industry 24	0.00	0.00	0.00	0.00
Industry 25	0.00	0.00	0.00	0.00
Industry 26	0.00	0.00	0.00	0.00
Industry 27	-108.58	1193.48	-280.31	804.59
Industry 28	0.00	0.00	0.00	0.00
Industry 29	-7.79	56.28	-32.66	15.83
Industry 30	0.00	0.00	0.00	0.00
TOTAL	-1256.86	4170.84	-2176.48	737.49

Table D-15 Water Intake Shifts by Industry Group, B.C. Region, 1966-1974
(million cubic metres)

		Structural Change Factors			
		Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-75.27	308.41	-285.12	-51.98
Industry	2	0.00	0.00	0.00	0.00
Industry	3	1.95	28.89	-23.23	7.60
Industry	4	1.80	1.58	-0.47	2.90
Industry	5	2.78	17.56	-17.19	3.14
Industry	6	-2.97	14.66	-9.21	2.49
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-0.02	0.03	0.01	0.02
Industry	9	0.00	0.00	0.00	0.00
Industry	10	0.08	0.08	-0.04	0.12
Industry	11	-165.56	172.34	63.94	70.72
Industry	12	0.00	0.00	0.00	0.00
Industry	13	-153.29	691.63	-224.03	314.30
Industry	14	0.00	0.00	0.00	0.00
Industry	15	-12.47	25.02	-8.19	4.35
Industry	16	38.26	83.30	-263.05	-141.48
Industry	17	-0.16	1.03	-0.62	0.24
Industry	18	-0.05	0.69	-0.45	0.19
Industry	19	-6.14	17.07	-4.14	6.80
Industry	20	0.04	0.05	-0.01	0.09
Industry	21	-0.92	-0.86	4.17	2.40
Industry	22	-1.10	40.98	-27.33	12.54
Industry	23	-7.45	88.74	-78.55	2.74
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-16.09	213.26	-80.57	116.60
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-11.19	74.91	-28.69	35.03
Industry	30	0.00	0.00	0.00	0.00
Total		-407.77	1779.36	-982.76	388.83

Table D-16 Gross Water Use Shifts by Industry Group, B.C. Region, 1966-1974
(million cubic metres)

		Structural Change Factors			
		Intake Coefficient	Final Demand	Production Technology	Total Shift
Industry	1	-76.57	309.12	-285.75	-53.20
Industry	2	0.00	0.00	0.00	0.00
Industry	3	-16.25	102.27	-82.23	3.79
Industry	4	-147.33	159.70	-47.72	-35.34
Industry	5	-2.92	31.67	-30.51	-1.76
Industry	6	-4.37	16.16	-10.14	1.65
Industry	7	0.00	0.00	0.00	0.00
Industry	8	-5.25	4.04	1.49	0.28
Industry	9	0.00	0.00	0.00	0.00
Industry	10	0.50	0.14	-0.13	0.51
Industry	11	-137.39	180.13	67.03	109.77
Industry	12	0.00	0.00	0.00	0.00
Industry	13	-2649.96	2908.44	-942.10	-683.63
Industry	14	0.00	0.00	0.00	0.00
Industry	15	-17.86	29.81	-9.77	2.19
Industry	16	13.35	122.75	-387.62	-251.51
Industry	17	-3.06	3.17	-1.93	-1.82
Industry	18	-1.13	2.11	-1.36	-0.39
Industry	19	-4.01	17.62	-4.27	9.34
Industry	20	-21.47	24.18	-2.73	-0.03
Industry	21	-6.82	-2.28	11.41	2.31
Industry	22	-90.07	128.97	-86.03	-47.13
Industry	23	-126.70	208.84	-184.82	-102.67
Industry	24	0.00	0.00	0.00	0.00
Industry	25	0.00	0.00	0.00	0.00
Industry	26	0.00	0.00	0.00	0.00
Industry	27	-23.80	217.67	-82.24	111.63
Industry	28	0.00	0.00	0.00	0.00
Industry	29	-20.58	80.53	-30.83	29.12
Industry	30	0.00	0.00	0.00	0.00
Total		-3341.68	4545.03	-2110.23	-906.88

Appendix E

Final Demand and Output Data for 1966

General Note

The following list shows how the commodity groups for the 1966 input-output table were allocated to industrial groups.

Industry	Includes these commodities:
1. Agriculture	Grain, Other Agriculture
2. Forestry, Fishing, Hunting and Trapping	Forestry Products, Fishing Products, Trapping Products
3. Metallic Minerals	Iron Ore
4. Mineral Fuels	Crude Petroleum, Natural Gas, Coal
5. Non-metallic Minerals	Sulphur, Asbestos, Other Minerals
6. Food and Beverages	Meat Products, Dairy Products, Fish Products, Feed, Flour and Wheat, Other Grain Mill Products, Bakery Products, Soft Drinks, Other Foods Products, Alcoholic Beverages
7 Tobacco Products	Tobacco
8. Rubber and Plastics	Tires and Tubes, Other Rubber Products, Plastic Products
9. Leather Products	Leather Products
10. Textiles, Knitting Mills and Clothing	Yarns and Man-made Fibres, Fabrics, Textile Products, Clothing
11. Wood Products	Lumber and Plywood, Other Wood Products
12. Furniture and Fixtures	Furniture and Fixtures
13. Paper and Allied Products	Pulp, Newsprint, Other Paper Stock, Industrial Paper Products, Household Paper Products
14. Printing and Publishing	Printed Matter
15. Primary Metals, except Iron and Steel	Aluminum Products, Copper and Copper Alloy Products, Nickel Products, Other Non-ferrous Metal Products
16. Iron and Steel	Iron and Steel Products
17. Metal Fabricating	Metal Fabricated Products
18. Machinery	Agricultural Macinery, Other Industrial Machinery
19. Transportation Equipment	Motor Vehicles, Motor Vehicle Parts, Other Transport Equipment

20. Electrical Products..................	Appliances, Other Electrical Equipment
21. Non-metallic Mineral Products.........	Cement and Concrete Products, Other Non-metallic Mineral Products
22. Petroleum and Coal Products...........	Fuels and Petroleum, Other Petroleum and Coal Products
23. Chemicals and Chemical Products.......	Industrial Chemicals, Fertilizers, Pharmaceuticals, Other Chemical Products
24. Miscellaneous Manufacturing...........	Scientific Equipment, Other Manufactured Products
25. Construction..........................	Residential Dwellings, Non-residential Buildings, Roads, Highways and Airstrips, Gas Oil Facilities, Dams and Irrigation Projects, Railways, Telephone and Telegraph Installation, Other Engineering Structures, Repair Construction
26. Transportation, Storage and Communication....................	Transportation Services, Transportation Marrgins, Communication
27. Electric Power........................	Electric Power
28. Gas and Other Utilities...............	Gas and Pipeline Margins, Other Utilities
29. Wholesale and Retail Trade............	Wholesale Trade, Retail Trade
30. Other.................................	Finance, Insurance and Real Estate, Personal Services Business Services

Table E-1 Industrial Final Demand Data, by Region, 1966
($million, 1966)

	Atlantic	Quebec	Ontario	Prairie	B.C.	National	Inflation Factor
Industry 1	55.88	-27.25	160.06	1734.88	47.49	1971.05	1.88
Industry 2	38.23	11.02	-36.65	12.34	59.42	84.35	1.49
Industry 3	218.44	9.63	442.43	135.45	232.60	1038.56	1.48
Industry 4	-74.19	-20.15	438.30	1051.98	59.94	1455.89	2.02
Industry 5	25.62	-239.50	379.68	-18.04	-51.02	96.75	1.37
Industry 6	161.09	1239.24	2195.75	932.39	409.29	4937.76	1.51
Industry 7	0.00	147.53	184.64	0.00	0.00	332.17	1.14
Industry 8	-13.10	78.53	398.76	-24.31	21.61	461.51	1.30
Industry 9	2.31	116.96	146.58	10.84	2.58	279.26	1.36
Industry 10	3.83	857.83	381.66	38.08	-1.56	1279.86	1.25
Industry 11	9.05	22.37	-89.99	46.57	691.39	679.39	1.50
Industry 12	3.01	212.83	265.62	41.38	35.66	558.49	1.38
Industry 13	234.44	742.41	499.03	-24.14	441.48	1893.21	1.52
Industry 14	28.73	302.27	574.18	104.92	73.04	1083.14	1.30
Industry 15	31.05	329.45	277.01	-12.64	47.21	672.08	1.39
Industry 16	25.95	95.01	243.21	0.00	44.43	408.60	1.39
Industry 17	-58.85	209.35	623.72	-115.03	-46.59	612.60	1.34
Industry 18	-28.20	145.23	990.84	3.21	-103.42	1007.67	1.24
Industry 19	78.15	479.36	3322.06	60.39	76.59	4016.55	1.16
Industry 20	-26.90	392.86	1052.83	-61.30	-34.58	1322.91	1.23
Industry 21	-28.99	42.45	54.06	-13.13	-34.82	19.57	1.26
Industry 22	79.70	239.35	272.96	130.46	79.93	802.39	1.90
Industry 23	-40.00	140.15	541.77	83.06	-6.64	718.34	1.36
Industry 24	-0.45	135.38	445.14	17.87	7.96	605.91	1.29

Table E-1 (continued)

Industry 25	764.18	2435.65	3308.35	2116.74	1293.42	9918.34	1.38
Industry 26	26.00	140.74	70.57	5.06	61.16	303.53	1.17
Industry 27	48.73	75.19	164.25	98.76	54.65	441.57	1.13
Industry 28	4.90	7.23	50.19	39.57	7.88	109.77	1.13
Industry 29	348.38	1211.58	1456.57	785.92	404.00	4206.45	1.26
Industry 30	-16.44	3227.01	8721.02	1668.20	1412.63	15012.41	1.25
TOTAL	1900.57	12759.71	27534.60	8849.49	5285.72	56330.10	

Source: Statistics Canada, manuscript copy of the 1966 regional input-oput table. The inflation factor was calculated on the basis of national output data by taking the ratio of 1974 output in current dollars (Statistics Canada, 1983a, p. 156-161) to 1974 output in constant 1971 dollars (Statistics Canada, 1982b, pp.99-110).

Table E-2 Industrial Final Demand Data, by Region, 1966 ($million, 1974)

	Canada Total in $1971	Regional Final Demand in $1974 Atlantic	Quebec	Ontario	Prairie	B.C.	Canada Total in $1974
Industry 1	1586.50	84.76	-41.34	242.80	2631.68	72.03	2989.92
Industry 2	88.44	59.59	17.18	-57.13	19.23	92.61	131.48
Industry 3	571.38	178.03	7.85	360.59	110.39	189.57	846.44
Industry 4	-132.55	13.64	3.70	-80.59	-193.42	-11.02	-267.68
Industry 5	172.44	62.56	-584.89	927.22	-44.05	-124.59	236.26
Industry 6	4364.15	215.11	1654.86	2932.17	1245.10	546.56	6593.80
Industry 7	294.76	0.00	149.84	187.54	0.00	0.00	337.38
Industry 8	78.93	-2.91	17.46	88.64	-5.40	4.80	102.58
Industry 9	232.59	2.61	132.16	165.62	12.25	2.91	315.55
Industry 10	1059.19	3.96	886.20	394.28	39.34	-1.61	1322.18
Industry 11	509.89	10.19	25.18	-101.31	52.43	778.39	764.89
Industry 12	485.07	3.60	254.83	318.04	49.55	42.70	668.72
Industry 13	1433.51	269.22	852.54	573.06	-27.72	506.97	2174.06
Industry 14	181.91	6.28	66.10	125.57	22.94	15.97	236.87
Industry 15	782.89	50.33	533.98	448.98	-20.49	76.51	1089.31
Industry 16	-55.98	-4.95	-18.11	-46.36	0.00	-8.47	-77.89
Industry 17	14.39	-1.85	6.58	19.62	-3.62	-1.47	19.27
Industry 18	573.83	-19.89	102.47	699.10	2.26	-72.97	710.97
Industry 19	2294.63	51.83	317.92	2203.24	40.05	50.80	2663.83
Industry 20	885.70	-22.21	324.33	869.19	-50.61	-28.55	1092.16
Industry 21	-54.65	101.74	-148.96	-189.73	46.06	122.20	-68.69
Industry 22	511.27	96.57	290.00	330.71	158.07	96.84	972.18
Industry 23	335.23	-25.34	88.77	343.14	52.60	-4.21	454.97
Industry 24	280.15	-0.27	81.03	266.43	10.70	4.77	362.66

Table E-2 (continued)

Industry 25	8202.39	872.00	2779.28	3775.10	2415.38	1475.90	11317.65
Industry 26	1911.57	191.90	1038.73	520.82	37.36	451.36	2240.17
Industry 27	580.10	72.06	111.18	242.87	146.04	80.81	652.96
Industry 28	182.32	9.16	13.51	93.83	73.98	14.73	205.22
Industry 29	6496.92	680.08	2365.14	2843.38	1534.21	788.66	8211.46
Industry 30	11987.81	-16.44	3228.28	8724.45	1668.85	1413.19	15018.32
TOTAL	45854.75	2941.35	14555.80	27221.27	10023.16	6575.39	61316.98

Source: The national final demand data were provided by the Input-Output Division of Statistics Canada, and are the same as those used in the national analysis of this thesis. The regional data were calculated by multiplying each regional figure of Table E-1 by its corresponding inflation factor (last column, Table E1) and by its national total in terms of $1971 (first column, this table), and then dividing this product by its national total in terms of $1966.

Table E-3 Industrial Output Data, by Region, 1966
($million, 1966)

	Atlantic	Quebec	Ontario	Prairie	B.C.	National	Inflation Factor
Industry 1	153.744	616.046	1326.94	2453.901	198.603	4749.234	1.8846
Industry 2	203.764	279.271	184.207	51.001	553.395	1271.638	1.4866
Industry 3	222.075	9.768	566.849	135.4663	232.608	1166.766	1.4814
Industry 4	26.418	0	10.435	1066.709	66.66	1170.222	2.0195
Industry 5	46.758	237.345	121.434	240.087	73.624	719.248	1.3701
Industry 6	493.696	1940.033	3011.41	1211.904	589.422	7246.465	1.5109
Industry 7	0	216.772	214.076	0	0	430.848	1.1446
Industry 8	1.432	196.397	583.365	22.18	29.63	833.004	1.2997
Industry 9	3.601	172.045	184.765	14.145	3.44	377.996	1.3567
Industry 10	33.264	1657.833	960.102	135.618	39.955	2826.772	1.2483
Industry 11	78.425	2799.281	278.735	119.1661	865.346	4140.953	1.5001
Industry 12	5.059	224.783	299.554	46.429	38.547	614.372	1.3786
Industry 13	298.634	1174.204	1151.175	110.089	538.257	3272.359	1.5166
Industry 14	32.361	346.365	655.606	115.38	81.51	1231.222	1.3021
Industry 15	38.037	1088.299	1228.814	239.2553	134.523	2728.928	1.3914
Industry 16	31.789	335.473	1078.115	41.4807	126.615	1613.473	1.3914
Industry 17	61.426	700.198	1703.266	209.688	183.663	2858.241	1.3393
Industry 18	4.515	257.67	1282.862	91.198	68.917	1705.162	1.239
Industry 19	99.507	581.013	3510.212	76.59	102.154	4369.476	1.1609
Industry 20	31.208	629.856	1634.753	52.532	49.493	2397.842	1.2331
Industry 21	136.873	332.415	565.604	152.476	69.607	1256.975	1.257
Industry 22	139.129	411.05	534.634	295.571	156.463	1536.847	1.9015
Industry 23	28.393	627.795	1376.803	152.923	109.593	2295.507	1.3572
Industry 24	9.951	194.634	573.486	23.863	23.828	825.762	1.2945

Table E-3 (continued)

Industry 25	868.644	2707.238	3811.71	2341.235	1438.231	11167.06	1.3798
Industry 26	141.751	633.565	845.993	421.597	277.458	2920.364	1.1719
Industry 27	100.264	343.457	429.618	193.101	140.589	1207.029	1.1256
Industry 28	10.081	33.003	131.289	77.376	20.271	272.02	1.1256
Industry 29	456.74	1557.922	2292.14	1078.244	641.046	6026.092	1.2639
Industry 30	866.079	4223.61	10308.78	2585.016	1868.971	19852.45	1.2528
TOTAL	4623.618	24527.34	40856.73	13754.22	8722.419	92484.33	

Source: Statistics Canada, munscript copy of the 1966 regional input-output table. The inflation factors were derived from Table E-1.

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Table E-4 Industrial Output Data by Region, 1966, in $1974 ($million, 1974)

	Canada Total in $1971	Atlantic	Quebec	Ontario	Prairie	B.C.	Canada Total in $1974
Industry 1	4855.86	296.25	1187.07	2556.90	4728.45	382.69	9151.35
Industry 2	1525.60	363.41	498.08	328.53	90.96	986.98	2267.96
Industry 3	1768.18	498.56	21.93	1272.57	304.12	522.20	2619.38
Industry 4	1259.58	57.42	0.00	22.68	2318.71	144.90	2543.72
Industry 5	852.84	75.96	385.59	197.28	390.04	119.61	1168.48
Industry 6	8116.50	835.48	3283.13	5096.22	2050.91	997.48	12263.22
Industry 7	464.02	0.00	267.22	263.89	0.00	0.00	531.11
Industry 8	84.41	0.19	25.87	76.83	2.92	3.90	109.71
Industry 9	429.87	5.56	265.45	285.07	21.82	5.31	583.21
Industry 10	2938.60	43.17	2151.34	1245.91	175.99	51.85	3668.26
Industry 11	1973.24	56.06	2000.99	199.25	85.18	618.57	2960.05
Industry 12	712.86	8.09	359.56	479.17	74.27	61.66	982.75
Industry 13	3596.93	497.83	1957.43	1919.04	183.52	897.29	5455.10
Industry 14	1490.88	51.02	546.11	1033.69	181.92	128.52	1941.27
Industry 15	2928.74	56.80	1625.14	1834.96	357.28	200.88	4075.05
Industry 16	1471.25	40.33	425.63	1367.86	52.63	160.64	2047.10
Industry 17	3285.18	94.56	1077.85	2621.93	322.78	282.72	4399.84
Industry 18	1989.38	6.53	372.47	1854.40	131.83	99.62	2464.84
Industry 19	4924.97	130.20	760.25	4593.06	100.22	133.67	5717.39
Industry 20	2626.95	42.16	850.88	2208.42	70.97	66.86	3239.29
Industry 21	1346.05	184.24	447.46	761.35	205.24	93.70	1691.98
Industry 22	1725.04	296.95	877.33	1141.10	630.85	333.95	3280.17
Industry 23	2472.16	41.50	917.61	2012.39	223.52	160.19	3355.21
Industry 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table E-4 (continued)

Industry 25	14029.48	1505.78	4692.94	6607.52	4058.49	2493.15	19357.88
Industry 26	7994.26	572.32	2558.02	3415.70	1702.20	1120.24	9368.47
Industry 27	1584.06	148.11	507.35	634.63	285.25	207.68	1783.02
Industry 28	250.72	10.46	34.24	136.21	80.27	21.03	282.21
Industry 29	11927.97	1142.65	3897.53	5734.36	2697.49	1603.74	15075.76
Industry 30	32282.98	1764.41	8604.49	21001.40	5266.29	3807.53	40444.12
TOTAL	120908.6	8825.998	40598.94	70902.32	26794.12	15706.54	162827.9

Source: As outlined for Table E-2, substituting Table E-3 for references to Table E-1.

Appendix F

Transposed Inverse Matrices for Canada and its Regions

Table F-1 Transposed Inverse, Industries 1 to 10, Canada, 1966

	Industries 1	2	3	4	5	6	7	8	9	10
Industry 1	1.13457	.019789	.00742	.033341	.019699	.193592	.000076	.011715	.000493	.015232
Industry 2	.018296	1.107794	.008538	.026344	.00869	.028173	.000052	.01188	.000635	.017899
Industry 3	.011421	.008902	1.024593	.014019	.055214	.018369	.000038	.006721	.000359	.006861
Industry 4	.011521	.009107	.008234	1.010784	.050498	.019529	.00003	.006875	.000377	.00656
Industry 5	.015107	.016061	.01244	.022826	1.024508	.023574	.000049	.008528	.000495	.015434
Industry 6	.432088	.053772	.007192	.02242	.011524	1.280526	.000165	.011895	.000521	.016709
Industry 7	.410213	.037978	.006038	.018746	.009828	.087693	1.303776	.009765	.000511	.017595
Industry 8	.016164	.023016	.006494	.014843	.007422	.026	.000053	1.03316	.00645	.125866
Industry 9	.034223	.02449	.006927	.01156	.005735	.068847	.000075	.075887	1.276106	.065119
Industry 10	.020274	.018438	.005364	.0109	.004288	.02172	.0000[illegible]	.022304	.007665	1.532902
Industry 11	.024529	.517945	.008549	.021775	.007437	.029865	.000065	.013542	.000668	.016854
Industry 12	.020159	.091213	.018598	.015147	.006695	.026628	.000087	.049211	.003025	.129689
Industry 13	.019929	.29216	.009356	.028777	.010116	.029583	.000054	.014557	.000805	.03131
Industry 14	.01661	.094116	.009587	.016723	.006509	.025662	.000051	.0113	.000686	.021821
Industry 15	.013389	.010533	.451417	.019953	.03032	.01915	.000059	.00702	.000417	.006894
Industry 16	.012572	.010614	.087703	.035781	.016195	.01787	.000055	.006288	.000359	.006169
Industry 17	.014102	.014653	.056186	.018781	.009666	.019971	.000061	.010204	.000492	.008755
Industry 18	.014541	.012562	.040648	.013827	.007601	.020138	.000074	.022609	.000677	.010346
Industry 19	.01005	.010424	.029266	.010407	.005896	.015124	.000037	.029437	.000888	.029644
Industry 20	.014357	.015932	.069476	.013613	.009061	.020508	.000062	.029306	.001045	.014507
Industry 21	.013899	.018593	.012901	.026224	.065497	.021554	.000043	.010142	.000514	.014183
Industry 22	.009106	.008628	.006149	.389507	.022854	1.01501	.000025	.00654	.000306	.005548
Industry 23	.024807	.024522	.011889	.033628	.022589	.050192	.000056	.019155	.000591	.0145
Industry 24	.017624	.033079	.048141	.014547	.009123	.026871	.000061	.02236	.004699	.044093
Industry 25	.019484	.052454	.031684	.019831	.047093	.025383	.000085	.019101	.000812	.017697
Industry 26	.012679	.012038	.007412	.02685	.008043	.018118	.000043	.015645	.000493	.010532
Industry 27	.003254	.004835	.002948	.025012	.004702	.004898	.000011	.002422	.000116	.002199
Industry 28	.005955	.006263	.003558	.009046	.004396	.00936	.000017	.00384	.000197	.003464
Industry 29	.082558	.019802	.006383	.020632	.006305	.039913	.000102	.012175	.000693	.015794
Industry 30	.030577	.01936	.008397	.013653	.006758	.054789	.000063	.017469	.000979	.015499

Source: Statistics Canada, Input-Output Division. Computer runs produced for this research.

Table F-1 (continued) Transposed Inverse, Industries 11-20, Canada, 1966

	Industries									
	11	12	13	14	15	16	17	18	19	20
Industry 1	.013795	.001189	.032612	.021738	.015122	.016716	.043264	.014282	.011645	.015937
Industry 2	.015934	.001504	.027705	.032615	.016298	.020431	.048733	.018218	.041617	.024511
Industry 3	.008483	.000906	.019635	.020096	.021572	.015962	.029848	.016351	.01165	.012643
Industry 4	.008943	.000966	.019312	.023166	.010178	.011762	.026699	.013421	.010177	.012925
Industry 5	.011949	.001112	.044344	.026891	.025343	.01952	.031465	.02035	.013288	.017134
Industry 6	.014606	.001247	.077366	.026162	.013992	.020582	.060797	.012443	.012816	.01505
Industry 7	.019825	.001743	.124715	.027736	.012024	.01401	.036726	.012218	.011266	.013817
Industry 8	.014248	.00122	.073845	.023152	.013213	.015261	.040292	.012322	.011232	.013817
Industry 9	.020019	.001403	.06292	.023743	.012912	.016713	.041437	.013717	.01266	.015022
Industry 10	.009702	.001305	.055578	.019687	.010255	.010928	.026103	.009867	.010313	.011753
Industry 11	1.180682	.012062	.04302	.032023	.016794	.021658	.052033	.015555	.027427	.020821
Industry 12	.161684	1.045822	.071747	.024691	.036377	.066595	.125548	.014004	.020043	.023746
Industry 13	.073939	.002[illegible]	1.242707	.029264	.019751	.01196	.044873	.012734	.018705	.01684
Industry 14	.028335	.001613	.386034	1.125079	.021246	.014087	.032906	.012802	.014112	.014983
Industry 15	.010386	.000966	.023386	.019502	1.206319	.090347	.048364	.016175	.013108	.016089
Industry 16	.011751	.000899	.021426	.01838	.049355	1.091316	.042456	.014208	.013067	.01557
Industry 17	.01419	.001635	.034993	.02049	.099195	.299878	1.188303	.022646	.01973	.030404
Industry 18	.012981	.001444	.027543	.021459	.083734	.140271	.125285	1.084064	.026369	.076772
Industry 19	.011791	.001738	.020848	.016314	.063217	.085039	.084541	.021463	1.224975	.035345
Industry 20	.01367	.006252	.042008	.020737	.170185	.089734	.088407	.028718	.016496	1.18571
Industry 21	.013087	.001107	.053781	.023377	.018212	.02264	.040075	.011153	.010469	.01644
Industry 22	.00897	.00084	.018084	.017083	.009567	.012398	.031805	.010116	.009092	.011559
Industry 23	.015038	.001601	.076317	.026964	.02394	.022335	.053406	.013623	.012419	.015135
Industry 24	.041647	.001989	.063011	.026108	.076717	.050397	.067653	.014788	.013789	.027234
Industry 25	.095701	.005413	.043201	.023399	.064248	.077186	.186843	.030861	.021033	.076277
Industry 26	.013349	.001271	.021562	.024205	.014676	.017683	.036609	.013084	.035007	.026541
Industry 27	.007436	.000502	.006108	.005938	.005818	.006733	.015979	.004643	.003062	.007001
Industry 28	.008405	.000672	.009729	.010815	.006958	.00833	.019723	.007527	.005035	.009165
Industry 29	14661	.001597	.053897	.034037	.012047	.015022	.037681	.013697	.014944	.016785
Industry 30	.014465	.002185	.047286	.067072	.016766	.020014	.049506	.020647	.021934	.026991

Table F-1 (continued)   Transposed Inverse, Industries 21-30, Canada, 1966

	Industries									
	21	22	23	24	25	26	27	28	29	30
Industry 1	.015129	.076652	.082461	.006319	.088321	.124143	.040026	.001473	.11779	.419877
Industry 2	.014706	.060353	.028097	.01464	.093726	.342079	.019805	.001818	.112427	.662251
Industry 3	.011788	.026061	.052125	.005179	.064011	.111175	.048958	.00106	.065948	.413635
Industry 4	.010119	.017461	.022197	.005453	.070916	.108765	.029078	.000814	.058178	.482543
Industry 5	.015537	.045491	.041641	.007544	.055523	.160065	.041345	.002221	.090932	.541185
Industry 6	.022757	.046916	.053914	.007053	.064416	.140386	.031237	.001853	.123511	.468658
Industry 7	.011151	.03972	.052517	.009954	.062751	.122625	.027743	.001299	.094853	.473798
Industry 8	.014455	.025256	.231582	.009442	.044291	.118231	.030528	.001648	.090431	.447531
Industry 9	.010975	.020877	.060275	.026786	.045239	.126187	.023461	.00152	.127027	.464022
Industry 10	.009187	.020007	.062436	.027585	.038945	.104217	.023197	.001256	.109234	.38233
Industry 11	.017911	.046398	.040558	.011384	.079401	.241903	.032057	.001776	.122366	.652848
Industry 12	.020199	.025774	.066935	.024839	.051033	.14114	.029676	.002122	.138079	.472566
Industry 13	.017366	.049471	.082793	.009446	.066051	.180824	.065906	.002943	.097996	.520351
Industry 14	.011859	.029688	.065667	.012466	.058988	.183228	.035148	.001737	.092321	.533393
Industry 15	.014293	.027541	.041163	.005614	.056941	.107345	.051008	.002197	.094219	.395377
Industry 16	.0247	.029361	.030224	.005069	.044939	.097184	.043215	.003005	.089171	.374616
Industry 17	.019373	.022281	.040381	.0078062	.04451	.11346	.030007	.00234	.10016	.407927
Industry 18	.012853	.019293	.03465	.009454	.041935	.113507	.022782	.001651	.106671	.405974
Industry 19	.024004	.014865	.029777	.009937	.033477	.091889	.018359	.00127	.063536	.332034
Industry 20	.019588	.0205	.054348	.013352	.044615	.122958	.026712	.001593	.100608	.411463
Industry 21	1.182585	.034321	.047434	.008329	.052693	.121992	.045642	.004824	.082192	.467602
Industry 22	.010649	1.023348	.041773	.005885	.070892	.155726	.024349	.000773	.049197	.346257
Industry 23	.029438	.053139	1.228909	.009309	.058566	.141276	.045697	.003394	.097122	.528744
Industry 24	.026482	.023921	.079935	1.038128	.050901	.136517	.026315	.001688	.106919	.513607
Industry 25	.117675	.036992	.050283	.017185	1.048298	.141659	.024902	.001895	.145266	.466222
Industry 26	.015911	.058637	.021799	.07399	.114127	1.260409	.018984	.001223	.086615	.397423
Industry 27	.008959	.013614	.006268	.002004	.076877	.034229	1.023491	.000224	.019935	.111844
Industry 28	.009906	.018937	.009474	.003068	.081757	.057919	.011949	1.000336	.034543	.223838
Industry 29	.011303	.041935	.028524	.008205	.068669	.234187	.039611	.002569	1.096926	.62583
Industry 30	.014934	.027257	.038928	.013352	.091815	.272252	.018248	.001292	.135922	1.419158

Table F-2 Transposed Inverse, Industries 1 to 10, Canada, 1972

	Industries									
	1	2	3	4	5	6	7	8	9	10
Industry 1	1.091674	.006641	.001737	.016517	.011153	.142444	.000079	.004365	.000145	.003381
Industry 2	.00349	1.115351	.001735	.01127	.002169	.008734	.000016	.003496	.000176	.006027
Industry 3	.002907	.001552	1.009665	.007612	.04462	.007508	.000015	.002594	.000121	.001937
Industry 4	.003621	.002208	.006158	1.005539	.046159	.009397	.000013	.003255	.000148	.002212
Industry 5	.003492	.002957	.003614	.011995	1.013803	.008831	.000019	.006136	.000155	.003308
Industry 6	.322353	.026019	.00204	.009323	.005184	1.219212	.000157	.008568	.000183	.004989
Industry 7	.271931	.014928	.001372	.006816	.003584	.044441	1.230802	.007326	.000174	.00771
Industry 8	.003883	.003532	.001741	.006826	.002671	.010285	.000021	1.030125	.001345	.076082
Industry 9	.010216	.006217	.001545	.004154	.001858	.031049	.000027	.069653	1.093083	.042086
Industry 10	.00405	.004411	.001202	.003679	.001082	.006749	.000028	.014368	.006147	1.330188
Industry 11	.006713	.315701	.002301	.007497	.00174	.009418	.000024	.003487	.000235	.00469
Industry 12	.003773	.027399	.007061	.004667	.001994	.008351	.000034	.027741	.003356	.068381
Industry 13	.006016	.161538	.003562	.015364	.00346	.010367	.000022	.008697	.00037	.012332
Industry 14	.003157	.029468	.001999	.005038	.001312	.007116	.000016	.004015	.000254	.006138
Industry 15	.003009	.002023	.341402	.009211	.018143	.007417	.000025	.002719	.000173	.001925
Industry 16	.003153	.002362	.089722	.01914	.008938	.007746	.000027	.002644	.00015	.001904
Industry 17	.002861	.003301	.034913	.007141	.003591	.006971	.000025	.003849	.000166	.002308
Industry 18	.002757	.002736	.018043	.004567	.002329	.006672	.00003	.011364	.000443	.00318
Industry 19	.002074	.002906	.01469	.003441	.001878	.005108	.000015	.020611	.000552	.013381
Industry 20	.002725	.003565	.031726	.004572	.002982	.006671	.000023	.013191	.00085	.004448
Industry 21	.003321	.003877	.004904	.01571	.044837	.008421	.000012	.005741	.000209	.00395
Industry 22	.002581	.001973	.003035	.334385	.01714	.008619	.000011	.002963	.00108	.001731
Industry 23	.010671	.006778	.004908	.021319	.012045	.032356	.000025	.012455	.00021	.005044
Industry 24	.003761	.007028	.012164	.005967	.002878	.009424	.000038	.022209	.002893	.032386
Industry 25	.004066	.017456	.013384	.006925	.02267	.007917	.000034	.0118	.000392	.009422
Industry 26	.002221	.001809	.001417	.01123	.001953	.005178	.000014	.006106	.000117	.002675
Industry 27	.000795	.00104	.004057	.010445	.002073	.001744	.000004	.001029	.000042	.000746
Industry 28	.001973	.001323	.000916	.00845	.001487	.00683	.000008	.001757	.000081	.001244
Industry 29	.01521	.003554	.000926	.005396	.001005	.007897	.000033	.004215	.00018	.00347
Industry 30	.012202	.004555	.002183	.004801	.001704	.032582	.00003	.008967	.00045	.005912

Source: Statistics Canada, Input-Output Division, Computer runs produced for this research.

Table F-2 (continued) . Transposed Inverse, Industries 11 to 20, Canada, 1972

	Industries									
	11	12	13	14	15	16	17	18	19	20
Industry 1	.003708	.000268	.010608	.006123	.003972	.003908	.014829	.004298	.005029	.004192
Industry 2	.003568	.000297	.005821	.008842	.003518	.004312	.012818	.005715	.016304	.006408
Industry 3	.001987	.000189	.00535	.007102	.008682	.007292	.008678	.005827	.005443	.00337
Industry 4	.00378	.000269	.006187	.009719	.005312	.003942	.01031	.005257	.003623	.004746
Industry 5	.003085	.000236	.012706	.008761	.012461	.007432	.008185	.008697	.005003	.004837
Industry 6	.00474	.000315	.045331	.01083	.004453	.006582	.031421	.003356	.005661	.004092
Industry 7	.007408	.000338	.091226	.009234	.003183	.003401	.013761	.002894	.004016	.003379
Industry 8	.00421	.000247	.031614	.007098	.004411	.003478	.012268	.002475	.004643	.003561
Industry 9	.006205	.000316	.028252	.007232	.003495	.00472	.010891	.007254	.006091	.003923
Industry 10	.002726	.000259	.022831	.006103	.002936	.003255	.008254	.002169	.004973	.002964
Industry 11	1.119037	.005649	.012911	.008307	.005491	.005513	.018041	.003801	.008476	.005003
Industry 12	.071355	1.030973	.034898	.006826	.014394	.036067	.062676	.003699	.00793	.007344
Industry 13	.055232	.001239	1.153903	.008968	.009701	.00478	.01445	.003186	.006116	.004333
Industry 14	.010865	.000359	.207045	1.070877	.005631	.002303	.006463	.002934	.003664	.002895
Industry 15	.003035	.000237	.006866	.006333	1.127856	.065386	.019344	.006015	.007587	.006798
Industry 16	.0044	.000254	.006255	.006707	.037406	1.074415	.024352	.007183	.009392	.007466
Industry 17	.005427	.000291	.011572	.005828	.070016	.189708	1.097741	.008015	.009649	.011452
Industry 18	.004525	.000422	.009397	.006735	.04037	.074124	.062828	1.05004	.014556	.032141
Industry 19	.006295	.001583	.007209	.004571	.037012	.048339	.042142	.012086	1.084226	.018318
Industry 20	.004333	.003593	.016387	.006019	.092469	.054704	.035949	.012184	.008155	1.102462
Industry 21	.006118	.000269	.029469	.007573	.00587	.007736	.017864	.003536	.00457	.00604
Industry 22	.003286	.000212	.006045	.006215	.003995	.004047	.013972	.003057	.00328	.003917
Industry 23	.004497	.000294	.03709	.011732	.013381	.007534	.024202	.003597	.005091	.004471
Industry 24	.01539	.000401	.034302	.009654	.039649	.02915	.024536	.00372	.005388	.010132
Industry 25	.052871	.002007	.015	.00606	.03203	.029651	.034769	.011576	.009567	.037412
Industry 26	.002633	.000273	.004589	.006927	.003122	.003408	.007548	.002679	.014628	.009051
Industry 27	.002586	.000123	.001753	.002468	.003794	.001781	.005182	.001174	.001145	.002272
Industry 28	.002602	.000174	.003191	.004973	.002022	.001896	.005934	.001891	.001918	.00292
Industry 29	.003331	.000245	.018053	.007522	.001954	.002181	.00698	.002154	.003171	.002759
Industry 30	.004379	.000569	.01762	.035079	.005042	.005194	.016626	.008652	.007937	.010104

Table F-2 (continued) Transposed Inverse, Industries 21 to 30, Canada, 1972

	Industries									
	21	22	23	24	25	26	27	28	29	30
Industry 1	.005074	.045337	.032697	.002037	.035981	.045222	.020711	.001002	.054791	.178993
Industry 2	.002961	.031574	.007408	.005788	.029240	.171139	.005876	.000895	.03907	.281445
Industry 3	.005051	.014948	.023303	.001937	.024091	.0487	.03165	.001233	.028139	.234932
Industry 4	.004493	.009012	.009621	.002405	.056701	.053842	.018125	.00076	.026845	.328238
Industry 5	.007811	.027444	.019786	.002641	.020214	.074482	.023926	.001806	.038025	.278203
Industry 6	.017079	.021416	.021638	.002686	.022176	.054765	.014969	.001592	.056466	.217181
Industry 7	.003004	.01631	.019764	.002149	.022833	.043531	.01238	.000943	.037604	.219511
Industry 8	.005616	.011406	.140145	.005201	.015074	.039778	.016072	.001592	.036555	.188699
Industry 9	.003512	.006986	.029401	.019882	.013199	.039674	.009679	.000874	.045275	.183593
Industry 10	.001991	.00687	.028986	.019811	.010395	.031611	.01	.000921	.045313	.140232
Industry 11	.008146	.016767	.013596	.004181	.02314	.084087	.016481	.001355	.045712	.270319
Industry 12	.007872	.007561	.027868	.013334	.013483	.04026	.011621	.001149	.057501	.173011
Industry 13	.006014	.027815	.044101	.003563	.021622	.065856	.037943	.003226	.040553	.239675
Industry 14	.002328	.009502	.02567	.004204	.014688	.058668	.01294	.001109	.029837	.198625
Industry 15	.007346	.013234	.018089	.002092	.021591	.044173	.032158	.002087	.043094	.204314
Industry 16	.015136	.012307	.014015	.002183	.021692	.043996	.028611	.003844	.045972	.217982
Industry 17	.010436	.007583	.018082	.002775	.014778	.040481	.014697	.001933	.043428	.18138
Industry 18	.004506	.005733	.013125	.004423	.012298	.037904	.009954	.001217	.04409	.169778
Industry 19	.010408	.00475	.012612	.005281	.009936	.032855	.008224	.000951	.027151	.145042
Industry 20	.008134	.006419	.024924	.005444	.012509	.043239	.011576	.00117	.040025	.169458
Industry 21	1.116711	.021856	.025095	.003341	.018818	.051765	.025799	.005497	.032184	.232286
Industry 22	.004361	1.021213	.035917	.003203	.049136	.097918	.015426	.001383	.022011	.199956
Industry 23	.0125799	.034645	1.14038	.004237	.024116	.062386	.02851	.004309	.043751	.273436
Industry 24	.010141	.010957	.041972	1.034895	.015236	.046422	.012061	.001203	.04135	.212761
Industry 25	.063945	.015329	.01901	.008379	1.012975	.04853	.00847	.001054	.064045	.187306
Industry 26	.003232	.027218	.005479	.002706	.036965	1.136906	.007826	.000684	.030745	.155
Industry 27	.003109	.012609	.002141	.000753	.046956	.021689	1.012834	.000197	.008253	.062724
Industry 28	.00304	.0127144	.003241	.001317	.043166	.037993	.008728	1.000285	.020867	.16677
Industry 29	.001774	.011784	.00537	.001926	.016287	.074952	.017498	.001649	1.025665	.197699
Industry 30	.004655	.010622	.014993	.006893	.043993	.162594	.008141	.00914	.069175	1.202649

Table F-3 Transposed Inverse, Industries 1 to 10, Canada, 1976

	Industries									
	1	2	3	4	5	6	7	8	9	10
Industry 1	1.090499	.007879	.002011	.014853	.010427	.143182	.000027	.005117	.000162	.002936
Industry 2	.003736	1.127524	.0021	.012447	.002394	.009656	.000009	.003289	.000209	.005545
Industry 3	.003551	.001657	1.015444	.010686	.047054	.009384	.000009	.002687	.000156	.00192
Industry 4	.004349	.002844	.010712	1.006913	.055551	.011544	.000009	.003507	.000198	.002362
Industry 5	.003344	.002484	.005724	.013385	1.017065	.008584	.00001	.004547	.000154	.001917
Industry 6	.320342	.024407	.00224	.008766	.0048977	1.225269	.000046	.008432	.000226	.003747
Industry 7	.251237	.014243	.001406	.006315	.003151	.044223	1.23523	.007928	.000183	.008053
Industry 8	.003758	.004797	.00277	.007246	.002495	.009838	.00001	1.030526	.001637	.053002
Industry 9	.009249	.004982	.001678	.003739	.001645	.028436	.000013	.071987	1.087543	.028831
Industry 10	.004234	.003052	.001198	.003485	.000935	.006369	.000013	.012606	.007641	1.287887
Industry 11	.007564	.311629	.003117	.007681	.001834	.009573	.000013	.006008	.000238	.004164
Industry 12	.003748	.023832	.003231	.004821	.001744	.007894	.000017	.028542	.004058	.06431
Industry 13	.006326	.148469	.00353	.017044	.003591	.011963	.000011	.008784	.00032	.011081
Industry 14	.003074	.024217	.001672	.005131	.001217	.007179	.000008	.003595	.00021	.003695
Industry 15	.003374	.001915	.365805	.011106	.019916	.00837	.000013	.002486	.000168	.001816
Industry 16	.003337	.001912	.087829	.020975	.00901	.008218	.000013	.00239	.000169	.001694
Industry 17	.002957	.003265	.038541	.007505	.003798	.007202	.000012	.004465	.000183	.002424
Industry 18	.002732	.002244	.018872	.00467	.002309	.006467	.000014	.010356	.00023	.002344
Industry 19	.001802	.002158	.011798	.003138	.001579	.004496	.000006	.019629	.00052	.009637
Industry 20	.002597	.003142	.033747	.004632	.002956	.006254	.000011	.010555	.000934	.003198
Industry 21	.00315	.005146	.004426	.015633	.047763	.008216	.000008	.006569	.000237	.003515
Industry 22	.003001	.002124	.004799	.354928	.021453	.007932	.000007	.003049	.000135	.001717
Industry 23	.009021	.005459	.006675	.02291	.011517	.0273	.000011	.01244	.000195	.004413
Industry 24	.004028	.006545	.016419	.004972	.002602	.008559	.000062	.020583	.004106	.019449
Industry 25	.003986	.017314	.012163	.006852	.023106	.007783	.000016	.010713	.000438	.009052
Industry 26	.001996	.001442	.001468	.011969	.001947	.004726	.000008	.005099	.000114	.001959
Industry 27	.000811	.000895	.002522	.016969	.001966	.002052	.000002	.000854	.000044	.000622
Industry 28	.001611	.001051	.000753	.003976	.001303	.00406	.000003	.001257	.00007	.00087
Industry 29	.017581	.002785	.000844	.005628	.000991	.007915	.000024	.00361	.000185	.002454
Industry 30	.011642	.003675	.001887	.004941	.001789	.032511	.000014	.006977	.000427	.004373

Source: Statistics Canada. Computer runs produced for this research.

Table F-3 Transposed Inverse, Industries 11 to 20, Canada, 1976

	Industries 11	12	13	14	15	16	17	18	19	20
Industry 1	.007564	.311629	.003117	.007681	.001834	.009573	.000013	.006008	.000238	.004164
Industry 2	.003748	.023832	.008231	.004821	.001744	.007894	.000017	.018542	.004038	.08431
Industry 3	.006326	.148469	.00353	.017044	.003591	.011963	.000011	.008784	.00032	.011081
Industry 4	.003074	.024217	.001672	.005131	.001217	.007179	.000008	.003595	.00021	.003695
Industry 5	.003374	.001915	.365805	.011106	.019916	.00837	.000013	.002486	.000168	.001816
Industry 6	.003337	.001912	.087829	.020975	.00901	.008218	.000013	.00239	.000169	.001694
Industry 7	.002957	.003265	.038541	.007505	.003798	.007202	.000012	.004465	.000183	.002424
Industry 8	.002732	.002244	.018872	.00467	.002309	.006467	.000014	.010356	.00023	.002344
Industry 9	.001802	.002158	.011798	.003138	.001579	.004496	.000006	.019629	.00052	.009637
Industry 10	.002597	.003142	.033747	.004632	.002956	.006254	.000011	.010555	.000934	.003198
Industry 11	1.12526	.006164	.012466	.007774	.007242	.005776	.022195	.003891	.007686	.005959
Industry 12	.069033	1.030664	.036009	.006849	.016829	.036871	.070336	.004195	.007358	.011119
Industry 13	.074609	.001409	1.139469	.008867	.008642	.004191	.013322	.003089	.005209	.003808
Industry 14	.012895	.00032	.182595	1.065208	.004125	.001828	.005358	.002328	.003029	.002426
Industry 15	.003269	.000179	.006537	.006845	1.139415	.056081	.022618	.006517	.006742	.006286
Industry 16	.003543	.000183	.005818	.006669	.040734	1.051011	.029328	.007338	.008977	.007135
Industry 17	.00536	.00033	.013758	.00614	.079497	.17584	1.10231	.008479	.008526	.008167
Industry 18	.00428	.000318	.007587	.005115	.041854	.075012	.057217	1.04737	.017033	.022525
Industry 19	.004945	.001154	.005765	.003841	.027827	.039279	.036815	.010933	1.076612	.01537
Industry 20	.004582	.002323	.014944	.005301	.096574	.039293	.034043	.015152	.006437	1.103694
Industry 21	.008382	.016559	.015643	.003957	.024752	.080624	.018229	.001523	.04774	.267645
Industry 22	.007505	.007463	.02625	.008029	.013521	.040557	.012746	.001341	.061661	.176378
Industry 23	.006483	.030936	.032511	.00338	.024854	.067419	.040957	.004176	.040903	.253431
Industry 24	.002206	.009535	.026697	.006299	.014045	.057909	.012688	.001225	.029897	.195773
Industry 25	.007714	.01739	.018248	.002225	.025861	.051229	.033928	.002626	.046692	.237724
Industry 26	.016387	.012009	.013716	.002094	.024051	.048134	.032676	.005437	.048374	.23162
Industry 27	.011191	.008017	.017219	.003915	.015466	.041952	.015889	.002204	.043309	.189794
Industry 28	.0049	.005548	.010367	.003368	.013439	.036608	.010268	.001284	.04629	.162171
Industry 29	.00855	.004234	.010695	.004247	.008896	.029758	.007581	.000919	.022051	.131819
Industry 30	.009319	.006663	.021144	.004995	.0128	.044914	.012126	.0013	.039271	.160884

Table F-3 (continued) Transposed Inverse, Industries 21-30, Canada, 1966

	Industries									
	21	22	23	24	25	26	27	28	29	30
Industry 1	.005156	.038451	.040253	.001803	.036409	.046069	.022515	.001127	.051809	.17934
Industry 2	.003588	.0332	.007669	.005308	.038301	.171039	.006149	.00109	.036763	.327748
Industry 3	.005807	.021484	.026957	.002264	.031399	.062382	.035649	.001502	.033044	.300773
Industry 4	.007188	.011901	.013442	.002801	.096743	.068004	.026636	.001178	.033006	.398663
Industry 5	.0096	.028477	.019592	.002428	.021696	.073668	.024247	.002333	.036484	.270982
Industry 6	.015833	.018702	.022705	.00237	.022515	.054556	.016008	.001795	.034296	.216623
Industry 7	.002822	.013961	.020051	.001916	.020637	.042249	.012957	.001105	.03461	.214632
Industry 8	.00488	.011321	.151274	.004625	.013821	.040281	.016893	.002141	.03515	.188355
Industry 9	.0037	.006194	.033498	.017529	.012895	.038746	.009659	.001179	.043661	.179482
Industry 10	.001647	.006103	.024962	.01598	.00938	.029426	.009741	.000982	.042705	.129581
Industry 11	.008382	.016559	.015643	.003957	.024752	.080624	.018229	.001523	.04774	.267645
Industry 12	.007505	.007463	.02625	.008029	.013521	.040557	.012746	.001341	.061661	.176378
Industry 13	.006483	.030936	.052511	.00338	.024854	.067419	.040957	.004176	.040903	.253431
Industry 14	.002206	.009535	.026697	.006299	.014045	.057909	.012688	.001225	.029897	.195773
Industry 15	.007714	.01739	.018248	.002225	.025861	.051229	.033928	.002626	.046692	.237724
Industry 16	.016387	.012009	.013716	.002094	.024051	.048134	.032676	.005437	.048374	.23162
Industry 17	.011191	.008017	.017219	.003915	.015466	.041952	.015889	.002204	.043309	.189794
Industry 18	.0049	.005548	.010367	.003368	.013439	.036608	.010268	.001284	.04629	.162171
Industry 19	.00855	.004234	.010695	.004247	.008896	.029758	.007581	.000919	.022051	.131819
Industry 20	.009319	.006663	.021144	.004995	.0128	.044914	.012126	.0013	.039271	.160884
Industry 21	1.125243	.021624	.02492	.00309	.019515	.054111	.027565	.006005	.031053	.235832
Industry 22	.00535	1.02431	.036125	.002562	.063184	.12022	.020548	.002545	.025007	.249572
Industry 23	.01124	.035832	1.151232	.003343	.022451	.065233	.026213	.006305	.039124	.266038
Industry 24	.006789	.008159	.039168	1.049704	.013857	.044651	.010588	.001194	.037743	.205842
Industry 25	.063165	.01449	.01957	.007622	1.012672	.047743	.008577	.001173	.062369	.185747
Industry 26	.003438	.028078	.004749	.0024	.036716	1.124956	.007621	.000871	.025299	.146028
Industry 27	.002719	.018533	.002156	.000653	.041294	.023154	1.007034	.000312	.008021	.067265
Industry 28	.002713	.010616	.002529	.000985	.039821	.035594	.008687	1.000286	.016066	.141451
Industry 29	.001658	.011798	.004808	.001547	.016027	.072969	.016513	.001568	1.021068	.1925
Industry 30	.00436	.010138	.012275	.005885	.044418	.154559	.008287	.000943	.059418	1.20417

Table F-4 Transposed Inverse, Industries 1 to 10, Atlantic Region, 1974

	Industries									
	1	2	3	4	5	6	7	8	9	10
Industry 1	1.037032	.030317	.000064	.000962	.003332	.181054	0	.00018	.000003	.000455
Industry 2	.001146	1.116377	.000159	.000425	.002224	.003009	0	.000153	.000006	.000464
Industry 3	.001694	.002235	1.000404	.001081	.171135	.004697	0	.000233	.000009	.000696
Industry 4	.002013	.005039	.000203	1.001931	.001243	.005585	0	.000247	.000011	.000115
Industry 5	.001049	.003879	.000236	.000715	1.013178	.002692	0	.000141	.000005	.003591
Industry 6	.134424	.13383	.000068	.00054	.001796	1.083704	0	.000468	.000004	.000759
Industry 7	0	0	0	0	0	0	1	0	0	0
Industry 8	.000889	.001072	.000006	.000785	.000578	.002168	0	1.001463	.000015	.002456
Industry 9	.000559	.001924	.000077	.000277	.000303	.001487	0	.001685	1.001943	.007353
Industry 10	.001711	.002415	.0000541	.000394	.000256	.002454	0	.003979	.000045	1.026309
Industry 11	.010384	.294911	.000113	.000776	.001067	.004286	0	.00043	.000005	.00026
Industry 12	.002159	.042775	.000126	.000432	.000505	.001955	0	.000524	.000004	.009337
Industry 13	.003416	.20722	.000145	.001257	.001812	.003054	0	.000199	.000008	.000237
Industry 14	.000845	.017017	.000048	.00036	.000406	.001758	0	.000099	.000034	.000111
Industry 15	.000882	.000952	.119271	.012955	.024016	.001891	0	.000112	.000004	.00018
Industry 16	.001255	.00162	.000168	.151345	.008288	.003133	0	.000152	.000006	.000103
Industry 17	.000562	.001616	.000118	.004328	.001512	.001262	0	.000124	.000002	.000042
Industry 18	.000855	.001554	.00402	.004174	.000701	.00187	0	.000598	.000003	.000377
Industry 19	.000817	.006739	.000108	.002013	.00048	.001446	0	.000441	.000003	.000349
Industry 20	.000601	.001474	.000522	.002323	.000623	.001419	0	.000948	.000003	.001303
Industry 21	.001289	.003663	.000175	.005181	.062732	.003107	0	.000262	.000006	.000314
Industry 22	.000203	.000343	.000029	.000192	.000615	.000516	0	.000078	.000001	.00002
Industry 23	.001211	.002412	.000316	.008178	.02373	.003267	0	.000724	.000006	.000156
Industry 24	.00112	.005747	.000083	.000796	.000505	.002771	0	.000627	.000108	.000501
Industry 25	.001345	.009126	.000114	.00186	.029948	.001691	0	.001186	.000006	.000353
Industry 26	.000955	.001785	.000103	.000727	.001896	.002029	0	.000136	.000004	.000229
Industry 27	.00051	.000722	.000027	.028449	.001387	.000845	0	.000094	.000002	.000043
Industry 28	.001961	.001198	.000079	.000656	.000783	.003895	0	.000196	.000008	.000122
Industry 29	.012451	.002606	.000072	.000936	.000484	.004417	0	.000571	.000008	.000849
Industry 30	.005513	.004201	.000083	.000533	.001637	.017113	0	.00069	.000034	.000208

Source: Statistics Canada, Input-Output Division. Computer runs produced for this research.

Table F-4 (continued) Transposed Inverse, Industries 11 to 20, Atlatic Region, 1974

	Industries									
	11	12	13	14	15	16	17	18	19	20
Industry 1	.001636	.000019	.003597	.001418	.000022	.000514	.002785	.000271	.001403	.000222
Industry 2	.007416	.000065	.000942	.00247	.000053	.000653	.00264	.000607	.03091	.000595
Industry 3	.002102	.000037	.002976	.004203	.002094	.000693	.003061	.000658	.002748	.000448
Industry 4	.011623	.000062	.002084	.004949	.000037	.00071	.002208	.001029	.004948	.000446
Industry 5	.00461	.000032	.010035	.002396	.001189	.000389	.001614	.000475	.001885	.000231
Industry 6	.002445	.000029	.015678	.002334	.000022	.00045	.009056	.000169	.004249	.000216
Industry 7	0	0	0	0	0	0	0	0	0	0
Industry 8	.00055	.000015	.0027	.001899	.00001	.000198	.000823	.000088	.000556	.000173
Industry 9	.001361	.000046	.004425	.001249	.000013	.000103	.000587	.000682	.001126	.000132
Industry 10	.000557	.000012	.006917	.001069	.000006	.000083	.000361	.000052	.000429	.000094
Industry 11	1.100314	.001694	.0002258	.002334	.000104	.000359	.002572	.000239	.008746	.000313
Industry 12	.107625	1.003226	.010902	.00193	.000664	.000503	.002123	.000152	.001659	.000149
Industry 13	.045838	.000275	1.031256	.002248	.000025	.000415	.00183	.000187	.006204	.000261
Industry 14	.003969	.000032	.082692	1.032979	.000009	.000128	.000888	.000163	.001093	.000145
Industry 15	.001147	.000021	.001133	.001677	1.001617	.041625	.024915	.001522	.006334	.001903
Industry 16	.002514	.000028	.001201	.002794	.000521	1.001392	.014206	.001048	.004353	.001087
Industry 17	.003582	.000019	.001179	.001118	.000663	.026316	1.047237	.000485	.001942	.000628
Industry 18	.002665	.000025	.002144	.001475	.002766	.023043	.068879	1.002995	.010297	.002845
Industry 19	.020604	.000715	.000767	.001241	.000385	.011487	.022836	.001919	1.011382	.005987
Industry 20	.002044	.000785	.003016	.001339	.003942	.007449	.017958	.000558	.002347	1.015484
Industry 21	.003051	.00003	.010559	.002747	.000091	.002712	.002267	.000317	.001248	.000255
Industry 22	.000556	.000008	.000175	.000467	.000009	.000152	.000501	.000035	.00044	.000124
Industry 23	.001828	.000026	.005328	.002714	.000076	.007603	.003161	.000143	.001355	.000278
Industry 24	.012791	.000056	.00733	.002185	.000184	.001691	.011692	.000174	.001461	.000352
Industry 25	.028215	.000244	.00212	.001374	.000382	.00675	.022152	.000453	.0001831	.00443
Industry 26	.001763	.000041	.000778	.002169	.000052	.000793	.00239	.000211	.013863	.00122
Industry 27	.001617	.000016	.000405	.000847	.00002	.000495	.001159	.000072	.000414	.000243
Industry 28	.000891	.000027	.001287	.003448	.000019	.00023	.00115	.000146	.000957	.000305
Industry 29	.001257	.000048	.00739[illegible]	.002416	.000055	.00021	.002328	.000112	.00114	.00022
Industry 30	.00203	.00009	.00336[illegible]	.015636	.00005	.000578	.003379	.000607	.003141	.001059

Table F-4 (continued) Transposed Inverse, Industries 21-30, Atlantic Region, 1974

	Industries									
	21	22	23	24	25	26	27	28	29	30
Industry 1	.003785	.035196	.029798	.000269	.029284	.01676	.015066	.000137	.034443	.093543
Industry 2	.001122	.041606	.000841	.002851	.020841	.056231	.00269	.000067	.024407	.173686
Industry 3	.002362	.043577	.009584	.000426	.040717	.03412	.02748	.000148	.030017	.302172
Industry 4	.001436	.0016559	.005872	.000409	.028685	.038988	.050686	.000461	.030352	.356635
Industry 5	.001094	.026692	.007032	.000253	.016563	.021729	.018229	.000079	.020377	.170469
Industry 6	.006705	.020042	.004781	.000771	.014199	.020897	.010377	.000193	.02495	.123105
Industry 7	0	0	0	0	0	0	0	0	0	0
Industry 8	.000592	.016807	.008817	.000217	.011277	.015247	.023603	.000061	.02357	.136246
Industry 9	.000366	.0004329	.00071	.000315	.006306	.014596	.006116	.000029	.010493	.088648
Industry 10	.000327	.009511	.000859	.000611	.006394	.01098	.012092	.000061	.017813	.073625
Industry 11	.001142	.027502	.003371	.000958	.016615	.028331	.01536	.000099	.029854	.166459
Industry 12	.00059	.009541	.004828	.000378	.009046	.015325	.009151	.000081	.037789	.10719
Industry 13	.001137	.052831	.015113	.000699	.016486	.023042	.036553	.000425	.020601	.148549
Industry 14	.000438	.00893	.001672	.000286	.008281	.027983	.008925	.000086	.013237	.109711
Industry 15	.001469	.039372	.002452	.000167	.017249	.015943	.032576	.000136	.029714	.119909
Industry 16	.002114	.054241	.001709	.000256	.020091	.020656	.018278	.000134	.030727	.20107
Industry 17	.000607	.007454	.001382	.000126	.007148	.012316	.006089	.000069	.015352	.08003
Industry 18	.000555	.008918	.000933	.00014	.008593	.01622	.008779	.000403	.029571	.105365
Industry 19	.000473	.007344	.002239	.00179	.008408	.014866	.005914	.000075	.02165	.088648
Industry 20	.00049	.005813	.006062	.000309	.007435	.018789	.006434	.000105	.015695	.089169
Industry 21	1.126595	.057838	.003314	.000801	.016965	.022625	.023926	.000119	.029196	.195939
Industry 22	.000964	1.007092	.001603	.000406	.018227	.022624	.004271	.00003	.004038	.032694
Industry 23	.003115	.071707	1.061162	.000643	.021885	.025484	.091015	.000573	.027118	.18772
Industry 24	.000645	.010435	.004305	1.046492	.010125	.022868	.011036	.000198	.026762	.138785
Industry 25	.055601	.015029	.002953	.00067	1.006339	.015905	.003705	.00005	.032984	.097192
Industry 26	.002232	.054476	.00057	.00049	.046555	1.094994	.003809	.000098	.024545	.114513
Industry 27	.002079	.123664	.000553	.000122	.04523	.010003	1.003062	.000037	.022126	.052035
Industry 28	.001145	.047349	.0006	.000266	.023429	.031435	.018002	1.000221	.073725	.246701
Industry 29	.000644	.013829	.000794	.00022	.012206	.039303	.011832	.000536	1.015082	.145602
Industry 30	.002418	.01016	.002092	.001059	.047962	.072179	.005252	.000298	.053728	1.132953

Table F-5 Transposed Inverse, Industries 1 to 10, Quebec Region, 1974

	Industries									
	1	2	3	4	5	6	7	8	9	10
Industry 1	1.118094	.008805	.000556	.000001	.001778	.437146	.000006	.001991	.000066	.001942
Industry 2	.002186	1.031429	.000918	0	.000576	.006823	.000003	.001166	.000109	.00346
Industry 3	.001695	.000774	1.042916	0	.023971	.005194	.000003	.000849	.000072	.001238
Industry 4	.000015	.000005	.000001	1	.000001	.000053	0	.000006	.000001	.000008
Industry 5	.002065	.00188	.011254	0	1.006117	.006358	.000003	.001106	.0001	.009047
Industry 6	.241087	.006955	.0004	.000001	.000908	1.246604	.000006	.003708	.000083	.00251
Industry 7	.001748	.008637	.000286	0	.0002	.005809	1.02329	.003691	.000074	.003679
Industry 8	.001507	.004262	.00564	0	.000508	.004417	.000002	1.028458	.000799	.034905
Industry 9	.001374	.003102	.000605	0	.000239	.003728	.000004	.040367	1.039485	.019788
Industry 10	.001177	.003386	.000343	0	.000305	.002989	.000003	.004341	.002327	1.252732
Industry 11	.008988	.194576	.001057	0	.00048	.0075	.000002	.002507	.000175	.002712
Industry 12	.002113	.017898	.00144	0	.000584	.004083	.000002	.015005	.00245	.037019
Industry 13	.004392	.139571	.00086	0	.001056	.006422	.000002	.004406	.000291	.00782
Industry 14	.001944	.025737	.000679	0	.000317	.004618	.000002	.001654	.000204	.00362
Industry 15	.001211	.000866	.154527	.000001	.00464	.00325	.000003	.000611	.000062	.0007
Industry 16	.002353	.001996	.020245	.000007	.005351	.004711	.000003	.000889	.000071	.001091
Industry 17	.001123	.001999	.006673	.000001	.000784	.0029	.000001	.001763	.000058	.00121
Industry 18	.001183	.001176	.004996	.000001	.000621	.002995	.000004	.002364	.000357	.001238
Industry 19	.001242	.002879	.00249	0	.000399	.003138	.000002	.010169	.000347	.018234
Industry 20	.001107	.001826	.0076	0	.000547	.003049	.000002	.006312	.000691	.001277
Industry 21	.001976	.003838	.002673	.000004	.049095	.005671	.000005	.002479	.000193	.002467
Industry 22	.00042	.000344	.000253	0	.001569	.001256	.000001	.000732	.000023	.000356
Industry 23	.003571	.003458	.003592	.000001	.001368	.011545	.000002	.00499	.000094	.002826
Industry 24	.001757	.006081	.017031	.000001	.002398	.004646	.000146	.022647	.00461	.028589
Industry 25	.001841	.007536	.006379	0	.009056	.003624	.000002	.006189	.000222	.004209
Industry 26	.001541	.000829	.00058	0	.000686	.003721	.000006	.001774	.000066	.001822
Industry 27	.00058	.000837	.000696	0	.000047	.00169	.000001	.000725	.000037	.0006
Industry 28	.002129	.000787	.000375	.000001	.000339	.006073	.000003	.000881	.000088	.001107
Industry 29	.012343	.002374	.000302	.000001	.000205	.008911	.000013	.001829	.000124	.002567
Industry 30	.009515	.002707	.000811	.000001	.000489	.029029	.00001	.00339	.000363	.004282

Source: Statistics Canada, Input-Output Division. Computer runs produced for this research.

Table F-5 Transposed Inverse, Industries 11 to 20, Quebec Region, 1974

	Industries									
	11	12	13	14	15	16	17	18	19	20
Industry 1	.002993	.00016	.013766	.005624	.001749	.000859	.011696	.001247	.000699	.001245
Industry 2	.001964	.000297	.004233	.008333	.001974	.000796	.007939	.002633	.00545	.00234
Industry 3	.001356	.00016	.00362	.006242	.007567	.0021	.004606	.003535	.001322	.001193
Industry 4	.000005	.000001	.000026	.000065	.000005	.000002	.000017	.000008	.000004	.000007
Industry 5	.00198	.000176	.011673	.007771	.002739	.000875	.003188	.002701	.000911	.001221
Industry 6	.002526	.0000158	.031614	.008783	.001533	.000985	.015058	.00089	.000561	.000836
Industry 7	.003213	.000215	.067739	.0084	.001034	.000482	.006816	.000742	.000444	.000708
Industry 8	.002467	.000134	.031554	.005263	.001979	.000629	.007694	.000886	.000749	.000865
Industry 9	.004011	.000167	.01914	.00519	.001467	.001544	.003281	.002966	.000664	.000712
Industry 10	.001268	.000096	.014475	.004567	.000959	.000261	.001917	.000531	.000353	.000507
Industry 11	1.110309	.007113	.009589	.005565	.005648	.002795	.015652	.00136	.001528	.001408
Industry 12	.077364	1.022074	.029034	.005034	.003079	.010903	.026737	.001329	.000686	.005122
Industry 13	.036176	.001443	1.128749	.00645	.004418	.000663	.007168	.001155	.001112	.001072
Industry 14	.007128	.000342	.206877	1.073698	.003761	.000325	.002985	.00119	.000689	.000788
Industry 15	.002152	.00012	.003605	.003847	1.121972	.007728	.006139	.005209	.001136	.003747
Industry 16	.007193	.000176	.005481	.005442	.046038	1.05743	.018496	.004321	.007047	.00523
Industry 17	.005649	.000174	.003074	.003443	.042077	.059369	1.056018	.003909	.0024	.003835
Industry 18	.003381	.000283	.004485	.003943	.03231	.031419	.031232	1.022921	.003851	.010125
Industry 19	.013087	.002578	.004361	.003728	.016119	.011235	.046945	.007878	1.030741	.011209
Industry 20	.002922	.001159	.010639	.00391	.052122	.01358	.018649	.004858	.001269	1.0433
Industry 21	.004517	.000194	.02403	.005596	.002748	.003758	.012064	.001536	.000937	.001604
Industry 22	.000803	.000059	.00145	.001473	.000602	.000248	.002731	.000314	.000416	.000567
Industry 23	.002029	.000177	.025111	.003943	.00897	.000839	.010667	.001101	.000681	.001096
Industry 24	.014209	.00035	.029322	.007416	.003626	.008797	.012212	.001816	.00104	.002928
Industry 25	.036434	.001803	.00841	.003989	.011053	.006445	.061379	.004281	.001333	.0182
Industry 26	.001803	.000217	.002707	.004716	.001554	.000798	.004529	.001019	.010384	.004096
Industry 27	.003416	.000186	.001686	.002879	.001526	.000632	.005955	.000634	.000294	.001841
Industry 28	.001414	.000161	.003615	.0073	.001179	.000352	.00326	.00106	.000697	.001232
Industry 29	.002509	.000179	.014947	.006801	.001052	.000481	.004133	.000943	.000896	.000935
Industry 30	.002945	.000486	.014462	.035748	.003012	.000978	.009323	.004513	.002065	.00397

Table F-5 (continued) Transposed Inverse, Industries 21-30, Quebec Region, 1974

	Industries									
	21	22	23	24	25	26	27	28	29	30
Industry 1	.005897	.030046	.026052	.000366	.036968	.024364	.015763	.001223	.061376	.133193
Industry 2	.001958	.032288	.003228	.003197	.028428	.105824	.003905	.00081	.031322	.267748
Industry 3	.002892	.033315	.01456	.001065	.02574	.027295	.02671	.000693	.027427	.203598
Industry 4	.000005	.000017	.000012	.000008	.000067	.000158	.000011	.000002	.00011	.002154
Industry 5	.001648	.027984	.017545	.00141	.017523	.034589	.019877	.00696	.030995	.250051
Industry 6	.008936	.013375	.01068	.000976	.015116	.022855	.008412	.001539	.044579	.152139
Industry 7	.000919	.0044	.008656	.000934	.011274	.017237	.004791	.000668	.012475	.156958
Industry 8	.0031	.00988	.076534	.003002	.008615	.0198374	.010149	.001266	.026123	.136832
Industry 9	.001121	.003876	.008105	.018418	.007403	.019734	.005098	.000455	.028834	.128579
Industry 10	.00061	.005231	.005303	.010314	.006699	.016386	.006332	.000774	.031138	.10651
Industry 11	.005212	.014042	.004674	.001741	.015638	.036377	.010917	.000887	.0043783	.178908
Industry 12	.00396	.005974	.01435	.005628	.008619	.019576	.007429	.000855	.050932	.121604
Industry 13	.003672	.030357	.015987	.001466	.01625	.031459	.026457	.000711	.027976	.174944
Industry 14	.001243	.009049	.012019	.001529	.010476	.036546	.008573	.000697	.02523	.161763
Industry 15	.002553	.012572	.00535	.000807	.015937	.017462	.019192	.001058	.031527	.124641
Industry 16	.006363	.009548	.004235	.000862	.018283	.025432	.03213	.007753	.104931	.172366
Industry 17	.003949	.005271	.007053	.00089	.008008	.017046	.007391	.001293	.029282	.109427
Industry 18	.001367	.004159	.002977	.001724	.007695	.018557	.006145	.001031	.0035112	.112745
Industry 19	.003487	.004934	.004817	.00292	.007795	.020486	.005498	.000925	.031035	.119774
Industry 20	.003503	.004108	.010514	.02144	.00778	.021513	.005258	.000786	.024546	.115026
Industry 21	1.08597	.036952	.012743	.001964	.01511	.028332	.019759	.005069	.034332	.205434
Industry 22	.002088	1.01483	.008081	.001075	.018663	.033225	.004622	.00072	.006478	.046755
Industry 23	.009854	.03976	1.090988	.00178	.013910	.030503	.01517	.002665	.031704	.204808
Industry 24	.003372	.009317	.02951	1.018082	.009629	.074881	.008232	.000918	.035117	.165532
Industry 25	.049157	.015721	.008929	.004198	1.006821	.022574	.004029	.000666	.048788	.126526
Industry 26	.002221	.030731	.001954	.001358	.038246	1.100762	.004264	.000853	.029339	.135709
Industry 27	.004529	.005549	.001177	.000584	.091806	.013164	1.015063	.000134	.008525	.063406
Industry 28	.001556	.035418	.002255	.000994	.027221	.039734	.013211	1.000974	.044539	.239011
Industry 29	.000916	.012286	.002629	.001001	.011665	.048142	.011043	.001799	1.019543	.177207
Industry 30	.002505	.009525	.006717	.004256	.036726	.086903	.005911	.001374	.060608	1.188153

Table F-6

Transposed Inverse, Industries 1 to 10, Ontario Region, 1974

	Industries									
	1	2	3	4	5	6	7	8	9	10
Industry 1	1.092995	.000941	.000693	.00002	.001561	.137795	.000065	.00207	.000046	.000752
Industry 2	.002799	1.059325	.00146	.00001	.000936	.006731	.000003	.002073	.00009	.002139
Industry 3	.001592	.00038	1.01089	.000036	.016711	.003904	.000002	.00115	.000046	.000587
Industry 4	.0013	.000356	.002134	1.0000[illegible]	.021007	.00336	.000002	.000954	.00004	.000396
Industry 5	.001979	.000992	.002541	.0000[illegible]	1.019856	.00457	.000002	.001478	.000053	.000657
Industry 6	.239782	.003202	.001095	.000032	.001373	1.181243	.00011	.005728	.000102	.001049
Industry 7	.5174	.004667	.000711	.000019	.000943	.068852	1.137671	.005068	.000073	.002286
Industry 8	.002373	.002062	.00119	.000035	.000689	.006339	.000002	1.020667	.00166	.030561
Industry 9	.006007	.001756	.001278	.000031	.000804	.018355	.000003	.058756	1.090502	.021725
Industry 10	.002857	.001633	.001653	.000031	.00039	.003733	.000001	.013222	.00592	1.124831
Industry 11	.00621	.131246	.001819	.00002	.000676	.004293	.000002	.003488	.000111	.001541
Industry 12	.002193	.00794	.006332	.000023	.000595	.003321	.000001	.023104	.002273	.017653
Industry 13	.003128	.088058	.002592	.0001	.001117	.005676	.000002	.007199	.000196	.002994
Industry 14	.001831	.011538	.001679	.000023	.000381	.003958	.000002	.00247	.000121	.000981
Industry 15	.00203	.000615	.400841	.000062	.008478	.003361	.000002	.001242	.000057	.000509
Industry 16	.002065	.00072	.049804	.000083	.002452	.003353	.000002	.00106	.000042	.000414
Industry 17	.001725	.001084	.026343	.000043	.001216	.003294	.000001	.002196	.00005	.000667
Industry 18	.001894	.000955	.014385	.000025	.000895	.003301	.000002	.00724	.000175	.001026
Industry 19	.001494	.000677	.011934	.000021	.000709	.002926	.000001	.013735	.000283	.004804
Industry 20	.001664	.001421	.025547	.000023	.001066	.003308	.000001	.010242	.000398	.001752
Industry 21	.002236	.002602	.002971	.00016	.033241	.004996	.000002	.006076	.000128	.00207
Industry 22	.000597	.00029	.000474	.00003	.001522	.001535	.000001	.000922	.000017	.000206
Industry 23	.006501	.002365	.002543	.000136	.003776	.024359	.000004	.009356	.000117	.001684
Industry 24	.00227	.002785	.056952	.000024	.001664	.004877	.000003	.013166	.001105	.006345
Industry 25	.00272	.005356	.006693	.000018	.013156	.003441	.000002	.008288	.000164	.003129
Industry 26	.00171	.000491	.000955	.000031	.000926	.003257	.000002	.004147	.000055	.000941
Industry 27	.000416	.000179	.0007269	.000179	.000461	.000851	0	.000389	.000012	.00015
Industry 28	.001267	.000369	.000492	.00002	.000601	.00276	.000001	.000975	.000037	.000383
Industry 29	.021017	.001347	.000571	.000026	.000384	.006368	.000007	.00285	.000135	.001368
Industry 30	.009103	.001491	.00155	.000017	.000837	.024988	.000009	.005393	.000265	.002226

Source: Statistics Canada, Input-Output Division. Computer runs produced for this research.

Table F-6 (continued) Transposed Inverse, Industries 11 to 20, Ontario Region, 1974

	Industries									
	11	12	13	14	15	16	17	18	19	20
Industry 1	.001703	.000127	.007049	.003967	.001149	.00255	.010086	.001352	.000935	.001625
Industry 2	.001546	.000268	.004644	.009763	.001753	.003357	.011597	.004243	.005391	.003905
Industry 3	.000996	.000113	.002924	.005308	.009704	.006536	.007422	.004572	.003397	.001644
Industry 4	.001232	.000121	.002276	.004803	.001454	.002267	.004423	.002254	.00838	.0016
Industry 5	.00238	.000141	.00878	.006392	.003005	.006625	.004814	.005445	.001564	.002172
Industry 6	.001689	.000171	.035735	.007066	.001932	.00519	.025694	.001529	.001175	.001492
Industry 7	.003027	.00228	.055326	.006875	.001225	.00227	.008618	.001651	.001044	.001637
Industry 8	.002081	.000141	.023408	.005975	.00207	.003702	.012466	.00176	.001768	.001753
Industry 9	.001822	.000153	.019672	.005833	.001387	.002357	.007993	.004129	.002696	.001444
Industry 10	.000996	.000119	.019684	.004893	.001876	.002771	.010694	.00132	.003083	.001109
Industry 11	1.081161	.00701	.010305	.005203	.003578	.006013	.024058	.001942	.002052	.001999
Industry 12	.03527	1.035242	.025437	.00524	.012077	.036107	.058311	.002833	.002466	.004518
Industry 13	.018542	.001838	1.133972	.006918	.005894	.003471	.007081	.001643	.00119	.001543
Industry 14	.002879	.000317	.147559	1.067321	.003771	.001511	.003667	.002144	.000974	.001231
Industry 15	.001825	.000105	.004411	.004537	1.086907	.056267	.016504	.003341	.002285	.002125
Industry 16	.003116	.000116	.003208	.004625	.020632	1.029634	.020091	.003985	.003032	.002948
Industry 17	.002602	.000162	.009242	.00458	.049964	.191641	1.0768	.004915	.003861	.007398
Industry 18	.002875	.000183	.006506	.006137	.030285	.074783	.050775	1.042951	.013527	.026553
Industry 19	.002139	.00042	.004621	.004095	.026886	.046071	.034741	.008261	1.076652	.009524
Industry 20	.00338	.002126	.012659	.004891	.063637	.044116	.034882	.014531	.002845	1.067529
Industry 21	.006728	.000228	.022687	.006636	.002898	.009073	.014081	.003047	.001431	.005857
Industry 22	.00087	.000064	.002181	.001629	.000742	.002319	.00734	.000622	.000562	.000872
Industry 23	.001811	.000182	.027588	.009534	.005222	.007745	.020243	.002264	.001659	.001863
Industry 24	.005075	.000205	.027033	.010041	.027565	.023379	.020887	.003132	.001835	.006973
Industry 25	.034098	.000198	.008734	.004516	.01298	.025109	.076262	.007009	.003404	.024675
Industry 26	.001589	.000232	.002906	.005453	.001521	.002834	.005649	.001812	.009553	.006517
Industry 27	.000875	.000062	.000732	.001427	.004229	.000961	.002305	.000492	.000293	.000819
Industry 28	.001527	.000136	.001939	.003958	.000806	.001473	.004416	.001382	.000869	.00176
Industry 29	.002042	.000171	.01399	.006815	.000861	.001736	.005671	.001649	.0013	.001473
Industry 30	.002444	.000487	.013945	.036336	.00253	.004405	.014275	.007768	.004174	.006788

Table F-6 (continued) Transposed Inverse, Industries 21-30, Ontario Region, 1974

	Industries									
	21	22	23	24	25	26	27	28	29	30
Industry 1	.003552	.032047	.043754	.000924	.027373	.020468	.013032	.001566	.043483	.10588
Industry 2	.002455	.034488	.005865	.005874	.030907	.115035	.004441	.001739	.030626	.306391
Industry 3	.004	.006710	.014065	.00121	.022067	.024258	.018607	.002353	.019994	.168501
Industry 4	.001919	.003402	.003374	.00094	.031411	.016082	.019226	.001321	.011863	.15391
Industry 5	.00226	.024122	.017671	.001367	.016758	.041613	.013506	.001717	.029066	.197091
Industry 6	.013925	.012016	.017775	.001393	.01436	.024863	.008406	.00268	.047094	.154681
Industry 7	.002439	.017536	.024428	.001266	.021963	.02367	.009837	.001515	.037558	.168907
Industry 8	.003899	.008085	.116535	.003981	.010068	.022831	.010752	.003206	.029937	.145823
Industry 9	.002221	.004873	.021231	.012151	.009861	.022997	.00684	.00175	.057585	.146769
Industry 10	.001198	.005018	.037083	.017656	.007796	.01864	.008408	.002396	.036083	.112081
Industry 11	.011474	.012724	.009783	.002411	.013306	.03248	.010011	.001873	.053162	.159948
Industry 12	.005446	.004452	.017949	.008039	.009319	.020999	.006894	.001798	.053175	.125035
Industry 13	.002776	.011759	.027597	.002381	.013508	.030427	.020259	.006022	.027115	.15809
Industry 14	.001129	.005258	.020919	.003347	.010367	.03603	.00742	.001815	.025978	.152127
Industry 15	.004895	.007964	.011812	.001031	.015694	.022854	.020007	.004124	.052313	.141142
Industry 16	.009936	.007466	.007903	.001019	.01581	.021008	.01782	.004832	.0053761	.145551
Industry 17	.006283	.005052	.012441	.002282	.01096	.022376	.009579	.002875	.036997	.137001
Industry 18	.003838	.003773	.008106	.002467	.010661	.022682	.006607	.001751	.045496	.139951
Industry 19	.007023	.003297	.00797	.002927	.007839	.019143	.005762	.001537	.030355	.127277
Industry 20	.007558	.004376	.017062	.004138	.009767	.025245	.007075	.00182	.033391	.134506
Industry 21	1.096993	.016946	.025812	.002902	.01473	.031333	.020888	.009938	.034037	.192259
Industry 22	.001409	1.017299	.024104	.000989	.018932	.029867	.005151	.001883	.007777	.048417
Industry 23	.00827	.037102	1.126453	.002733	.016482	.038108	.015902	.009878	.040031	.207527
Industry 24	.00987	.0006132	.031214	1.050087	.012013	.029061	.007343	.001728	.039634	.18431
Industry 25	.054186	.010688	.014146	.005	1.007992	.023826	.004564	.001419	.038701	.136943
Industry 26	.002607	.032501	.004004	.002266	.037303	1.105494	.006582	.001528	.034678	.140538
Industry 27	.001399	.002809	.000848	.000305	.024687	.010813	1.002216	.014363	.007203	.038629
Industry 28	.002385	.010989	.002004	.000034	.041359	.040166	.007454	1.001122	.019129	.125584
Industry 29	.001048	.01127	.003638	.001379	.011752	.048348	.010069	.001899	1.021303	.171284
Industry 30	.003739	.008824	.011192	.005734	.045796	.092255	.005464	.001482	.064663	1.178142

Table F-7 Transposed Inverse, Industries 1 to 10, Prairie Region, 1974

	Industries 1	2	3	4	5	6	7	8	9	10
Industry 1	1.046966	.000415	.000735	.03202	.01013	.04545	0	.000295	.000007	.000641
Industry 2	.004111	1.132105	.0003	.038197	.0033	.005671	0	.000346	.000015	.001034
Industry 3	.002414	.000215	1.002787	.011228	.079235	.003383	0	.000274	.000006	.000134
Industry 4	.005238	.00039	.00063	1.005977	.029962	.007698	0	.000428	.000012	.00025
Industry 5	.00239	.000317	.001633	.014172	1.00569	.003257	0	.000201	.000008	.000159
Industry 6	.58858	.004398	.000877	.021588	.007089	1.145658	0	.000779	.000014	.001392
Industry 7	0	0	0	0	0	0	1	0	0	0
Industry 8	.003312	.00117	.00078	.010671	.00363	.004832	0	1.006918	.000063	.008073
Industry 9	.079126	.001449	.002271	.006777	.005473	.136689	0	.001066	1.03082	.005033
Industry 10	.008332	.003535	.000156	.003097	.000797	.00329	0	.002118	.006377	1.07882
Industry 11	.008126	.142074	.002118	.013376	.001687	.00401	0	.001054	.000027	.000605
Industry 12	.002352	.007644	.003696	.003909	.001073	.002223	0	.003787	.00009	.00874
Industry 13	.004287	.114874	.001334	.024044	.003247	.004537	0	.000975	.000058	.000674
Industry 14	.001984	.004239	.000921	.004454	.000888	.002557	0	.000226	.000029	.000227
Industry 15	.002262	.000313	.40948	.014291	.036618	.002981	0	.00031	.000006	.000139
Industry 16	.003706	.000448	.014111	.00872	.004405	.002883	0	.000244	.000008	.000216
Industry 17	.00178	.000668	.011274	.003701	.002017	.001973	0	.00043	.000006	.000229
Industry 18	.002103	.000392	.014881	.004464	.002723	.002343	0	.001067	.000011	.00062
Industry 19	.002136	.003187	.006944	.004328	.001695	.002192	0	.002368	.000153	.002092
Industry 20	.002403	.000816	.021604	.006988	.00354	.003051	0	.002524	.000015	.000319
Industry 21	.003812	.002707	.001591	.029634	.028403	.005159	0	.000694	.000019	.000695
Industry 22	.004673	.000507	.000712	.771005	.024052	.006751	0	.000579	.000011	.000269
Industry 23	.009658	.001637	.003478	.051023	.02553	.01688	0	.0016	.000015	.001143
Industry 24	.002741	.001733	.005544	.00726	.001621	.0034	0	.002182	.00016	.000705
Industry 25	.002669	.00357	.005055	.012612	.047028	.002588	0	.002616	.000013	.000612
Industry 26	.002418	.000396	.000481	.035439	.003866	.002916	0	.000781	.000009	.00055
Industry 27	.000927	.00025	.000336	.050309	.004292	.001241	0	.000206	.000003	.000074
Industry 28	.00143	.000207	.000245	.0074	.002391	.001859	0	.000195	.000004	.000093
Industry 29	.023701	.000906	.000203	.012032	.001285	.004342	0	.000676	.00003	.001244
Industry 30	.016158	.000822	.000486	.007788	.002807	.024174	0	.001077	.000037	.000699

Source: Statistics Canada, Input-Output Division. Computer runs produced for this research.

Table F-7 (continued) Transposed Inverse, Industries 11 to 20, Prairie, 1974

	Industries									
	11	12	13	14	15	16	17	18	19	20
Industry 1	.000846	.000031	.001131	.001576	.001854	.000279	.002436	.001397	.000331	.000249
Industry 2	.001161	.000087	.000949	.004683	.000725	.000362	.002872	.001675	.00133	.000549
Industry 3	.00057	.000038	.00079	.002647	.007079	.006098	.004343	.002287	.001258	.000239
Industry 4	.001202	.00007	.001082	.006251	.001568	.000554	.003192	.001799	.000662	.000632
Industry 5	.000826	.000034	.001396	.002866	.00413	.002383	.002155	.004733	.000458	.000278
Industry 6	.001298	.000053	.012565	.003241	.002216	.000382	.00545	.001044	.000406	.000271
Industry 7	0	0	0	0	0	0	0	0	0	0
Industry 8	.002398	.000053	.007393	.002436	.001963	.00021	.001749	.000465	.00134	.000298
Industry 9	.001212	.000041	.00527	.002636	.005756	.000438	.002204	.0006064	.000389	.000231
Industry 10	.00063	.000094	.005346	.001702	.000377	.000102	.000685	.000275	.000453	.000123
Industry 11	1.109316	.006953	.00876	.003043	.005368	.00076	.009057	.000672	.000599	.000324
Industry 12	.033188	1.013351	.018872	.002093	.009387	.001546	.01346	.000501	.000605	.000836
Industry 13	.032587	.000811	1.033862	.003521	.003368	.000229	.002159	.000554	.000447	.000249
Industry 14	.001428	.000051	.037504	1.042894	.002329	.000135	.001126	.000527	.000308	.000185
Industry 15	.001234	.000048	.000918	.002277	1.041007	.007014	.020608	.003154	.002252	.000799
Industry 16	.002046	.000073	.001219	.002318	.035845	1.003586	.055954	.007615	.005026	.001927
Industry 17	.003425	.000074	.001601	.001589	.028651	.043143	1.075274	.003807	.004922	.001127
Industry 18	.001382	.000065	.001581	.001916	.037822	.03903	.048873	1.011503	.003107	.003412
Industry 19	.02037	.00747	.004134	.001748	.017642	.010352	.033677	.004049	1.012728	.002138
Industry 20	.002128	.000164	.004636	.002485	.054751	.006314	.024221	.001864	.0041593	1.021558
Industry 21	.001894	.000068	.022157	.003759	.003986	.004438	.011832	.001051	.00056	.00041
Industry 22	.001416	.000071	.002002	.005472	.001774	.000639	.005293	.001531	.000705	.000673
Industry 23	.00128	.00006	.01257	.003434	.008805	.000464	.005278	.000704	.000482	.000334
Industry 24	.006937	.000083	.007139	.002821	.011133	.002629	.00804	.000954	.000863	.00234
Industry 25	.023139	.000506	.004243	.002053	.012831	.005643	.040394	.002382	.001119	.006846
Industry 26	.001411	.000106	.000823	.003759	.001196	.000878	.006697	.000599	.006394	.00197
Industry 27	.001413	.000037	.000406	.001369	.000846	.000369	.002625	.000311	.000192	.000468
Industry 28	.001012	.000034	.000414	.001532	.000605	.000277	.002025	.000315	.000308	.000393
Industry 29	.001241	.000055	.006354	.003493	.000498	.000252	.00248	.000544	.000611	.000289
Industry 30	.001325	.00016	.002766	.019698	.001215	.00057	.004609	.002846	.001528	.001278

Table F-7 (continued) Transposed Inverse, Industries 21-30, Prairie Region, 1974

	Industries									
	21	22	23	24	25	26	27	28	29	30
Industry 1	.001334	.040364	.010881	.000213	.021902	.013231	.011169	.001395	.021308	.086061
Industry 2	.001591	.049057	.001906	.002117	.027152	.070662	.004029	.000983	.025317	.259758
Industry 3	.003101	.010075	.013317	.0003	.017794	.015095	.017604	.001147	.013769	.149215
Industry 4	.002194	.00558	.001925	.000559	.044682	.025253	.012307	.001683	.016921	.357562
Industry 5	.001067	.012483	.002841	.000313	.014205	.024247	.013745	.003793	.015562	.14846
Industry 6	.003649	.025644	.007829	.00032	.018057	.019425	.010738	.002205	.032033	.133847
Industry 7	0	0	0	0	0	0	0	0	0	0
Industry 8	.001791	.006743	.12025	.001007	.009672	.016602	.012775	.003601	.020018	.122704
Industry 9	.001467	.006586	.006527	.001416	.010459	.017583	.006994	.001514	.060195	.128084
Industry 10	.000354	.002132	.01323	.003991	.004807	.012468	.004247	.001259	.025105	.075695
Industry 11	.003735	.01452	.006541	.000554	.013415	.024938	.01127	.002045	.041032	.170085
Industry 12	.001397	.003348	.006496	.000257	.007129	.013038	.005763	.00121	.032692	.090816
Industry 13	.004538	.022247	.028852	.000494	.013555	.020889	.018609	.003953	.016786	.139988
Industry 14	.000565	.004246	.007153	.000332	.007478	.027268	.005863	.001020	.013393	.112898
Industry 15	.003993	.010804	.017524	.000304	.019147	.016949	.026729	.002237	.018382	.127722
Industry 16	.003738	.004137	.00434	.000321	.015972	.015715	.033382	.003037	.090819	.127176
Industry 17	.003314	.002991	.002865	.000257	.007507	.013286	.006048	.001138	.024343	.088826
Industry 18	.001217	.003722	.003531	.000266	[illegible]139	.015285	.006087	.001181	.029584	.104677
Industry 19	.006244	.003449	.00377	.000331	[illegible]433	.01621	.008781	.001513	.031004	.097124
Industry 20	.002745	.006072	.03568	.000356	.009252	.02382	.00935	.001717	.024046	.119146
Industry 21	1.147236	.022537	.013451	.00201	.016585	.024997	.018326	.009561	.026344	.201192
Industry 22	.002803	1.023561	.004812	.001286	.052663	.040845	.014102	.003704	.018319	.310757
Industry 23	.005843	.0206118	1.062553	.0012	.018932	.030842	.028276	.018618	.020367	.179863
Industry 24	.002367	.007487	.008878	1.047266	.009669	.022017	.007262	.0001236	.024844	.142852
Industry 25	.046529	.014521	.005632	.001531	1.006888	.01776	.004019	.001069	.037048	.1122672
Industry 26	.002621	.039916	.001009	.000863	.04974	1.070706	.009508	.001305	.024765	.126396
Industry 27	.002809	.006342	.000509	.000168	.060378	.012279	1.001505	.016057	.006062	.056946
Industry 28	.001974	.007756	.000438	.000188	.041967	.029675	.006555	1.000593	.010292	.085063
Industry 29	.000649	.012947	.00105	.000345	.011431	.038917	.011063	.001853	1.014305	.149574
Industry 30	.002125	.008578	.002481	.001521	.03988	.066384	.005101	.001206	.043819	1.132498

Table F-8 Transposed Inverse, Industries 1 to 10, B.C. Region, 1974

	Industries 1	2	3	4	5	6	7	8	9	10
Industry 1	1.041739	.021368	.000118	.008813	.001384	.185719	0	.00036	.000005	.000461
Industry 2	.001915	1.231938	.000425	.008073	.001391	.005477	0	.000377	.000019	.001084
Industry 3	.000898	.001275	1.001353	.003555	.026674	.002434	0	.000183	.000006	.000102
Industry 4	.001744	.002329	.000209	1.003898	.017484	.005151	0	.000336	.000013	.000192
Industry 5	.001216	.00276	.000322	.007358	1.046793	.003246	0	.000254	.000008	.000299
Industry 6	.148965	.078218	.000161	.003322	.000778	1.09848	0	.001141	.000007	.000233
Industry 7	0	0	0	0	0	0	1	0	0	0
Industry 8	.000869	.003158	.000129	.002109	.000385	.002364	0	1.010163	.00003	.000752
Industry 9	.001088	.010005	.000127	.000777	.000241	.002656	0	.0000706	1.00386	.007354
Industry 10	.004063	.002137	.000056	.001236	.000152	.00267	0	.001748	.000527	1.044642
Industry 11	.002498	.486757	.000252	.005217	.000851	.004596	0	.000425	.000014	.000537
Industry 12	.001171	.040029	.000276	.001399	.000292	.001951	0	.008912	.0002	.009315
Industry 13	.002299	.182882	.000254	.010457	.001018	.003586	0	.000411	.000016	.000286
Industry 14	.001132	.032006	.000274	.002641	.000359	.002493	0	.000256	.000127	.000139
Industry 15	.000701	.001287	.103546	.007233	.003764	.001684	0	.000139	.000004	.000072
Industry 16	.002154	.001958	.001801	.002646	.001587	.003003	0	.000221	.000008	.000169
Industry 17	.000713	.002032	.002441	.001202	.000322	.001587	0	.000212	.000005	.000205
Industry 18	.000975	.002094	.002375	.001316	.001112	.001935	0	.000883	.000005	.000114
Industry 19	.000802	.008874	.001173	.001004	.000258	.001652	0	.002119	.000012	.002087
Industry 20	.000822	.002903	.006958	.00146	.000467	.001878	0	.005184	.000009	.000137
Industry 21	.001433	.007272	.002816	.010639	.028616	.003795	0	.000883	.00001	.000173
Industry 22	.000739	.001298	.000115	.270621	.005111	.002069	0	.000314	.000005	.000095
Industry 23	.001516	.003303	.000413	.005667	.000936	.005323	0	.001179	.00001	.000129
Industry 24	.001099	.007536	.001812	.00257	.00116	.002636	0	.005271	.000029	.000475
Industry 25	.001404	.021471	.000841	.003973	.017512	.002052	0	.002429	.000014	.000933
Industry 26	.001012	.002393	.000196	.010626	.001076	.002252	0	.000298	.000009	.000396
Industry 27	.000273	.000732	.000071	.003023	.000496	.000727	0	.000094	.000002	.000045
Industry 28	.000667	.001311	.000086	.002857	.000809	.00161	0	.000177	.000005	.000098
Industry 29	.015705	.003566	.000133	.003709	.00034	.005207	0	.000537	.00002	.00087
Industry 30	.005843	.004902	.000278	.002405	.000904	.01851	0	.000952	.000046	.000389

Source: Statistics Canada, Input-Output Division. Computer runs produced for this research.

Table F-8 (continued) Transposed Inverse, Industries 11 to 20, B.C. Region, 1974

	Industries									
	11	12	13	14	15	16	17	18	19	20
Industry 1	.002566	.000031	.005097	.002141	.000596	.000337	.003972	.000821	.000358	.000424
Industry 2	.003025	.000094	.002935	.006179	.001129	.000477	.008322	.003745	.007439	.001058
Industry 3	.001458	.000028	.001845	.002675	.008531	.0032	.003519	.004462	.000262	.000428
Industry 4	.0029	.000053	.002977	.00572	.001193	.001707	.003841	.005071	.000478	.000778
Industry 5	.002798	.000036	.007561	.003669	.001648	.001461	.002171	.004253	.000415	.000459
Industry 6	.004527	.00004	.022634	.004729	.00075	.000567	.017695	.001042	.000713	.00038
Industry 7	0	0	0	0	0	0	0	0	0	0
Industry 8	.003541	.000025	.011016	.002233	.000881	.000182	.004343	.000791	.000658	.000359
Industry 9	.019075	.000038	.008574	.003016	.000683	.00069	.008487	.014774	.000319	.000332
Industry 10	.002333	.000018	.006714	.001923	.00027	.000076	.001385	.000513	.000184	.000187
Industry 11	1.081289	.000879	.004797	.005	.000892	.000319	.005739	.002233	.003218	.00074
Industry 12	.083182	1.006368	.012054	.00244	.002244	.000952	.026928	.001082	.000572	.001258
Industry 13	.144371	.000224	1.040507	.003703	.001672	.000318	.007397	.001384	.001347	.000501
Industry 14	.025375	.000059	.179008	1.048228	.002153	.00018	.002757	.001871	.000517	.000355
Industry 15	.001815	.000019	.002088	.001838	1.037022	.004721	.004885	.004731	.000264	.000346
Industry 16	.002564	.000032	.002764	.003178	.016204	1.394424	.004181	.003859	.000397	.000512
Industry 17	.003025	.000022	.003418	.001779	.022996	.02964	1.093606	.004529	.001455	.001246
Industry 18	.002983	.000025	.004328	.002069	.020201	.030843	.031362	1.026085	.001662	.005835
Industry 19	.018428	.001935	.002784	.001817	.010918	.004466	.03936	.003692	1.0085	.002808
Industry 20	.003679	.000348	.003518	.002432	.06604	.003645	.031626	.002121	.000735	1.020678
Industry 21	.009871	.000048	.018396	.003963	.000858	.001554	.010381	.001701	.000402	.000541
Industry 22	.001751	.000029	.001483	.002329	.000592	.00058	.003796	.001639	.000325	.000471
Industry 23	.002901	.000035	.01073	.003286	.003038	.000472	.013965	.001024	.000336	.000401
Industry 24	.011892	.00004	.016414	.004291	.016942	.001293	.009837	.001895	.000756	.001701
Industry 25	.044501	.000488	.005017	.002159	.00493	.002936	.046618	.002851	.00084	.00942
Industry 26	.00242	.000073	.001939	.004626	.000713	.000383	.003614	.00111	.007283	.002463
Industry 27	.001239	.000017	.000605	.000962	.000523	.000097	.001393	.000293	.000087	.000298
Industry 28	.002117	.000034	.001015	.0018255	.000414	.000171	.002467	.000617	.000327	.00057
Industry 29	.003549	.00004	.010633	.003695	.000472	.000192	.003641	.000952	.000475	.000404
Industry 30	.004001	.000146	.00804	.020786	.001607	.000577	.007566	.005835	.001375	.001995

Table F-8 (continued) Transposed Inverse, Industries 21-30, B.C. Region, 1966

	Industries 21	22	23	24	25	26	27	28	29	30
Industry 1	.003304	.028151	.009861	.000387	.026184	.018667	.012334	.004231	.037628	.093087
Industry 2	.001643	.027596	.001855	.002713	.029405	.08462	.003579	.000574	.030221	.323284
Industry 3	.002415	.011249	.011531	.000393	.019482	.016582	.023602	.000784	.016553	.143187
Industry 4	.001551	.009381	.010675	.000634	.032259	.028211	.00684	.003044	.023747	.309038
Industry 5	.001101	.024738	.009094	.000604	.012891	.030041	.008354	.001235	.023171	.191649
Industry 6	.01193	.009346	.003152	.00055	.013174	.022208	.006677	.002291	.037964	.138876
Industry 7	0	0	0	0	0	0	0	0	0	0
Industry 8	.000936	.005585	.140681	.001466	.007967	.016518	.015122	.002004	.018255	.111546
Industry 9	.00044	.002297	.002806	.002033	.006878	.016713	.003368	.0004	.02552	.107695
Industry 10	.000296	.003155	.003322	.001774	.005308	.014418	.007164	.001001	.029938	.07897
Industry 11	.00132	.015022	.005021	.001459	.023002	.047168	.011378	.001982	.031157	.26368
Industry 12	.000701	.003867	.006939	.001197	.00834	.016474	.006	.000864	.038121	.108903
Industry 13	.001381	.028297	.027002	.000804	.016891	.029155	.022046	.004901	.02275	.185558
Industry 14	.000612	.007333	.009278	.000649	.009964	.032913	.009621	.001369	.019393	.14283
Industry 15	.001406	.013665	.002121	.000234	.012193	.01175	.008168	.002019	.01712	.098055
Industry 16	.003606	.003723	.001971	.000434	.018842	.020207	.022745	.00325	.094746	.16672
Industry 17	.000756	.002381	.00322	.000306	.007319	.014039	.005837	.001131	.019409	.092956
Industry 18	.001486	.002508	.001681	.000378	.007638	.016724	.006877	.000975	.032375	.105591
Industry 19	.001139	.002631	.004944	.000504	.007557	.016286	.005861	.00082	.0234	.095863
Industry 20	.001158	.003264	.019623	.001146	.008085	.022984	.008752	.001067	.021557	.107002
Industry 21	1.136644	.023937	.007336	.002623	.015063	.025227	.015077	.008064	.029306	.193802
Industry 22	.001357	1.010503	.004988	.001664	.026731	.030103	.007393	.003178	.0122	.121361
Industry 23	.002194	.010656	1.07093	.001361	.014031	.023659	.045405	.006232	.021866	.152711
Industry 24	.001191	.00772	.010037	1.035254	.008832	.021669	.007448	.00104	.024471	.134673
Industry 25	.04252	.010238	.006188	.001952	1.006559	.019407	.003204	.000701	.041008	.111708
Industry 26	.001771	.033025	.000926	.000944	.037728	1.107164	.007088	.000701	.025649	.125046
Industry 27	.001082	.009576	.000304	.000129	.02512	.0054	1.027651	.001192	.004834	.043649
Industry 28	.001827	.008494	.000528	.000256	.041992	.033067	.007195	1.000332	.015037	.095074
Industry 29	.000612	.010814	.001028	.000454	.010742	.040662	.010776	.001652	1.016562	.147426
Industry 30	.002312	.007105	.002939	.00189	.04308	.072846	.005073	.001026	.055526	1.131637

Appendix G

Sample Industrial Water Use Survey Questionnaire

Statistics Canada
Fisheries and Environment Canada

WATER USE IN MANUFACTURING INDUSTRIES 1976

Si vous désirez un questionnaire en français, veuillez cocher ☐ et retourner à la Division des industries manufacturières et primaires, Statistique Canada, Ottawa, K1A 0T6

In all correspondence concerning this questionnaire please refer to the first seven digits in the top line of the mailing address below.

Mailing Address (Please correct if necessary)

Physical Location of Establishment (Please correct if necessary)

Form EC-5-3309-2.1

SECTION 1: GENERAL INFORMATION

1.1 AUTHORITY This survey is conducted under the authority of the Statistics Act Statutes of Canada, 1970-71-72, Chapter 15, which guarantees the CONFIDENTIALITY of your return. The Act also states that the filing of a completed return by this establishment is compulsory. Under Section 11 of the Act an agreement has been made with the Department of Fisheries and the Environment for the exchange of data reported herein. SUBJECT TO YOUR APPROVAL, UNLESS YOU OBJECT IN WRITING AND MAIL YOUR LETTER TOGETHER WITH THE COMPLETED QUESTIONNAIRE TO STATISTICS CANADA, the Manufacturing and Primary Industries Division of Statistics Canada, will share the data with the Department of Fisheries and the Environment. They will in turn share this data with the provincial agencies listed in the covering letter UNLESS YOU OBJECT IN WRITING.

1.2 COMPLETION AND RETURN The data included in this report must relate to your calendar year 1976. Please complete this questionnaire within 30 days of receipt, retain one copy for your files and return one copy to Statistics Canada utilizing the return envelope provided.

NOTE

(i) Shaded areas are for office use only.

(ii) Water volumes are to be reported in "thousands of Imperial gallons" per average operating day; except where specified.

(iii) If you wish to receive a copy of the aggregate results from the 1972 Survey, please check this box. ☐

DETAILS OF OPERATION		CODE	NUMBER
1a Indicate the average annual number of employees:	Production and related workers	1.1	
	Administrative, sales and office workers	1.2	
	Total	1.3	
1b Indicate the number of days of operation during the reporting period		1.4	
1c Indicate the number of hours worked in an average day		1.5	

1d Indicate the major products produced by your plant and list the process used. (So that distinction between products made by different processes can be made.)

PRODUCT	PROCESS

SECTION 2: WATER INTAKE BY KIND AND SOURCE

INSTRUCTIONS

(i) In this section report the quantity of new water brought into your operation. For the purpose of this questionnaire, new water is defined as *water introduced for the first time in this operation, regardless of quality or source.*

(ii) Brackish water is defined as *water containing more than 1000 parts per million of dissolved solids.*

(iii) In items 2a, 2b and 2d describe source by giving the name:

(iv) In items 2c and 2e please specify the type of source.

(v) In item 2a please include the volume of water supplied by any type of water utility which serves either the general public and/or another industry.

(vi) In items 2b to 2d please include water obtained from your own water supply system and your portion of water obtained from any joint water supply system, EXCLUDING WATER RECIRCULATION IN YOUR PLANT AND WATER PUMPED BY PLANT FACILITY BUT INTENDED FOR USE OUTSIDE THE INDUSTRIAL ESTABLISHMENT.

(vii) Place a "1" in the box marked "M" if the quantity is a metered figure; if box "M" is left blank, it will be assumed that the figure is an estimate.

	SOURCE	CODE	Volume per day ('000 Imperial gallons)			
			M	Fresh	M	Brackish
2a	Public water utility system (name)	2.1			X	XXX
2b	Self-supplied surface water system (lake, river, etc.) (name)	2.2			X	XXX
2c	Self-supplied groundwater system (well, spring, etc.) (specify)	2.3				
2d	Self-supplied tide water (salt water) body (bay, ocean, etc.) (name)	2.4	X	XXX		
2e	Other sources (specify)	2.6				
2f	Total water intake (sum of 2a to 2e)	2.7				

SECTION 3: TREATMENT OF INTAKE WATER AND COST OF ACQUISITION

INSTRUCTIONS Indicate the amount of intake water treated prior to use. In the space after each category of treatment, indicate the specific process used.

	CATEGORY OF TREATMENT	CODE	Office Use	Volume per day ('000 Imperial gallons)
3a	Filtration (specify type)	3.1		
3b	Chlorination & disinfection (specify type)	3.2		
3c	Corrosion and slime control (specify type)	3.3		
3d	Screening (specify type)	3.4		
3e	Hardness and alkalinity control (specify type)	3.5		
3f	Other (specify)	3.6		
3g	Total amount of water treated (not necessarily equal to the sum of the figures reported in 2f)	3.7		

3h	Total amount spent on purchasing water (if any) during 1976	3.8	COST	$

SECTION 4: WATER INTAKE BY PURPOSE

INSTRUCTIONS Report the amount of water used within the industrial plant by initial use. This section should not include recirculated water. In 4d "Other Uses" should not include water pumped by plant facility, and intended for initial use outside the industrial establishment. Place a "1" in the box marked "M" if the quantity is a metered figure; if box "M" is left blank, it will be assumed that the figure is an estimate.

	PURPOSE	CODE	M	Volume per day ('000 Imperial gallons)
4a	Process water — includes all water which comes in direct contact with products and/or materials. It is further defined to include water which is consumed in milling and special processes, water which is included in final output, or water which has been used for another purpose but which is finally used as process water.	4.1		
4b	Cooling, condensing and steam — Defined as water which does not come in direct contact with the products, materials or by-products of the processing operation. Includes pass-through water used in the operation, cooling or process equipment (including air conditioning) and water introduced into boilers for the production of steam for process operations or electric power.	4.2		
4c	Sanitary service	4.3		
4d	Other uses (specify)	4.4		
4e	Total (4a to 4d, must equal sum of figures reported in 2f)	4.5		

SECTION 5: WATER RECIRCULATED OR REUSED BY PURPOSE

INSTRUCTIONS If there was any water recirculated or reused within your plant, please indicate the additional quantity of water that would have been required by purpose, had no water been recirculated or reused. Please place a "1" in the box marked "M" if the quantity is a metered figure; if box "M" is left blank, it will be assumed that figure is an estimate.

	PURPOSE	CODE	M	Volume per day ('000 Imperial gallons)
5a	Process	5.1		
5b	Cooling, condensing, etc.	5.2		
5c	Other uses (specify)	5.3		
5d	Total (items 5a to 5c)	5.5		

SECTION 6: WATER DISCHARGE

INSTRUCTIONS

(i) In this section please report the volume of all water routed to its ultimate point of discharge.

(ii) Do not report the volume of water held in ponds, lagoons or basins and intended for recirculation or reuse until such water is actually discharged.

(iii) Do not include the volume of water lost in production, through evaporation, or otherwise consumed and not brought to the ultimate point of discharge.

(iv) In items 6a to 6c please describe point of discharge by giving the name.

(v) In item 6d please specify.

(vi) In item 6e please identify the use intended.

(vii) Place a "1" in the box marked "M" if the quantity is a metered figure; if box "M" is left blank, it will be assumed that the figure is an estimate.

	DISCHARGE POINT	CODE	M	Volume per day ('000 Imperial gallons)
6a	Public utility sewer (municipality, etc.) (name)	6.1		
6b	Fresh water body (lake, river, etc.) (name)	6.2		
6c	Tide water (salt water) body (bay, ocean, etc.) (name)	6.3		
6d	Ground (incl. seepage from holding ponds, lagoons, etc.) (specify)	6.4		
6e	Transferred to other uses outside plant after use in process (use)	6.7		
6f	Total water discharge (must be equal to or less than amount reported in 4e)	6.8		

SECTION 7: TREATMENT PRIOR TO DISCHARGE

INSTRUCTIONS: In items 7b to 7d, specify treatment process used in each of the treatment methods.

NOTE: If more than one treatment method is employed, the total reported in 7e may exceed the total reported in 7a.

TREATMENT METHOD	CODE	Office Use	Volume per day ('000 Imperial gallons)
7a Indicate the total volume of water treated prior to discharge (if any)	7.1		
7b Primary (specify process) (i)	7.2		
(ii)	7.3		
7c Secondary (specify process) (i)	7.4		
(ii)	7.5		
7d Tertiary (specify process) (i)	7.6		
(ii)	7.7		
7e Total (items 7b to 7d)	7.8		

7f Please estimate the total operation and maintenance cost of treating waste water in 1976 as reported in 7a above	7.9	COST	$

SECTION 8: MONTHLY TOTALS

INSTRUCTIONS In this section break down, as accurately as possible, the total yearly water intake and water discharged into monthly totals. Report in thousands of Imperial gallons per month.

Month	Code	'000 Imperial gallons per month		Month	Code	'000 Imperial gallons per month	
		Intake	Discharge			Intake	Discharge
January	8.1			July	8.7		
February	8.2			August	8.8		
March	8.3			September	8.9		
April	8.4			October	8.10		
May	8.5			November	8.11		
June	8.6			December	8.12		
				TOTAL	8.13		

CERTIFICATION:

I certify that the information contained herein is complete and correct to the best of my knowledge and belief and covers the calendar year 1976.

Signature of authorized person	Title	Date		
Name of contact regarding this report	Address (if different from front page)	Telephone		Telex
		area code / number	ext.	

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