LETTER OF TRANSMITTAL

Honourable Jean J. Charest
Minister, Environment Canada
Government of Canada

Honourable Harold Martens
Associate Minister, Agriculture and Food
Minister Responsible for SaskWater
Province of Saskatchewan

Dear Mr. Charest and Mr. Martens:

We are pleased to present the final report of the Canada-Saskatchewan South Saskatchewan River Basin Study.

This report documents the findings and recommendations of the study. We believe that the study has produced valuable information about the water resources of Saskatchewan's portion of the South Saskatchewan River Basin. This information will help ensure that these water resources will be protected and managed for the social, environmental and economic well-being of the people of Saskatchewan and Canada.

It has been our pleasure to work with the people involved in the South Saskatchewan River Basin Study. Their dedication and spirit of co-operation helped ensure that the study met its objectives.

Respectfully submitted,

R. A. Halliday
Study Board Co-Chairman
Environment Canada

W. L. Dybvig
Study Board Co-Chairman
SaskWater

Saskatchewan Landing Provincial Park, at the upstream end of Lake Diefenbaker, is a popular recreation spot

LETTRE D'ENVOI

M. Jean J. Charest
Ministre, Environnement Canada
Gouvernement du Canada

M. Harold Martens
Ministre adjoint, Agriculture et Aliments
Ministre responsable de la société SaskWater
Province de la Saskatchewan

Messieurs les Ministres,

Nous avons l'honneur de vous présenter le rapport final issu de l'étude Canada-Saskatchewan sur le bassin de la rivière Saskatchewan-sud.

Ce rapport contient les conclusions et les recommandations des auteurs de l'étude en question. À notre avis, on y fournit des renseignements très utiles sur les ressources hydriques de cette partie de rivière qui coule en Saskatchewan. Grâce à cette information, il sera désormais plus facile de protéger et de gérer ces ressources, de façon à assurer le mieux-être des habitants de la Saskatchewan et du Canada sur les plans social, environnemental et économique.

Il nous a été très agréable de travailler avec les responsables de cette étude. Le dévouement et l'esprit de collaboration dont ils ont fait preuve ont grandement contribué à l'atteinte des objectifs fixés.

Veuillez agréer, Messieurs les Ministres, l'assurance de nos sentiments les plus respectueux.

R.A. Halliday
Co-président du comité de l'étude
Environnement Canada

W.L. Dybvig
Co-président du comité de l'étude
SaskWater

EXECUTIVE SUMMARY

The South Saskatchewan River, which has its headwaters in Alberta's Rocky Mountains, flows eastward across the prairies toward Hudson Bay. The South Saskatchewan River is the only reliable supply of high quality water in the southern half of Saskatchewan. It supports industrial, agricultural, municipal and recreational water uses. As a result, it is vitally important to the economic, social and environmental well-being of the people of Saskatchewan.

In the early 1980s, there was increasing concern about the ability of the South Saskatchewan River to meet the needs of Saskatchewan. These concerns stemmed from increasing development in Alberta, plans for significant irrigation development in the Saskatchewan portion of the basin and several years of drought.

In response to these concerns the governments of Canada and Saskatchewan signed the Canada-Saskatchewan South Saskatchewan River Basin Study Agreement. The agreement identified three objectives for the study: document the issues; assess the resource; and, develop a framework plan for future management of the water resources in the Saskatchewan portion of the basin. The information produced by the study was to guide water management and development decisions in the interests of all water users dependant upon the water resources of the basin.

The conclusions and recommendations of the Canada-Saskatchewan South Saskatchewan River Basin Study are summarized below. Both are organized according to four general categories: public involvement, water management, research and implementation.

CONCLUSIONS

Public Involvement

- Greater public education would help people to understand the basis for water management decisions.
- Input from all water users is required to ensure that water management decisions will serve to maximize the benefits of the water resource.

Water Management

- The waters of the basin are well managed but management practices will have to adapt to the changing conditions produced by decreases in water supply from Alberta and increasing use in Saskatchewan.
- On average, Saskatchewan receives 78 percent of the natural flow in the South Saskatchewan River. This will decrease to 72 percent by the year 2000 and 67 percent by the year 2020, at which time further decreases should stop because of development limits in Alberta.
- Water use in Saskatchewan from the South Saskatchewan River is about 500 000 dam^3. This will have increased to about 650 000 dam^3 by the year 2000 and about 900 000 dam^3 by the year 2020.
- Water use in Alberta will continue to have a more significant impact on the water resources of the Saskatchewan portion of the basin than water use in Saskatchewan.
- On average, Saskatchewan delivers 71 percent of the natural flow in the South Saskatchewan River to Manitoba. This will decrease to 65 percent by the year 2000 and 57 percent by the year 2020.

- Reservoir operating plans should continue to be based on annual and seasonal forecasts for water supply and the needs of users on the reservoir and downstream.
- Water quality objectives and a supporting water quality monitoring program would be an effective way of protecting water quality for all uses in the basin.
- Under average conditions, a summer target daily average flow range of 60 to 150 cubic metres per second downstream of Lake Diefenbaker would benefit users on the reservoir and downstream.
- Under extreme conditions, it will be necessary to allow the flows downstream of Lake Diefenbaker to move out of the target flow range.
- Water conservation offers significant benefits. In areas like Swift Current and the Saskatoon Southeast Water Supply (SSEWS) system it could reduce the frequency and duration of water shortages. Benefits in the form of delayed or eliminated costly expansion to water treatment and delivery systems accrue to those users who conserve.
- A greater amount of public access to the river would increase the potential for recreation benefit.
- Regional water supply systems could help solve water quantity and quality problems being experienced by some municipalities in the basin.
- Swift Current Creek is at the limit of development for irrigation if water use is not reduced or no additional water is made available.
- The capacity of the SSEWS system must be increased if irrigation is allowed to expand beyond that forecast for the year 2020.
- There is sufficient water in the South Saskatchewan River to meet the needs of existing uses as forecast to the year 2020 without difficulty.
- Beyond the year 2020, there should be sufficient water available to allow increased use by municipalities, industries or irrigation projects, or improve the conditions for instream water uses like recreation or fish and wildlife.
- Of the consumptive uses, industry has the most room for further growth.
- By the year 2020, water consumption will not exceed 50 percent of the natural flow even in drought years.

Research

- There is a need for a more effective way of monitoring subtle long-term changes in the health of the ecosystem.
- There is a need for more information on the instream water uses and how to quantify their benefits.

Implementation

- The development of data bases needs to be harmonized with the requirements of analytical tools for project evaluation.
- A procedure to ensure the implementation and to monitor the results of the study's recommendations should be put in place.
- By the year 2010, it should be possible to determine if the water use forecasts used to carry out the study were accurate and, therefore, whether a follow-up study is needed.

RECOMMENDATIONS

Public Involvement

- Develop and implement a public information program to assist the public in understanding the water resource management issues of the study area and a process to make their input possible.
- Continue to inform existing users about extreme variations in water quantity and quality that may affect their use of the water.
- Make new water users aware of the extreme variations in water levels that can occur to ensure that water use activity and associated structures are designed to cope with the extremes.
- Encourage water conservation by all users, particularly those on the SSEWS system and Swift Current Creek, where water shortages already occur.

Water Management

- Implement the basin specific water quality objectives developed through the study and the monitoring program designed to ensure that the objectives are met.
- Encourage appropriate development, including the provision of appropriate public access, in shoreline areas.
- Continue to base reservoir operating plans on annual and seasonal forecasts for water supply and the needs of users on the reservoir and downstream.
- Establish a summer target daily average flow range of 60 to 150 cubic metres per second for the South Saskatchewan River downstream of Lake Diefenbaker.
- Continue the practice of maintaining minimum daily average flows above 42.5 cubic metres per second downstream of Lake Diefenbaker.
- Apply the target and minimum flow criteria for the South Saskatchewan River from Gardiner Dam to the confluence with the North Saskatchewan River.
- Do not exceed the current levels of irrigation development in the Swift Current Creek system unless more water is made available through conservation, changes in reservoir operation, or the development of new storage.
- Consider modifying the operating plans for Duncairn and Highfield reservoirs to make more water available in the Swift Current Creek system.
- Investigate the feasibility of developing regional water supply systems for municipalities and other users that currently experience water quantity or water quality problems.

Research

- Encourage research aimed at quantifying the benefits of instream water uses.
- Encourage research aimed at developing a monitoring system capable of detecting subtle long-term changes in the health of the ecosystem.

Implementation

- Work toward more compatible databases and tools to help ensure a more consistent approach to project evaluation.
- Establish a procedure to ensure the implementation and to monitor the results of the study's recommendations.
- Consider carrying out a follow-up study of the Saskatchewan portion of the South Saskatchewan River Basin in the year 2010.

CONTENTS

Lake Diefenbaker stores more than 9 000 000 dam^3 of water

INTRODUCTION

Attitudes toward water are changing. Nowhere is this more true than on the prairies, where there is ever increasing awareness of the value of an adequate supply of good quality water.

The Canada-Saskatchewan South Saskatchewan River Basin Study focused on the Saskatchewan portion of the basin. It looked at the relationships between the quantity and quality of the water resource and its many uses. It provides information to help guide water management decisions in the interests of all water users. The study results will help ensure the water resources of the river basin can continue to meet the needs of existing and future uses within Saskatchewan.

Those involved with the study hope it will contribute to improved public understanding about this most valuable of all resources - water.

Brad Fairley
Study Director

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THE STUDY

Rip rap protects the Qu'Appelle Dam from erosion caused by waves

THE STUDY

This section of the report explains how the study originated, how it was managed and the process used to produce the final product.

STUDY BACKGROUND

The South Saskatchewan River represents the most reliable supply of good quality water in the southern half of Saskatchewan. As a result, it contributes significantly to the social and economic well-being of the people of the region. During the early 1980s, several events led to increasing concern about the ability of the river to meet future needs.

The water resources of the South Saskatchewan River are intensively used by Alberta. Alberta irrigates more than half a million hectares of land in its portion of the basin. During the mid-1980s, Alberta completed a planning study which identified a range of future development options. Several of the options provided for significant expansion of irrigation which would further reduce the amount of water passed to Saskatchewan.

Since its development more than 20 years ago, Lake Diefenbaker has become the focus for development in Saskatchewan's portion of the basin. This multi-purpose reservoir supports irrigation, hydro-electric energy generation, recreation, industrial and municipal water supply. In Saskatchewan, plans were also laid during the 1980s for further development based on the water resources of the South Saskatchewan River, particularly Lake Diefenbaker.

These plans included significant irrigation development. At the same time, proposals were made to further develop the recreation potential of the reservoir. Such developments would place additional demands on the water resources of the South Saskatchewan River.

While further development was being considered for the South Saskatchewan River Basin in both Alberta and Saskatchewan, there were several drought years in the 1980s. The droughts led to increased demand for water while the supply was reduced. In Saskatchewan, this caused problems for most water uses. There was concern regarding the ability of Lake Diefenbaker to support continued development. Weed growth at the upstream end of Lake Diefenbaker also led to concerns that the high quality water in Lake Diefenbaker was at risk.

The possibility of increased development, coupled with a reduced supply, led to greater concern about diverting water from the basin. Prior to the study, there had been a number of options identified for increased diversion of water from the South Saskatchewan River. However, when such diversions were identified, existing users expressed concern about the possible impacts. There was a clear need to determine the importance of the water in the basin to existing and potential future users.

The Canada-Saskatchewan South Saskatchewan River Basin Study was undertaken to provide information to guide water management. It will help ensure that the water resources of the basin can meet the needs of existing and future users.

THE STUDY AGREEMENT

On May 16, 1986, Federal Environment Minister Tom McMillan and Minister Responsible for SaskWater, Eric Berntson, signed the Canada-Saskatchewan South Saskatchewan River Basin Study Agreement. The agreement set aside 1.6 million dollars for the study with expenses shared equally by SaskWater and Environment Canada. The agreement established policies and procedures for a study of the Saskatchewan portion of the South Saskatchewan River Basin.

The agreement identified three objectives for the study:

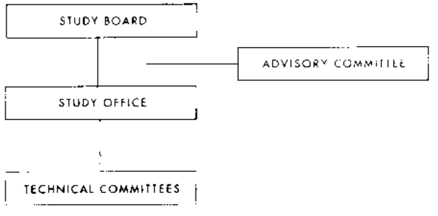
a. "document the current and emerging water and related issues in the South Saskatchewan River Basin in Saskatchewan;"

b. "carry out an assessment of the water and related resources of the South Saskatchewan Basin, and their current and future use;"

c. "develop a framework plan for the conservation and management of the water in the South Saskatchewan Basin in Saskatchewan which allows for the evaluation of water resource projects."

STUDY ORGANIZATION

The South Saskatchewan River Basin Study Board was responsible for the completion of the study. The board had one representative from each of the two sponsoring agencies: Environment Canada and SaskWater.



An advisory committee provided policy information to the study board. Senior officials, representing agencies with water management responsibilities or interests in the basin, made up the advisory committee.

The study board set up the South Saskatchewan River Basin Study Office and staffed it with a director, assistant director and secretary. The director was responsible to the study board for the day-to-day administration of the study.

Technical committees assisted the study office. Representatives for the committees were drawn from agencies with responsibilities related to water management. The agencies included federal and provincial departments, crown corporations and municipalities.

The technical committees provided the study office with expert advice on water quantity, water quality, water use and public involvement. A management strategies technical committee was responsible for drawing together the information produced by the other technical committees and identifying management options.

The technical committees also helped develop terms of reference for work carried out by consultants. More than 20 different consultants participated in the study. The consultants played a role in compiling the basic information needed to carry out the study.

Historic sites like Batoche provide an important link with the past

PARTICIPATING AGENCIES

Environment Canada
SaskWater

Agriculture Canada
Agri-Food Development Branch
Prairie Farm Rehabilitation Administration
Western Economic Diversification

Saskatchewan Environment and Public Safety
Saskatchewan Parks and Renewable Resources
Saskatchewan Culture, Multiculturalism and Recreation
Saskatchewan Rural Development
Saskatchewan Agriculture and Food

SaskPower
City of Saskatoon
Meewasin Valley Authority

PLANNING PROCESS

establish goals and objectives

▼

identify issues

▼

assess the resource

▼

identify management strategies

▼

evaluate management strategies

▼

develop recommendations and prepare the framework plan

Early in the study, the study board defined the planning process and eight planning principles.

The planning process included the use of a base year as the reference point for the analysis of future conditions. The base year for the South Saskatchewan River Basin Study was 1986 — the year the study began.

There were three separate planning exercises undertaken. They related to three different time horizons. The short-term planning exercise focused on the year 2000 and dealt with water management issues in the basin. The long-term planning exercise looked at the year 2020 and established a range of development options. The third and final planning exercise was the system-limit. It helped put the long-term planning exercise in perspective by identifying the development limits of the basin. The public participated in each planning exercise.

PUBLIC INVOLVEMENT

The study's public involvement program had two goals: to increase the public's understanding of the water resources of the study area and how they are managed; and, to provide the public with direct input to the study.

Study office staff compiled a list of individuals and groups interested in the study. The list with more than 1 000 addresses, included individuals, water users associations, environmental groups, wildlife organizations, Indian Bands, cottage groups, park boards, recreation groups and municipalities. This list was used to maintain communication with these groups throughout the study.

Representatives from the study office visited more than 50 different groups and agencies. During the visits, the representatives informed the groups about the study and gathered information about water resource management issues and development opportunities.

Forty members of the public participated in a survey. This five-round survey helped identify issues and possible solutions.

Study office staff prepared and distributed ten editions of a newsletter. The first edition was inserted in all newspapers distributed in the study area to create a general awareness of the study. Later editions were distributed to everyone who had asked to be placed on the mailing list. The newsletter provided basic information on water management and progress reports on the study.

During four rounds of public meetings, people had an opportunity to receive information and provide input to the study. These meetings were advertised through newspapers, radio and posters and held in communities located in the basin. At each meeting, the study director made a presentation on the study and its findings, and answered questions.

In addition, staff from the study office and the sponsoring agencies participated in conferences and trade shows. They also made presentations to service clubs and community groups upon request.

Swift Current Creek is the only significant tributary to the South Saskatchewan River in the study area

PLANNING PRINCIPLES

The wise and efficient management and use of water should be promoted through all possible means.

The ecological integrity of water resource systems should be maintained.

Public involvement is essential for the study to achieve its objectives.

All water uses that have social, economic or environmental value should be considered.

Domestic water use should be the highest priority among all uses.

The water resources of the basin should be managed for the benefit of all people in the province.

Water resources should be developed and managed consistent with the concept of sustainable development.

Interprovincial sharing of water is based on the Master Agreement on Apportionment.

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THE STUDY AREA

Pelicans often nest on the shores of Lake Diefenbaker

THE STUDY AREA

The Saskatchewan River system is the fourth longest in North America. The system's two main components, the North and South Saskatchewan rivers and their tributaries begin on the eastern slopes of the Rocky Mountains and flow across the prairies into Hudson Bay. It drains an area of about 336 000 square kilometres.

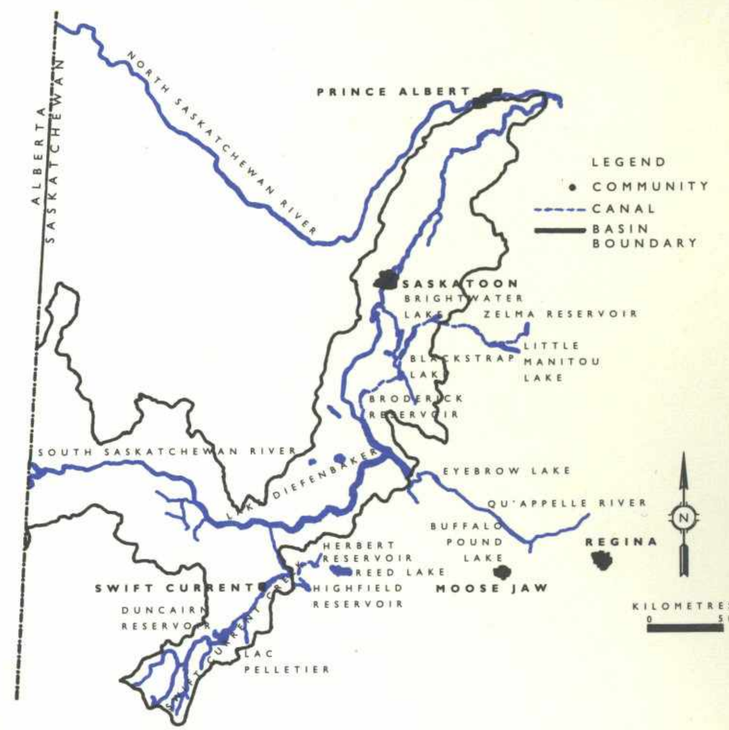
The South Saskatchewan River is fed by three major tributaries in Alberta: the Red Deer, Bow and Oldman rivers. These rivers converge near the Alberta-Saskatchewan boundary creating the South Saskatchewan River. The South Saskatchewan River flows east into Saskatchewan where it picks up the flow of Swift Current Creek, the only significant tributary in Saskatchewan. At Elbow, the South Saskatchewan River turns north and flows 380 kilometres until it meets the North Saskatchewan River near Prince Albert. From there, the Saskatchewan River flows into Manitoba.

The study area is that portion of the South Saskatchewan River Basin which lies in Saskatchewan. It includes all land that drains into the river. The study area is a complex ecosystem with important physical and cultural features.

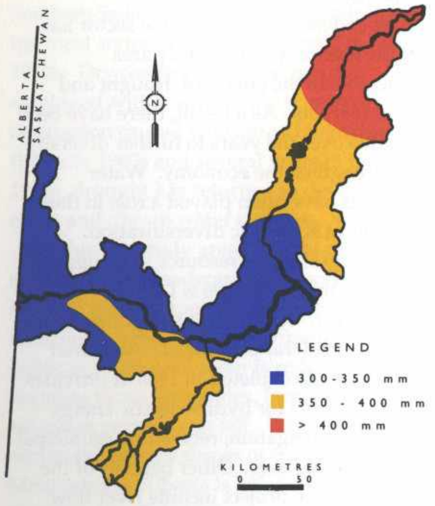
The following sections describe the study area and how it is managed.

SASKATCHEWAN RIVER BASIN

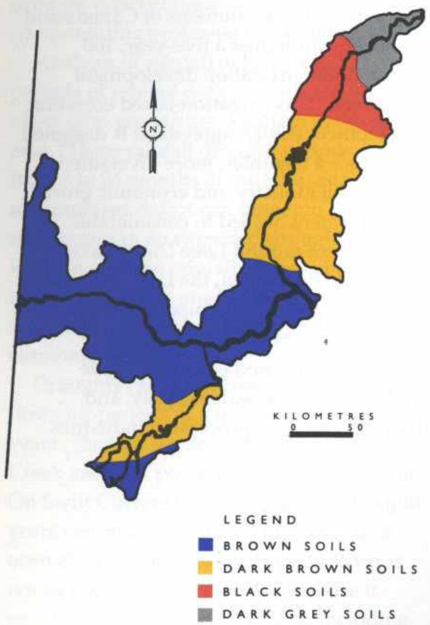
SOUTH SASKATCHEWAN RIVER BASIN IN SASKATCHEWAN



ANNUAL PRECIPITATION



SOILS



GEOGRAPHY

The bedrock of the study area is about 100 million years old. This bedrock formation is called the Bearpaw and is composed of alternating layers of clay, silt and sand. The glaciers deposited a layer of till over the area creating the landscape seen today.

The study area is relatively flat. Several sets of hills and the river valley provide the only breaks in the terrain. Elevations range from about 600 metres above sea level at the west end of the study area to 400 metres above sea level at the east end.

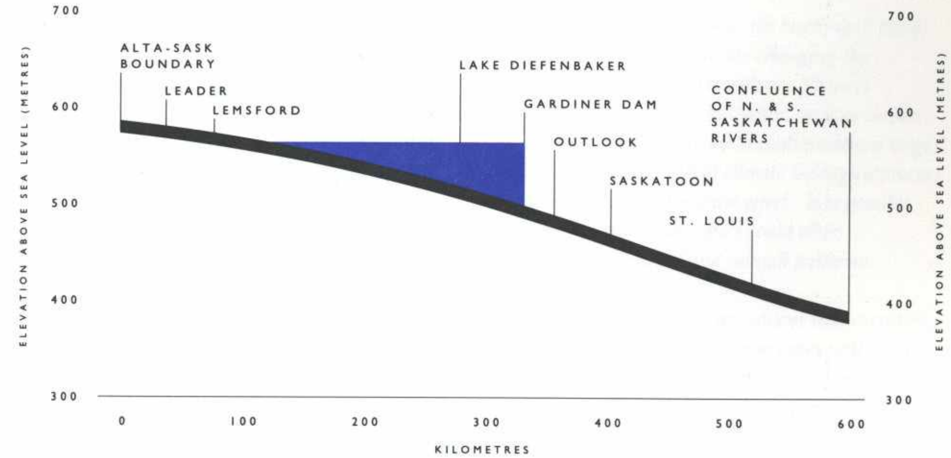
The climate of the study area, which is classified as cold continental, is characterized by short hot summers and long cold winters. Temperatures in the basin typically range from extremes of 38 degrees Celsius in summer to minus 40 degrees Celsius in winter. Annual precipitation varies from less than 300 millimetres in the west to more than 400 millimetres in the north.

Soils and vegetation are closely related. Short-grass prairie covers the dry southern half of the study area. In the wetter central portion of the basin, the mixed prairie predominates. The northern portion of the basin lies within the parkland region where higher rainfall supports aspen groves. Evergreen forest predominates at the northern tip of the study area.

The geography of the study area affects its water resources. Climate influences the timing of river flows. Peak flows on the South Saskatchewan River occur in June when the mountain snowpack melts. Low flows occur during the winter when most precipitation falls as snow and there is little runoff. Flows vary significantly one year to the next.

The landscape influences the drainage system. The study area is relatively flat.

PROFILE: SOUTH SASKATCHEWAN RIVER



This flatness results in a poorly defined drainage system producing many small sloughs, marshes and undrained lakes.

Soils and vegetation influence water quality. The soils of the basin are fertile and easily eroded. This results in high levels of nutrients and other dissolved and suspended materials in the waters of the study area.

HISTORY

The southern grassland area of Saskatchewan was originally inhabited by the Plains Indians. Their language gave rise to many of the names given to rivers, valleys and hills in the study area. The name Saskatchewan means swift current or rapid river.

The opening up of the study area, based on the fur trade, saw the South Saskatchewan River used as a major transportation route. The first transcontinental railway reached the southern plains in 1886, providing a more convenient and efficient way for incoming settlers to reach the area.

Since the turn of the century, the rich resources of the South Saskatchewan River Basin have enabled it to prosper. The population of the basin has continued to grow while the province's population levelled off. In addition, the rural population of the basin has remained constant while it has decreased in the remainder of the province.

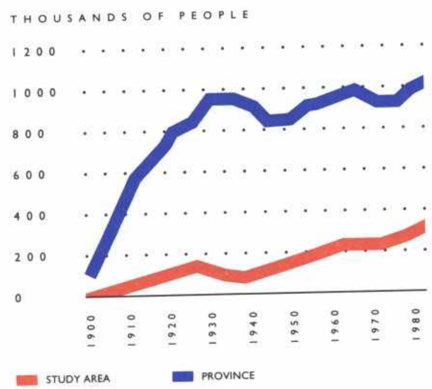
The climate and soils of the region made it an ideal area for grain production and so the early economy was based on farming. The last thirty years have seen the economy diversify. The development of resources like oil, potash and natural gas, has led to growth in the manufacturing and service sectors. The total value of output from the basin is larger than for any other river basin in the province.

Dependence on the resource sector has left the economy of the study area vulnerable to the effects of drought and world markets. As a result, there have been attempts over the years to further diversify and strengthen the economy. Water resources have often played a role in these attempts at economic diversification.

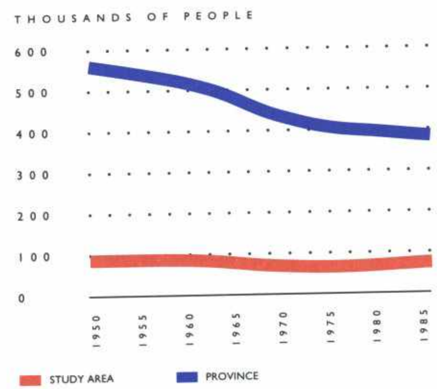
The largest water resource development project in the study area is Lake Diefenbaker. This project was constructed through a federal-provincial cost-shared agreement. Completed in 1968, it provides a water supply for hydro-electric energy generation, irrigation, recreation, municipal and industrial uses. Other benefits of the multi-purpose project include river flow regulation and flood control. It would cost more than one billion dollars to construct the project today.

In 1986, the Governments of Canada and Saskatchewan signed a five-year, 100 million dollar, irrigation development agreement. This irrigation-based economic development (IBED) agreement is designed to produce a healthier, more diversified agricultural industry and economic growth. The agreement has led to considerable development around Lake Diefenbaker. When fully developed, the Luck Lake and Riverhurst pressurized pipeline irrigation projects will serve more than 20 000 hectares. Associated projects include wildlife, domestic water supply, and livestock and food processing industries.

TOTAL POPULATION OF THE STUDY AREA AND THE PROVINCE



RURAL POPULATION OF THE STUDY AREA AND THE PROVINCE



Southern Saskatchewan has frequent droughts, the most serious of which occurred in the 1930s. Dry conditions on the prairies combined with a worldwide economic depression caused widespread hardship. In the early 1960s and several years in the 1980s, drought has returned to devastate crops and dry up water supplies.

Within the study area drought can take several forms. Inadequate or poorly timed rain can reduce crop yields. When the local snowfall is light, the spring runoff and recharge to ground water is reduced. Supplies to municipalities, farms and irrigation projects can fail. When snow and rain in the eastern slopes of the Rocky Mountains in Alberta is below normal, the resulting low flows affect many users on the South Saskatchewan River and Lake Diefenbaker. Occasionally, several types of drought occur at the same time, compounding problems for water users.

Analysis of rainfall data shows that periods of rainfall deficit which would affect crop growth are common in the study area. These rainfall drought periods range from 3 to 24 months in duration and the accumulated deficit can range up to 360 millimetres in an extended drought period. With an average rainfall of only about 350 millimetres in the study area, it can take several years of above average rainfall to eliminate this deficit.

Droughts can affect rivers by reducing flows for periods of a few months to several years. Smaller streams like Swift Current Creek are most prone to extended droughts. On Swift Current Creek the flow in drought years can be as little as twenty percent of normal. The South Saskatchewan River is not as susceptible to drought because it receives runoff from a large area including the Rocky Mountains. As a result, the supply of water in drought years is usually no less than half of normal. However, in drought years when the flows are lower than normal, human uses have a much greater impact on the river.

Related to the issue of drought is climate change. Many people believe that the increased concentration of greenhouse gases such as carbon dioxide might lead to a climate change. Long-term temperature increases could reduce water supply and lead to increased demand, making problems associated with drought worse than at present.

The battle to overcome drought in southern Saskatchewan has been a priority for the people and governments throughout the past century. Many successful methods to fight drought have been found.

People have learned that deep ground water is resistant to the effects of drought. Ground water now represents a more reliable source for farms and small towns. Unfortunately, ground water is not available in all areas.

Improved agricultural practices have greatly reduced the impacts of drought. Experience has shown that stubble and reduced tillage can prevent erosion and conserve soil moisture. In addition, agricultural research has produced drought resistant crops.

The construction of water storage projects has also reduced the effects of drought. These projects range in size from small farm dugouts to larger reservoirs like Duncairn Reservoir and Lake Diefenbaker. Water available during wet periods can be stored for use during droughts.

Irrigation is yet another means of coping with drought. Irrigation can help stabilize crop production and allow greater crop diversity.

In addition to improved agricultural methods and structural developments, the people of the region have learned to deal with drought by conserving water and rationing it when it is in short supply.

Despite the progress made in dealing with drought, it continues to cause hardship. Efforts to reduce its harmful effects will always be a part of prairie life.

Human activities such as the burning of fossil fuels and deforestation are changing the composition of the atmosphere. There is widespread concern that gases, such as carbon dioxide, are building up to concentrations large enough to affect global climate through a process known as the greenhouse effect. It is possible that the greenhouse effect could alter temperature, wind and rainfall patterns.

While there is general agreement that increasing concentrations of greenhouse gases will affect climate, there is considerable uncertainty about the magnitude of the effect, the timing and the impact on specific areas like the South Saskatchewan River Basin. As a result, it was not possible to consider it in detail within the Canada-Saskatchewan South Saskatchewan River Basin Study.

Until more definite information is available on climate change and its impacts, water managers must keep decisions regarding future water supply and use as flexible as possible. The models developed by the South Saskatchewan River Basin Study can incorporate new information on the effects of climate change when it becomes available.

SYSTEM OPERATIONS

The study area consists of three interrelated systems: the mainstem of the South Saskatchewan River; the Saskatoon Southeast Water Supply system; and the Swift Current Creek system. SaskWater is responsible for the management of these systems.

South Saskatchewan River

Alberta manages its portion of the South Saskatchewan River Basin to meet the needs of many different users. A series of dams allow Alberta to regulate the flow to a large extent. Alberta operates the system within the terms of the Master Agreement on Apportionment. Under this Agreement, Alberta must allow 50 percent of the flow to pass to Saskatchewan. In drought years, Alberta has rationed water among its users in order to meet its obligations to Saskatchewan.

No significant management of South Saskatchewan River flows was possible in Saskatchewan until Lake Diefenbaker was completed in 1968. This lake has a storage capacity approximately equal to the average annual flow of the river. As a result, it permits management of the water resource to a substantial degree.

Lake Diefenbaker has changed the character of the river downstream. The seasonal flow pattern is reversed with winter flows now exceeding summer flows. The reservoir has also reduced erosion, improved water quality and changed the shoreline vegetation.

Flood flows downstream of the lake have been significantly reduced and the flows are much more reliable as a result. In addition to reducing the risk of flooding, the regulated flows improve the value of the water for downstream hydro-electric energy generation and recreation.

Because the runoff varies from year to year, the operators cannot guarantee that conditions for all users will be the same every year. Based on the best forecasts of inflows, the operators try to balance the needs of all users with the available supply each year. In drought years the lake level and downstream river flows are usually lower than desirable. A minimum flow is maintained downstream of Lake Diefenbaker in drought years. In flood years lake levels and river flows tend to be higher.

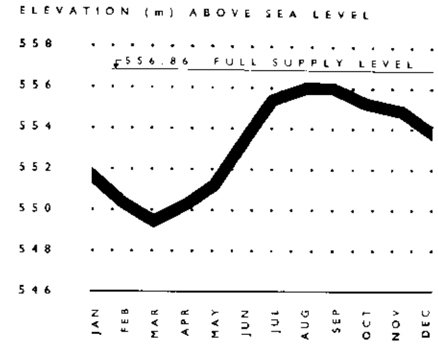
LAKE DIEFENBAKER

Area	43 000 hectares
Length	225 kilometres
Maximum depth	58 metres
Capacity	9 400 000 cubic decametres

Lake Diefenbaker has raised the water level in the South Saskatchewan River valley. This makes the water much more accessible to water users such as irrigators and wildlife projects on the uplands around the lake. Lake Diefenbaker also permits gravity diversion of water into the Qu'Appelle River system for municipal, agricultural, recreation and wildlife uses.

The only other control structure on the mainstem is a three metre high weir in Saskatoon which helps to stabilize the water level of the river in the city. Sedimentation has reduced the effectiveness of the weir.

LAKE DIEFENBAKER AVERAGE ELEVATIONS



Saskatoon Southeast Water Supply (SSEWS) System

The SSEWS system consists of a series of pump stations, canals and reservoirs. It begins at Lake Diefenbaker and ends near Lanigan, 150 kilometres away. The system delivers water to municipal, industrial, agricultural and waterfowl projects. SaskWater owns and operates the system.

The SSEWS system starts at the East Side Pump Station located near Gardiner Dam. The pump station lifts water into a canal where it flows by gravity to Broderick Reservoir. This reservoir supplies the South Saskatchewan River Irrigation District Number 1 and the town of Broderick.

A canal flows from Broderick Reservoir to Brightwater, the next reservoir in the system. The town of Hanley and a number of waterfowl projects draw water from Brightwater Reservoir. A canal delivers water from Brightwater Reservoir to Blackstrap Lake.

SaskWater manages Blackstrap Lake for water-based recreation. Operators hold water levels stable so that beaches are attractive and docks and boat launches work properly. Several irrigation projects and municipalities also draw water from Blackstrap Lake.

Downstream of Blackstrap Lake, canals deliver water to Bradwell and Zelma reservoirs and Little Manitou Lake. Bradwell and Zelma reservoirs serve several potash mines, towns, irrigation and waterfowl projects. Water is pumped to Dellwood Reservoir to meet municipal and industrial uses.

The canal capacities of SSEWS system are not large enough to meet the summer peak demands when the irrigators require large volumes of water. In order to meet these peak demands, operators must fill the reservoirs before the irrigation season starts. It is easier to meet the needs of municipal, industrial and waterfowl projects because their demands are relatively small or spread throughout the year.

SASKATOON SOUTH EAST WATER SUPPLY SYSTEM

SSEWS SYSTEM RESERVOIRS

RESERVOIR	AREA (hectares)	CAPACITY (cubic decametres)
Broderick	522	16 400
Brightwater	252	8 200
Blackstrap	1 250	61 650
Bradwell	163	4 620
Zelma	416	14 500
Dellwood	225	5 800

MASTER AGREEMENT ON APPORTIONMENT

The Master Agreement on Apportionment, which was signed in 1969 by Canada, Alberta, Saskatchewan and Manitoba, is administered by the Prairie Provinces Water Board. The Agreement governs the quantity and quality of water in all interprovincial eastward flowing streams including the South Saskatchewan River. The conditions of the agreement which apply to the South Saskatchewan River are summarized below:

- *Alberta must pass 50 percent of the natural flow in the river to Saskatchewan.*
- *Alberta is allowed to consume 2 600 000 cubic decametres annually, even if this exceeds 50 percent of the natural flow.*
- *Alberta must maintain a minimum flow of 42.5 cubic metres per second to Saskatchewan or half the natural flow whichever is less.*
- *Saskatchewan must pass to Manitoba half of the flow it receives from Alberta and half of all flow originating in the Saskatchewan portion of the basin.*

Swift Current Creek

Although Swift Current Creek is the largest tributary to the South Saskatchewan River in Saskatchewan, it contributes less than one percent of the flow in the river. As a result, the management of Swift Current Creek has no effect on the South Saskatchewan River.

Swift Current Creek relies on spring runoff for most of its flow and so the water supply in the basin is highly variable. Duncairn Reservoir, also known as Reid Lake, was constructed in 1942 to stabilize the water supply. The reservoir stores water during periods of high flow so that it can be used during dry periods. Duncairn Reservoir supplies water for municipal, waterfowl, fisheries and irrigation purposes.

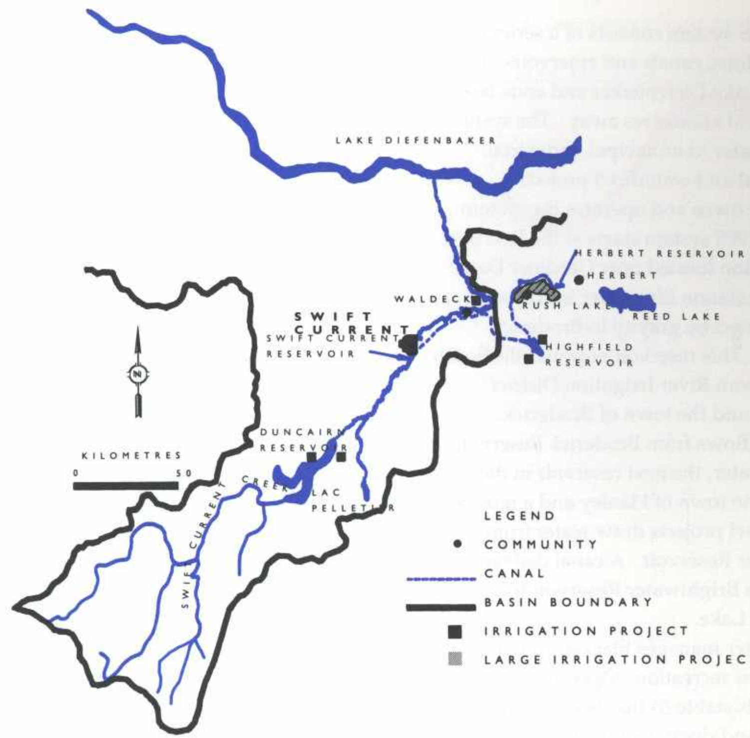
Water flows from Duncairn Reservoir down Swift Current Creek to Swift Current Reservoir. From this small reservoir, water is distributed to a number of users. Releases are made to supply users located further downstream on Swift Current Creek. The city of Swift Current withdraws its water from the reservoir. In addition, a series of canals and reservoirs deliver water from Swift Current Reservoir to municipal and irrigation users outside the basin. These users include the town of Herbert and the Rush Lake and Herbert irrigation projects.

Lac Pelletier is a small lake on Pelletier Creek, a tributary of Swift Current Creek. A small control structure is used to stabilize water levels for recreation. The stable water levels enhance conditions for cottagers who boat and fish.

SaskWater and PFRA co-operate in the management of the Swift Current Creek system. Management effort focuses on Duncairn Reservoir, the major storage reservoir in the system. Although Duncairn Reservoir permits storage of water from wet to dry years, it does not have sufficient capacity to totally stabilize the supply. Operators always keep sufficient water in the reservoir to protect fish in the reservoir and to guarantee water for the city of Swift Current. As a result, a series of dry years can lower reservoir levels and reduce the supply of water for irrigation.

Water uses in Swift Current Creek have developed to the point where the supply is inadequate in dry years. Irrigation shortages and rationing occur about 25 percent of the time. SaskWater has restricted further irrigation development because it would make the shortages worse.

SWIFT CURRENT CREEK SYSTEM



SWIFT CURRENT CREEK SYSTEM RESERVOIRS

RESERVOIR	AREA (hectares)	CAPACITY (cubic decametres)
Duncairn	1 451	103 000
Lac Pelletier	300	16 700
Swift Current Creek	32	421
Highfield	519	14 900
Herbert	63	2 600

The towers on the top of Gardiner Dam house equipment used to control the amount of water flowing through the dam

3

THE ISSUES

Spillway gates are operated to protect Gardiner Dam during floods

THE ISSUES

The first objective of the study agreement was to identify the current and emerging water management issues in the study area. For the purposes of this study, issues were considered to be matters where some question, dispute or controversy existed. The study also analyzed the issues to help the public and water managers better understand them.

The public, particularly those segments of the public that are likely to be directly affected by the study results, played an important role in identifying issues. Study office staff contacted representatives of interest groups. These groups represented recreation, environment and municipal interests.

Through public meetings and newsletters, the views of the public were also collected. In identifying issues, study office staff also reviewed government reports, conference proceedings and professional and academic journals. Government agencies with water management responsibilities were also consulted.

A wide range of issues were identified. The issues ranged from those specific to a particular area within the basin to those common to the entire basin. Some of the issues were also common to the prairies and, in some cases, North America.

The water users of the study area have different understandings of the water resource and the issues surrounding its management. In some cases, issues stemmed from: vested interests; an unwillingness to accept information; and, an incomplete understanding of the resource. Public education and information can help resolve these issues.

The issues are presented below by geographic distribution.

BASIN-WIDE ISSUES

More than 95 percent of the water in the South Saskatchewan River comes from Alberta. As a result, people raised concerns about the quantity and quality of water coming from Alberta and how they might change in the future.

Drought is a recurring problem which affects the study area in two ways. First, local shortages of precipitation can increase the demand for water by users. Second, if the snowfall in the Rocky Mountains is below normal, the flow in the South Saskatchewan River is reduced. Either type of drought can cause problems. When they coincide, as they did in 1984, the water management problems become much worse. In addition to reducing water supplies, drought can lower water quality.

Related to the issue of drought is climate change. Many people believe that the increased concentration of greenhouse gases such as carbon dioxide might lead to a climate change. Long-term temperature increases could reduce water supply and lead to increased demand, making problems associated with drought worse than at present.

People throughout the study area expressed concern about the health of the natural environment. In particular, environmental issues like waterfowl staging, wetland drainage and shoreline habitat were identified. Other concerns included long-term changes in the environment and its ability to support future development.

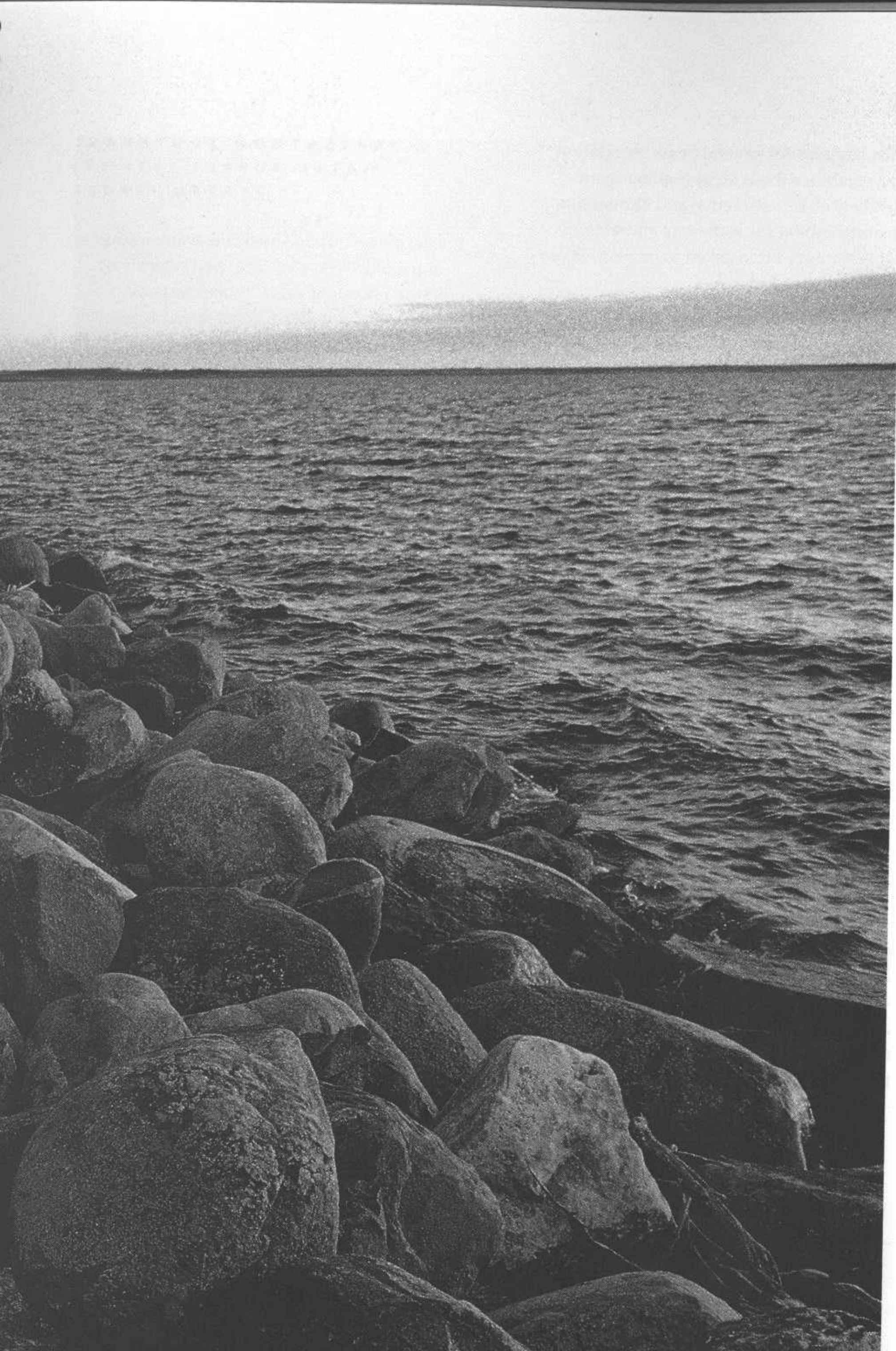
A number of the basin-wide issues focused on water quality. Concern was expressed about pesticides, salinity, mercury and algae and weeds because they reduce the quality of water for all uses.

Several groups identified diversion of water as an issue. Water is diverted out of the basin at three locations: Swift Current Creek, the SSEWS system and the Qu'Appelle Dam. Although the total amount of water diverted is small, there were concerns expressed that these diversions might affect existing uses of the river. The public also expressed concern that more water might be diverted from the basin in the future.

Several communities which are not located on the South Saskatchewan River experience problems with water supply. Water quality problems are also common in some communities. These problems with supply can slow economic development.

Issues related to land management were also identified. There was concern expressed about soil management. Soil salinity can result from natural causes and agricultural practices. In addition, excessive tilling can lead to erosion which can affect the water quality.

Water is released from Lake Diefenbaker through the Qu'Appelle Dam to stabilize flows in the Qu'Appelle River system



ISSUES UPSTREAM OF LAKE DIEFENBAKER

The water resources upstream of Lake Diefenbaker are the least intensively used in the study area. As a result, there were few issues unique to this particular part of the basin. All of the issues identified related to the fluctuations in flow and water level. At times, these fluctuations cause problems for irrigation intakes and ferry operation. They can also make the river unsuitable for water-based recreation activities.

LAKE DIEFENBAKER ISSUES

Most of the issues identified specific to Lake Diefenbaker relate to its operation. Operators consider all the different uses when managing the reservoir. In general, this involves storing a portion of the high summer flows to fill the reservoir by late summer. The water stored during the summer months is released during the winter to generate hydro-electric energy.

When there is not enough water to fill the reservoir most uses suffer. Recreational uses like boating and swimming become more difficult. Some irrigators experience difficulty reaching the water with pump intakes and, when they can reach it, their pumping costs increase. Hydro-electric energy generation is reduced. In addition, waterfowl and fish habitat become less productive.

During flood years, inflow to the reservoir can also cause problems. If the reservoir fills early in the summer, its ability to protect downstream areas from flooding is reduced. High water levels reduce shoreline habitat and the amount of beach area available for recreation.

Algae and weed growth is an issue throughout the basin. However, they are of particular concern at Lake Diefenbaker. High concentration of plant nutrients already cause problems at the upstream end of Lake Diefenbaker. If nutrient concentrations are allowed to increase in the main portion of the reservoir, algae and weeds would cause problems for most uses. As a result, the reservoir's value to southern Saskatchewan would be reduced.

Water managers identified shoreline management as an issue at Lake Diefenbaker. The high rate of shoreline erosion in some areas can make development hazardous. Agricultural practices in areas adjacent to the reservoir can increase the flow of sediment and pesticides to the lake.

ISSUES DOWNSTREAM OF LAKE DIEFENBAKER

Concerns raised in this part of the basin often related to summer flows. In drought years, water managers sometimes reduce flows to 42.5 cubic metres per second. At this flow, ferry operation and recreational uses can be impaired. Low flows contribute to poor water quality downstream of Saskatoon.

In wet years, flooding can occur downstream of Lake Diefenbaker. High flows make the river unsafe for recreation and increase the rate of erosion. The erosion can result in the loss of crop land and damage to shoreline structures. Increased flows during the goose nesting season can destroy nests.

Hydro-electric energy production produces hourly fluctuations in flow and water levels immediately downstream of Gardiner Dam. These fluctuations reduce the suitability of the river for recreation and irrigation pumping.

Several groups identified insufficient public access to the river as an issue. At Saskatoon, where the river is intensively used for recreation, there is abuse of private property by people trying to get to the river.

Municipal and industrial effluent was identified as an issue both within Saskatoon and downstream. At times of low flow, these effluents reduce the suitability of the river for recreation immediately downstream of the city.

Although Lake Diefenbaker has reduced the rate of bank erosion in the river downstream, erosion remains an issue in some areas. Productive farm land is lost and damage to shoreline facilities, like pump sites, occurs.

During periods of low flow, large sand bars and islands are sometimes exposed. If this happens for several years, vegetation may stabilize these areas making them aesthetically unattractive and eliminating nesting habitat for some rare shorebirds. Operators are often asked to increase flows to flush the system.

SWIFT CURRENT CREEK ISSUES

The water resources of Swift Current Creek are the most intensively used in the study area. Swift Current Creek is used by municipalities, irrigators and different types of recreation.

As a typical prairie stream, the flow on Swift Current Creek varies significantly. While the risk associated with flooding has been reduced through reservoir operation and land use controls, flooding remains a concern.

In years with low flow, there is sometimes not enough water to meet all the needs. In these years, rationing among irrigators becomes necessary. This can have significant economic impacts on farmers. There is also some concern about whether there is enough water in the basin to support growth by the city of Swift Current.

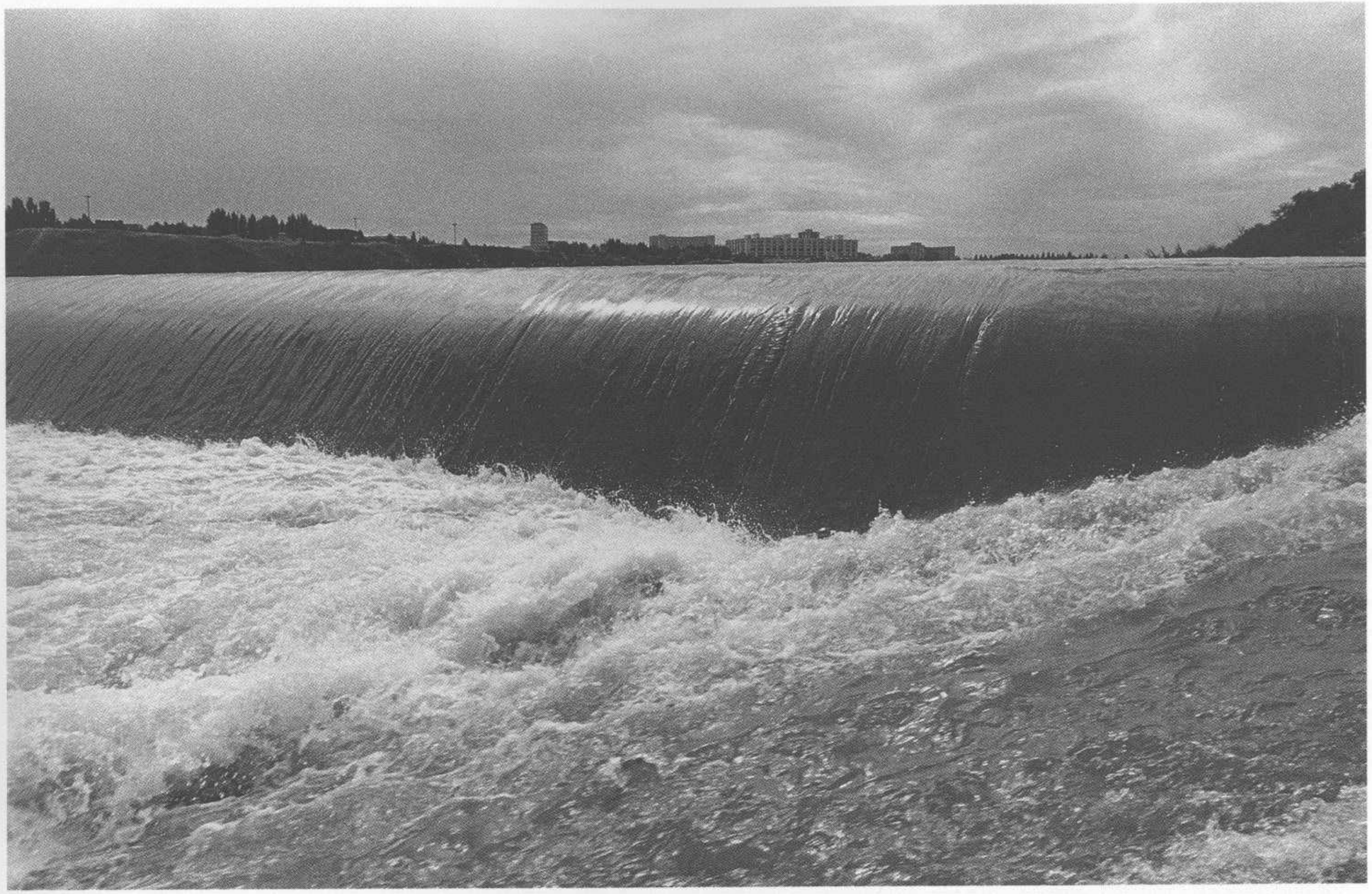
Water managers identified shoreline management as an issue on Duncairn Reservoir. Unauthorized cottage development has occurred in the flood zone. These developments could reduce opportunities to increase the storage in the reservoir.

SASKATOON SOUTHEAST WATER SUPPLY (SSEWS) SYSTEM ISSUES

Like Swift Current Creek, the water resources of the SSEWS system are used intensively. During drought years, when the peak demands for water are high, it is necessary to ration water among irrigators.

Water quality is an issue within the SSEWS system. Due to high evaporation rates and ground water inflows, the quality of the water deteriorates with distance from the source. Concentrations of salt in the reservoirs are approaching levels where some uses could be affected.

The South Saskatchewan River Irrigation District Number 1 (SSRID), a major water user on the SSEWS system, was developed in the early 1970s. Due to limited experience with irrigation in the province at that time, some problems developed. Most notable was the reduced productivity of some land within SSRID because of a high water table and the build up of salt in the soil. Irrigation development has slowed in these problem areas. Research is underway to identify economical ways of dealing with these problems.



The Saskatoon weir was built in 1939 to stabilize water levels on the South Saskatchewan River within the city.

Basin-wide

- *quantity of water coming from Alberta*
- *quality of water coming from Alberta*
- *ecosystem health*
- *climate change*
- *wildlife habitat*
- *drought*
- *eutrophication*
- *organic contaminants*
- *salinity*
- *mercury*
- *diversion of water out of the basin*
- *municipal water supply*
- *soil management*
- *wetlands*

Upstream of Lake Diefenbaker

- *flow and water level fluctuations*

Lake Diefenbaker

- *fluctuating water levels*
- *eutrophication*
- *shoreline management*

Downstream of Lake Diefenbaker

- *flow and water level fluctuations*
- *summer flows*
- *public access*
- *municipal and industrial effluent*
- *erosion and sedimentation*

Swift Current Creek

- *municipal water supply*
- *irrigation water supply*
- *flooding*
- *shoreline management*

SSEWS System

- *water supply*
- *water quality*
- *soil salinity*

4

RESOURCE ASSESSMENT

The Great Sand Hills are a unique natural feature of the study area

RESOURCE ASSESSMENT

Water Quantity

The second objective of the study was to assess the water and related resources of the study area. This was done from four different perspectives: water quantity, water quality, water use and the environment.

WATER QUANTITY

Water quantity affects most water uses either directly or indirectly. Ferries require a specific depth to operate while the amount of hydro-electric energy produced is directly related to the amount of water that flows through the turbines. Water quantity can also affect water quality which deteriorates during low flow.

Water Quantity Measurements

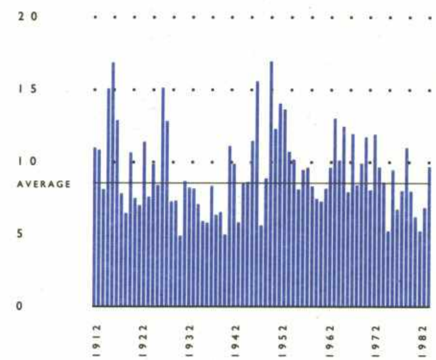
Volume is the most common way of measuring water quantity. Water managers measure volume in cubic decametres (dam^3) — a ten metre cube. A standard farm dugout has a capacity roughly equal to one cubic decametre.

The rate of flow is another common way of measuring water quantity. Flow measures the volume of water that moves past a point in a given period of time. Flow is commonly measured in cubic metres per second (m^3/s). It would take about 1 000 garden hoses to produce a flow equal to one cubic metre per second. A flow of 1 m^3/s would fill a farm dugout in about 15 minutes.

Natural flow can be defined as the flow that would have occurred if there had been no human intervention. It is calculated by adding the amount of water used by developments to the measured flow. The Master Agreement on Apportionment, the agreement which governs the sharing of water between prairie provinces, is based on natural flow.

SaskWater and Environment Canada co-operate to measure river flows and reservoir elevations at more than 15 different locations in the study area.

SOUTH SASKATCHEWAN RIVER ANNUAL NATURAL DISCHARGE

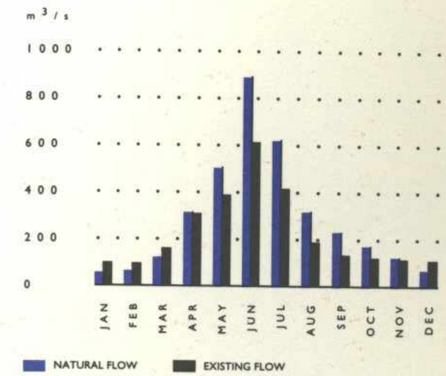


South Saskatchewan River

On average, Alberta uses 22 percent of the flow in the South Saskatchewan River. In dry years when the supply is smaller, the Alberta use rises to 42 percent. Alberta also changes the seasonal pattern of flows reducing high summer peaks and increasing winter low flows.

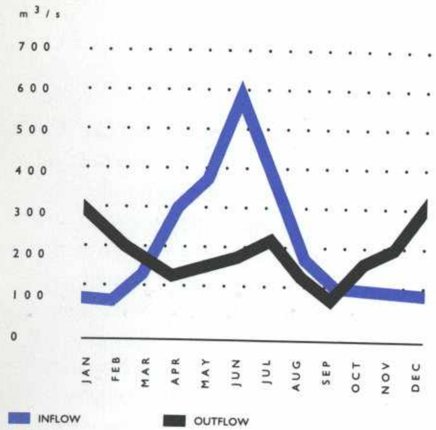
In the study area, the average annual natural discharge of the South Saskatchewan River is 9 400 000 dam^3. About 60 percent of the flow occurs in May, June and July. During these months the snow on the eastern slopes of the Rocky Mountains melts and runoff from early summer rains enters the river. Monthly average flows of more than 2 000 m^3/s have occurred. The peak flow exceeded 4 000 m^3/s in 1953.

MONTHLY FLOWS FOR NATURAL AND EXISTING CONDITIONS AT THE ALBERTA-SASKATCHEWAN BOUNDARY



Lake Diefenbaker and its operation has changed the natural flow patterns of the South Saskatchewan River. The reservoir is used to store water during the summer and release it during winter. As a result, the size and frequency of summer flood peaks downstream of Lake Diefenbaker have been greatly reduced. In addition, winter minimum flows which occasionally dropped below 20 m^3/s now average about 200 m^3/s. In drought years, Lake Diefenbaker is used to maintain a downstream minimum flow of 42.5 m^3/s.

LAKE DIEFENBAKER INFLOW-OUTFLOW COMPARISON



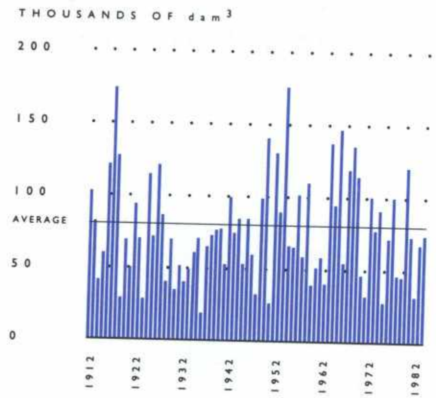
Lake Diefenbaker has increased the amount of water lost to evaporation. About 250 000 dam^3 of water are lost from the lake's 40 000 hectare surface area each year. Irrigation, recreation, waterfowl and municipal developments on Lake Diefenbaker consume an additional 250 000 dam^3. The water lost to evaporation and use on the reservoir is not available to downstream users.

The South Saskatchewan River carries a large quantity of sediment. Each year 6 700 000 tonnes of sediment enters Lake Diefenbaker. All of this suspended material is caught in the lake. Most of it collects in the west end of the lake where it appears as mud flats during periods of low water. The sediment does not affect the usefulness of the reservoir. At the current rate, it will take about 1 400 years to fill the lake with sediment.

Swift Current Creek

The flow in Swift Current Creek is highly variable because it is entirely dependant upon local runoff. Annual natural discharge varies from a high of about 270 000 dam^3 to a low of about 20 000 dam^3. The average annual natural flow is about 80 000 dam^3 — less than one percent of the flow in the South Saskatchewan River. The flow on Swift Current Creek also varies dramatically from one season to the next. Natural flows peak in April at about 12 m^3/s and decrease to less than 1 m^3/s in the winter months.

SWIFT CURRENT CREEK ANNUAL NATURAL DISCHARGE

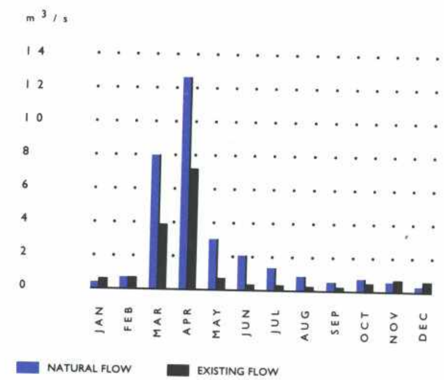


In 1942 the Duncairn Dam was built creating Duncairn Reservoir. The reservoir stores water during high flow periods for release during low flow periods. A number of water uses have developed to take advantage of the reliable supply of water.

The reservoir and its associated uses dramatically affect the quantity of water available in the basin. Consumption now reduces flows at the mouth of the creek to about 30 percent of the naturally occurring values. The seasonal distribution of flows has been changed through the maintenance of a base flow during dry summer months and during the winter months when the channel normally freezes.

Duncairn Reservoir controls floods in about 80 percent of the years. In flood years the flows can be reduced by as much as 50 percent. However, in extreme floods, damage to farming operations and urban development in the valley occurs.

SWIFT CURRENT CREEK MONTHLY FLOWS FOR NATURAL AND EXISTING CONDITIONS



Saskatchewan River

Downstream of the study area the South and North Saskatchewan rivers join to form the Saskatchewan River. The North and South Saskatchewan rivers contribute equally to the flow in the Saskatchewan River. As a result, water management in the study area affects downstream flows important to hydro-electric energy generation, ferry operation, hunting and fishing.

Ground Water

Some farms, communities and industries rely on ground water. The quantity and quality of ground water is, however, inadequate for major developments at most locations in the study area. Existing users in the study area withdraw about 23 000 dam^3 per year of ground water. The potential sustainable yield of ground water is estimated to be 500 000 dam^3 per year. However, much of this water is of poor quality and would be expensive to obtain.

WATER QUALITY

Water represents a vital part of the ecosystem. All living things depend on water for their survival; a high quality resource is therefore important for the well-being of the entire ecosystem.

Water Quality Measurements

The precise quality of water required depends on its intended use. Drinking water must be free from constituents which are damaging to our health. Recreational water users prefer a weed and algae free environment, and yet, weeds and algae provide habitat for aquatic organisms, including fish. Irrigators require water which is free of pathogens and compounds which are damaging to plant growth. Municipalities and industries prefer water of as high a quality as possible, otherwise the costs of treatment and distribution are increased.

The physical, chemical and biological characteristics of water are measured to help ensure its suitability for different uses.

Physical measurements include the concentration of dissolved oxygen, temperature and clarity. These can affect the usefulness of water to fish or the suitability for human consumption.

The chemicals found in water can be broken into four groups: salts, nutrients, metals and pesticides. High concentrations of ions like sodium, potassium, calcium and sulphate can negatively affect crops and aquatic organisms. They can also interfere with industrial processes. Water high in sodium is not suitable for irrigation because of its effect on soil structure. Sodium also contributes to heart problems in people.

Nutrients like phosphorus and nitrogen can stimulate aquatic plant growth. Algae and weeds can reduce the suitability of the water for a wide variety of uses. High levels of nitrate in drinking water pose a health risk to people. Municipal sewage and agricultural runoff are common sources of nutrients.

Metals like iron and manganese, can give drinking water an unpleasant taste. Others, such as copper and silver, are toxic to aquatic life at fairly low concentrations. Many of these metals occur naturally in the environment.

Pesticides can be detected in concentrations as low as a few parts per billion. At these concentrations they cannot be tasted, seen or smelled. Pesticides are sometimes found in agricultural runoff.

Water is routinely checked for the presence of bacteria. Certain bacteria indicate possible contamination of the water. Contaminated waters cannot be used for irrigation and swimming because of the risk to human health.

Saskatchewan Environment and Public Safety and Environment Canada are responsible for monitoring water quality in the study area. Together they routinely monitor water quality at eight different sites.

South Saskatchewan River

The South Saskatchewan River begins as clean, clear water flowing out of the Rocky Mountains. As the water flows across Alberta, there is some decline in its quality. There is some natural accumulation of sediment, salts and nutrients. Irrigation return flows, and municipal and industrial sewage also change the water quality. When the water reaches Saskatchewan it is still suitable for all uses.

Within the study area, Lake Diefenbaker causes the first significant change in water quality. As the South Saskatchewan River enters the reservoir, it deposits large amounts of nutrient-rich sediment which cause algal blooms. By acting as a settling pond, Lake Diefenbaker significantly improves the water quality. At the downstream end of the lake, the quality of the water is amongst the highest in southern Saskatchewan.

As the water flows north from Lake Diefenbaker, its quality deteriorates. Local runoff contributes small amounts of pesticides and fertilizers while several communities periodically discharge their sewage lagoons into the river. Water quality deteriorates further at Saskatoon. Within the city, large volumes of municipal and some industrial sewage increase the concentration of most types of pollution. These include nutrients, metals, bacteria and salts.

The concentrations of the pollutants decrease downstream of the city, but some remain above background levels all the way to the North Saskatchewan River.

At one time, mercury was being released into the river near Saskatoon. Since the elimination of an industrial mercury source, the concentration of mercury in the river continues to diminish. Saskatchewan Parks and Renewable Resources publish fish consumption guidelines to reduce risk to human health.

Further downstream methoxychlor, a pesticide, is released into the river to control blackfly larvae. Although the methoxychlor disappears quickly from the water, it can be found in the sediments long after its use. Work is underway to find a suitable replacement.

WATER QUALITY OBJECTIVES

Water quality objectives provide a basis for managing water quality. Where the existing water quality is better than the objectives, measures will be taken to maintain the existing water quality. Where the existing water quality does not meet the objectives measures will be taken to improve water quality to meet the objective.

Water quality objectives were developed for the study area using existing water quality data and scientific information regarding the effect of water quality on specific uses. The following list identifies some of the water quality objectives for the South Saskatchewan River.

	Objective
Dissolved Salts	*500 mg/L*
Phosphorus	*0.06 mg/L*
Iron	*1.0 mg/L*
Manganese	*0.2 mg/L*
Copper	*0.01 mg/L*
Nickel	*0.025 mg/L*
2,4-D	*0.002 mg/L*
Carbofuran	*0.0017 mg/L*
Coliform Bacteria	*100 000/L*

WHAT IS EUTROPHICATION?

Eutrophication is a natural aging process whereby a body of water becomes richer in plant nutrients such as phosphorus and nitrogen. Although eutrophication is a natural occurrence, people can dramatically accelerate the process.

By disposing of sewage into a watercourse or causing increased erosion from land, the concentration of plant nutrients can be increased. This often leads to excessive weed and algae growth which can reduce the suitability of the water for recreation. When the plant matter decomposes, it consumes the oxygen in the water. This can make water unsuitable for drinking and can kill fish and other aquatic life.

Parks in the study area provide recreation for more than one million visitors each year

Water Quality

SUMMER PHOSPHORUS LEVELS IN THE SOUTH SASKATCHEWAN RIVER

Saskatoon Southeast Water Supply (SSEWS) System

The SSEWS system withdraws relatively high quality water from Lake Diefenbaker and delivers it to users through a series of canals and reservoirs. The quality of the water deteriorates as it moves through the system.

Low flows and high evaporation have combined to increase the concentration of salt in the SSEWS system reservoirs. The situation has been made worse by inflows of highly saline ground water. The concentration of salt in Bradwell and Zelma reservoirs has increased to the point that irrigation of some crops is not possible. Little Manitou Lake is a natural saline lake. With no outlet, evaporation has concentrated salts over thousands of years.

Nutrient levels also increase with distance from the source. At Blackstrap Lake, nutrients produce weed growths which inhibit recreational activities like boating and swimming.

Swift Current Creek

The water quality of Swift Current Creek is fairly typical of prairie streams. The low summer flows and fertile soils produce naturally high levels of sediment, salts and nutrients.

Human activities have affected water quality. Runoff from agricultural areas contributes nutrients and pesticides to the creek. However, reservoirs in the system improve water quality by maintaining base flows during dry periods. Municipal sewage does not affect water quality because Swift Current, the only major municipality in the Swift Current Creek basin, uses effluent irrigation.

Although the water quality in Swift Current Creek is poor when compared to the South Saskatchewan River, it is adequate to meet the needs of existing uses.

More than half of the flow in Swift Current Creek is withdrawn each year. The flow that remains represents less than one percent of the flow in the South Saskatchewan River. As a result, Swift Current Creek has no effect on the water quality of the South Saskatchewan River.

Ground Water

The quality of ground water in the study area varies with location and depth. There are small shallow deposits of high quality ground water located throughout the basin which can be used for most purposes. The larger more reliable sources of ground water tend to be much deeper but have high concentrations of salt which can limit their use. Sampling indicates that water quality generally deteriorates with depth. The deepest ground water is of very poor quality and is unsuitable for most uses.

WATER USE

The water of the South Saskatchewan River is used for hydro-electric energy generation, agriculture and as a supply for municipal and industrial needs. It also supports a variety of recreational activities.

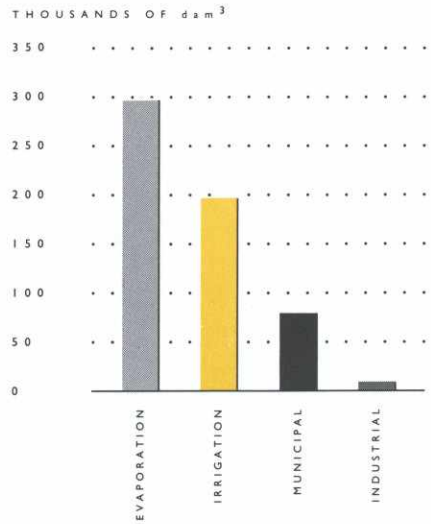
Water use is either instream or offstream. Offstream or consumptive water uses withdraw water from the river. They use the water but generally return some to its source. The return flows are often polluted. The major offstream water uses in the study area are irrigation, municipal and industrial.

Instream water uses, sometimes called nonconsumptive, include recreation and ferries. They use the water in the river or reservoir and tend to not actually consume any water. Nonconsumptive uses do not reduce water quality or affect other uses.

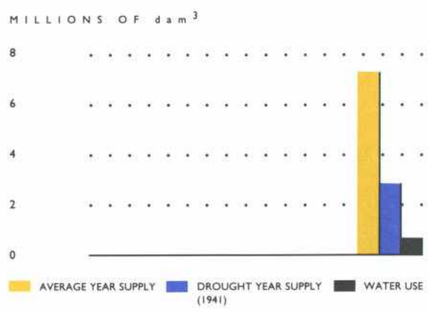
The following sections describe each of the major types of use found in the study area. The description includes their water quantity and quality preferences or requirements. Where appropriate, information about any seasonal pattern of use is included.

The Coteau Creek Generating Station produces about one million megawatt-hours of electricity each year

STUDY AREA WATER USE BY TYPE



STUDY AREA WATER SUPPLY AND USE



Water Use Measurements

There are three different ways to measure water use: allocation, gross use and net use. Each type of measurement has particular advantages and disadvantages.

SaskWater gives all consumptive water users a permit to withdraw a specific volume of water each year. Each permit includes an allocation of water based on estimated requirements. These permits identify how much of the resource is already allocated.

Some users, like irrigators, withdraw significantly less than their allocation. As a result, the allocations are not necessarily indicative of actual use. Because allocations and actual consumption can be so different, gross use is sometimes a better measure of water use.

Net use is valuable when describing consumptive water uses which return a large amount of the water withdrawn. This is the case for most thermal generating stations. In situations such as these, both allocations and gross water use provide overestimates of the water required. From a water management perspective, net use is a preferable measurement.

Municipal

All of the municipal water use figures presented in this report are based on gross water use.

Thirty municipalities rely on the South Saskatchewan River, the SSEWS system or Swift Current Creek for all or part of their water requirements. These communities, which represent more than 40 percent of the province's population, withdraw about 82 000 dam^3 annually. Water use ranges from a high of about 40 000 dam^3 for Saskatoon to only 20 dam^3 for the town of Bradwell. Eight of the communities — Regina, Moose Jaw, Pense, Tuxford, Marquis, Guernsey, Lanigan and Viscount — lie outside the study area. The remaining 34 municipalities in the study area rely on ground water or small reservoirs for their water.

MUNICIPAL WATER USE

Community	Population (1986)	Water Use (dam^3)	Litres Per Person Per Day	Rate Structure
Allan	810	90	300	C
Blucher (R.M.)	470	50	290	D
Bradwell	160	20	340	A
Broderick	120	10	230	D
Cabri	630	120	520	C
Clavet	340	40	320	A
Dalmeny	1 330	120	250	C
Elbow	320	50	430	C
Eston	1 380	250	500	A
Guernsey	190	30	430	D
Hanley	490	60	340	A
Kindersley	4 910	640	360	C
Lanigan	1 700	260	420	C
Leader	1 130	170	410	C
Marquis	100	10	270	A
Martensville	2 760	210	210	A
Moose Jaw	35 070	7 290	570	C
Osler	590	60	280	A
Outlook	2 140	500	640	C
Pense	520	70	370	C
Regina	175 070	34 200.*	530	A
Saskatoon	177 640	39 410	610	C
Shields	40	10	680	D
St. Louis	450	50	300	B
Swift Current	15 670	3 160	550	A
Thode	40	10	680	D
Tuxford	80	20	690	C
Vanscoy	320	50	430	C
Viscount	360	40	300	C
Warman	2 460	230	260	C

* - This includes about 10 000 dam^3 of ground water

A - Flat rate: the price of each unit of water is the same, regardless of amount used

B - Increasing Block: the more water used, the more expensive it becomes

C - Decreasing Block: the more water used, the cheaper it becomes

D - Flat Fee: flat fee per month or year regardless of amount used

Per capita water use is the total amount of water used by a community divided by its population. Per capita water use, which varies significantly from one municipality to another, is influenced by a number of factors. Water availability affects per capita use. Those communities which experience water shortages tend to have low per capita use. The pricing strategy used by the community also influences water use. Per capita use tends to be higher in communities which use a declining block rate structure — the more water used, the lower the price. Communities that have an increasing block rate structure encourage water conservation by charging more for each additional unit of water. Per capita water use tends to be higher in communities with a lot of industry because the industrial water use is included in the calculation.

Municipalities supply most of their water to individual residences, but also provide water to institutional and commercial users like schools and businesses. Some of the larger communities also provide water to industries like manufacturing plants and dairies.

Like many other uses, municipal water use varies from season to season. Municipalities use twice as much water during the summer as they do in the winter. This increased use can be attributed to lawn and garden watering.

As the population of the study area has increased so has water use. Per capita water use has also increased. Conveniences and luxuries like dishwashers, automatic sprinklers and swimming pools have produced significant increases in the per capita use. In Saskatoon, for example, per capita water use now exceeds 600 litres per person per day.

Although water quality within the study area is generally good, all municipalities treat their water before distributing it to users. On average, communities return 70 to 80 percent of the water they withdraw as sewage. All communities in the study area treat their sewage before releasing it.

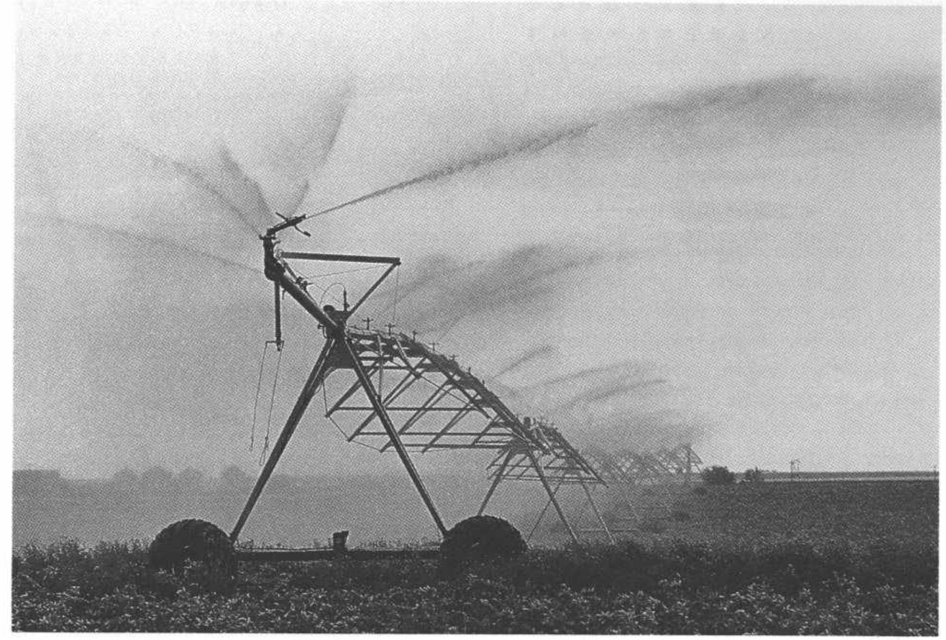
Industrial

Industrial users return a large portion of the water they withdraw. As a result, net water use is the most useful measure of industrial water use in the study area.

Industrial water use accounts for about two percent of the water use in the study area. Mineral extraction, manufacturing and thermal electric power generation are the three major types of industrial water use in the study area.

There is one thermal electric generating station located in the study area — the Queen Elizabeth II Power Station located at Saskatoon. This coal-fired facility, which uses water for cooling, is operated to meet peak power demands. As a result, water use varies from year to year. In a dry year like 1984 when hydro-electric energy production was down, the plant might withdraw 75 000 dam^3. During 1986, a wet year, the plant was used only occasionally and withdrew much less water — 4 000 dam^3.

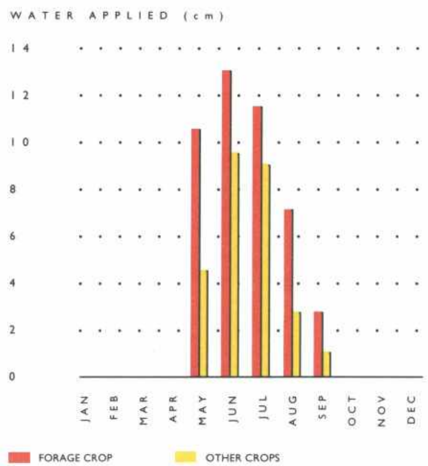
The Queen Elizabeth II Power Station returns more than 95 percent of the water it withdraws from the South Saskatchewan River. The power plant uses the water from the river without treating it because its hardness does not cause scaling problems in the condensers.



After evaporation, irrigation is the largest consumer of water in the basin

IRRIGATION WATER USE

IRRIGATION WATER USE BY CROP



Potash mines make up the mineral extraction industry in the study area. The potash industry started in the 1960s and expanded through the 1970s. However, there has been no significant growth in the last ten years. There are seven potash mines that rely on water from the study area. Five withdraw water from the SSEWS system. A sixth mine withdraws its water from Patience Lake located west of Saskatoon. A seventh potash mine, located outside the study area, withdraws water from Buffalo Pound Lake which is supplied from Lake Diefenbaker.

The five potash mines located on the SSEWS system consume about 4 500 dam^3 per year or about 80 percent of the water used in the study area for industrial purposes. The mines use the water for processing the potash and do not require high quality water. Most use it with little or no treatment. Each mine, however, does require a small amount of treated water for drinking and washing. None of the water used by the potash mines is returned to the river. It is recycled and eventually lost through evaporation.

Manufacturers include chemical plants, breweries, dairies, meat packers and some light industries. Most of these are located in, and rely on, municipalities to supply their water. Some of the industries, such as breweries, require very high quality water and so they treat it again before they use it. Most of these industries also rely on the municipal waste treatment systems for handling their wastewater. Two chemical plants in Saskatoon provide their own sewage treatment.

Agriculture

There are two major types of agricultural water use: irrigation and stockwatering. Irrigation makes continuous cropping and greater crop diversification possible. Both can help stabilize the economy. In the study area, irrigation first developed in the Swift Current Creek area. Lake Diefenbaker has since become the centre for irrigation in the study area and the province.

Irrigation is the largest consumer of water in the study area. The 50 000 hectares of irrigated land in the basin consume about 170 000 dam^3 of water. This represents about 75 percent of all the water consumed in the basin. Unlike most other water uses, irrigation shows a strong seasonal pattern. The irrigation season and the amount of water applied is dependant upon the crop. Forage producers, which often produce two or more crops per summer, can apply more than 45 centimetres of water. Irrigators producing specialty crops like peas, beans, flax and canola apply slightly less water. Irrigators producing cereal grains like spring wheat, barley, soft wheat, and durum, have a shorter season and use less water. During an average summer they might apply 30 centimetres of water.

Rainfall patterns also affect the amount of water applied by irrigators. For example, irrigators in the dry western portion of the study area apply about 30 percent more water per hectare than irrigators located in the relatively wetter northeastern end of the basin. In some parts of the study area, water use patterns are also influenced by the availability of water. In the Swift Current Creek area, the demand for irrigation water exceeds the supply in dry years. In this situation, irrigators must ration water or stop irrigating early in the growing season.

In general, the water of the South Saskatchewan River is of good quality for irrigation. Its relatively low concentration of salt makes it suitable for application to most types of soil. Irrigation return flow, the water which drains from the irrigated field, can have a negative impact on the receiving water. However, with centre-pivot irrigation, there is very little return flow.

The second type of agricultural water use is stockwatering. Although it consumes significantly less water than irrigation, it is still an important use. Livestock consume about 12 000 dam^3 each year. Livestock production is an important part of efforts to diversify the economy through irrigation.

Because stockwatering uses significantly smaller volumes than irrigation, it is not necessarily located on the mainstem of the river. Stockwatering is distributed throughout the basin. In general, the surface water of the basin is of sufficiently good quality to water livestock.

LIVESTOCK WATER USE IN THE STUDY AREA

Type	Number	Water Use (litres per day)	Total Annual Water Use (cubic decametres per year)
dairy cattle	20 000	160	1 170
beef cattle	370 000	70	9 460
pigs	137 000	20	1 000
sheep	14 000	11	60
horses	12 000	70	310
poultry	1 000 000	0.3	110

Hydro-Electric Energy Generation

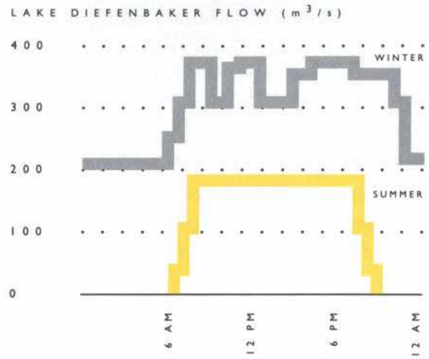
The Coteau Creek Generating Station located at Gardiner Dam is the only hydro-electric energy generating facility in the study area. SaskPower owns and operates the generating station which would cost 140 million dollars to build today. Gardiner Dam allows SaskPower to generate more electricity during the winter when it is most valuable.

Coteau Creek Generating Station has three equal sized pairs of turbines and generators. These turbines can handle a maximum flow of 400 m^3/s. Flows in excess of 400 m^3/s are diverted around the power station and are not used to generate electricity. On average, Coteau Creek Generating Station produces 770 000 megawatt-hours of electricity per year. This represents about 5 percent of SaskPower's total annual generation.

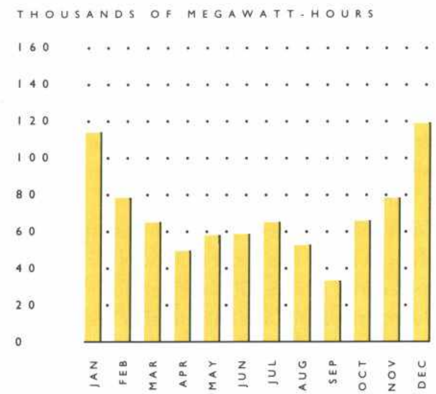
Although the Coteau Creek Generating Station accounts for only a small percentage of total production, it plays an important role within SaskPower's generating system. Hydro-electric generating stations such as Coteau Creek are capable of responding to changes in power requirements quickly. For this reason, the Coteau Creek station is used to generate power in response to peak seasonal and hourly changes in provincial demands.

Gardiner Dam and the operation of the Coteau Creek Generating Station have an effect on the output of downstream power stations. The Nipawin and E.B. Campbell generating stations, located downstream on the Saskatchewan River, benefit from the flow regulation provided at Gardiner Dam. For example, winter power production at the E.B. Campbell power station doubled following the completion of Gardiner Dam.

TYPICAL HOURLY FLOWS THROUGH THE COTEAU CREEK GENERATING STATION



AVERAGE MONTHLY ENERGY OUTPUT AT COTEAU CREEK GENERATING STATION



Like other users, SaskPower has preferences regarding water quantity. High water levels on Lake Diefenbaker in the early winter allow SaskPower to increase the value of hydro-electric energy production. Coteau Creek Generating Station does not require any particular water quality.

IRRIGATION METHODS

There are two main types of irrigation, sprinkler and surface, practised in Saskatchewan. The selection of the irrigation method depends on the type of crop to be grown, soil characteristics, local topography, quantity of water available, and the farmer's financial position.

Surface or gravity irrigation consists of the direct application of water to a field from a ditch through gates or siphons. In most cases, the land must be levelled beforehand in order to control the movement of water over the soil. Border dyke irrigation, which involves the near-complete flooding of the land and furrow irrigation, which involves the partial flooding of the land, are two common methods of surface irrigation.

Sprinkler irrigation, which involves pumping water and distributing it from above ground, has become the most popular form of irrigation in recent years. Commonly used methods of irrigation in the sprinkler category are the wheel roll and the centre-pivot. The main advantage of the sprinkler method is that it uses water more efficiently. Other benefits include a greater degree of control in the application of small amounts of water, reduced labour requirements, and the relative ease in the conversion from dryland to irrigation farming.

Recreation

Recreation represents an important water use in the study area. The waters of the study area support many water-based recreational activities including boating, fishing, swimming and water skiing. A number of other recreational activities are enhanced by the presence of water. These include hiking, camping, picnicking and hunting.

Since the completion of the Lake Diefenbaker project, the South Saskatchewan River has become a focus for recreation. The regulated river flows downstream of Lake Diefenbaker are ideal for water-based recreation. Major canoeing and rowing competitions are regularly held on the river. Lake Diefenbaker now supports a yacht club and numerous marinas.

PARKS AND RECREATION FACILITIES

	Beach	Swimming Pool	Golfing	Playground	Fishing	Boat Launch	Riding Horses	Hiking Trails	Tennis Courts	Picnic Grounds	Campgrounds
Elbow Recreational Area			■		■	■				■	
Saskatchewan Landing Provincial Park	■			■	■	■		■		■	■
Douglas Provincial Park	■			■	■	■		■		■	■
Danielson Provincial Park	■			■	■	■				■	■
Blackstrap Provincial Park	■			■	■	■				■	■
Pike Lake Provincial Park	■	■	■	■	■	■		■	■	■	■
Lemsford Ferry Regional Park		■	■	■	■					■	■
Eston Riverside Regional Park		■	■	■						■	■
Cabri Regional Park				■		■				■	■
Prairie Lake Regional Park	■			■	■	■				■	■
Herbert Ferry Regional Park	■			■	■	■		■		■	■
Palliser Regional Park	■	■	■	■	■	■	■			■	■
Lac Pelletier Regional Park	■		■	■	■	■	■	■		■	■
Outlook and District Regional Park		■	■	■	■			■		■	■
Chinook Parkway - Swift Current			■	■	■	■	■	■	■	■	
Meewasin Valley Authority - Saskatoon		■	■	■	■	■	■	■	■	■	■

Winter recreation is also important in the study area. The frozen surfaces of the lakes and rivers are routinely used for snowmobiling, cross-country skiing and ice fishing. There are also several major organized winter events, including ice fishing derbies and winter festivals.

There are national, provincial, regional and municipal parks within the study area. They represent a focus for water-based and water-enhanced recreational activities. Collectively, these parks provide a full range of recreational opportunities to more than one million visitors each year.

Each type of recreation has a particular preference with respect to river flow or reservoir elevation. On the South Saskatchewan River a summer flow of between 60 and 150 m^3/s meets the needs of the greatest number of recreational uses. Summer elevations of between 554 and 556 metres above sea level meet the needs of most uses on Lake Diefenbaker. The lake is considered full when it reaches 556.86 metres above sea level.

Recreational activities like swimming and boating require water of reasonably good quality. In particular, the water must be relatively free from bacteria. In general, the water of the South Saskatchewan River is of suitable quality for recreational purposes.

There are cottage subdivisions on several of the lakes and reservoirs in the study area including Pelletier, Duncairn, Diefenbaker and Blackstrap. Cottagers prefer stable high water levels.

The water resources of the South Saskatchewan River also enhance recreational opportunities outside the basin. Small amounts of water released through the Qu'Appelle Dam at the south end of Lake Diefenbaker stabilize water levels and improve water quality in the Qu'Appelle River system.

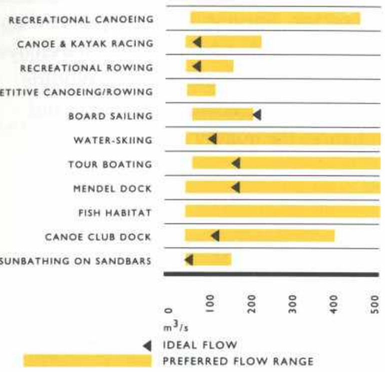
The parks of the study area provide some of the highest quality recreation opportunities available in the southern half of the province. Although park use fluctuates from one year to the next, there is an overall trend of increasing use. Most of the parks in the study area appear to have unused capacity and, therefore, should be able to meet increased demand.

Ferries

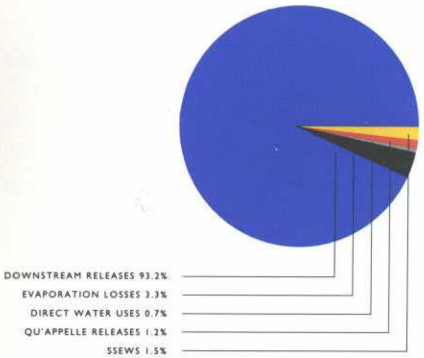
In the early 1900s, the South Saskatchewan River was an important means of transportation. Today the river acts more as a barrier to transportation for local residents, farm operations and businesses. Ferries have become a necessity for these people. Eight ferries operate on the South Saskatchewan River from mid-April to mid-November. Three of these, Estuary, Lemsford and Lancer, are located upstream of Lake Diefenbaker. The Riverhurst ferry is located on Lake Diefenbaker. Clarkboro, Hague, St. Laurent and Weldon ferries are located downstream of Gardiner Dam.

The Riverhurst ferry is capable of operating throughout the full range of lake levels. During the winter this ferry is replaced by an ice road. The other seven ferries operate best when the flow in the river is stable and moderate. Fluctuating flows can make it necessary to move between high and low flow approach ramps. Flood flows produce velocities which can restrict ferry operation. Extremely low flows produce shallow water which can result in load restrictions for the ferries.

PREFERRED FLOWS FOR RECREATIONAL ACTIVITIES AND FACILITIES AT SASKATOON



WATER USE FROM LAKE DIEFENBAKER



ENVIRONMENT

This section discusses fisheries, wildlife, waterfowl, endangered species, natural areas and heritage resources. Each of these resources can be affected by water management activities. The following sections describe these resources and how they interact with water.

Fisheries

The waters of the study area provide a diversity of fish habitat. This habitat supports 27 species of fish.

The habitat requirements of fish vary with the species. For example, in the study area, lake trout can be found only in Lake Diefenbaker, whereas pike can be found in most of the lakes and rivers. Habitat requirements also change with the life cycle. For example, adult walleye prefer deep slow moving water but spawn in shallow, swift flowing water.

Although habitat requirements vary, some general requirements are commonly shared. In lakes and reservoirs, fish require a minimum depth of about 10 metres to successfully survive the winter. Similarly, a stable water level helps to ensure fish can reproduce. In rivers, fish require a sustained flow and suitable spawning habitat. All fish require water of reasonably good quality. In general, the waters of the study area meet the water quality requirements of the species present.

The habitat requirements of fish are taken into account in the operation of Lake Diefenbaker, Duncairn Reservoir and the SSEWS system reservoirs. However, it is not always possible to maintain ideal conditions. Lake trout, a species stocked in Lake Diefenbaker, spawns during the autumn in shallow water. Most of the eggs are lost when the reservoir is drawn down during the winter.

Surveys show that fishing is one of the most popular recreational activities in the study area. In order to help meet the demand for fishing, Saskatchewan Parks and Renewable Resources has stocked Lake Diefenbaker, several reservoirs on the SSEWS system and Duncairn Reservoir.

Waterfowl

Waterfowl is a general term which includes ducks and geese. Geese commonly found in the study area include Canada, Ross', white-fronted, snow and lesser snow. Pintails, mallards, canvasbacks and redheads are the ducks generally found in the study area.

Migrating ducks and geese arrive in the study area in April and early May. They gather in staging areas which have broad expanses of open water. Resident birds disperse to an assortment of wetland types shortly after arrival. A good mix of open water and vegetation is considered optimum breeding habitat for most species.

Nesting usually occurs from late April to early July. Undisturbed dense grass and shrubs adjacent to wetlands provide preferred nesting cover for most waterfowl. Some species, like mallards, may nest considerable distances from wetlands. Once the young waterfowl have hatched, permanent water is necessary for their survival. Seasonal and permanent wetlands, about one hectare in size with vegetated shorelines, are most commonly used to raise the young. Some species will travel to several different waterbodies in order to meet their food and cover requirements.

After breeding, most waterfowl disperse to areas where they moult and grow new feathers. Habitat requirements for moulting vary with species but because the birds cannot fly at this time, waterbodies larger than 50 hectares that have a good food supply are preferred.

Fall migrating waterfowl use the study area from mid-August until freeze-up. Again, habitat requirements vary but large waterbodies close to cereal crop production generally receive the greatest use. Since the creation of Lake Diefenbaker, large numbers of ducks, geese and sandhill cranes stage at the upstream end of Lake Diefenbaker and on the South Saskatchewan River as far west as Leader. Because the numbers of birds present often exceed 1 000 000, the area has taken on worldwide significance for hunters, photographers, bird watchers and tourists in general.

SPORT FISH IN THE STUDY AREA

	NORTHERN PIKE	LAKE TROUT	WALLEYE	YELLOW PERCH	SAUGER	GOLDEYE	LAKE WHITEFISH	LAKE STURGEON	LAKE TROUT
DUNCAIRN RESERVOIR	■		■	■					
LAC PELLETIER	■			■			■		
SOUTH SASK. RIVER UPSTREAM OF LAKE DIEFENBAKER	■		■		■	■	■	■	
LAKE DIEFENBAKER	■	■	■	■	■	■	■	■	■
SOUTH SASK. RIVER DOWNSTREAM OF LAKE DIEFENBAKER	■		■		■	■		■	■
BLACKSTRAP RESERVOIR	■		■				■		
BRIGHTWATER RESERVOIR	■		■	■					
BRODERICK RESERVOIR	■		■	■					
DELLWOOD RESERVOIR	■		■						
ZELMA RESERVOIR	■		■						

Although the Lake Diefenbaker area is famous for its fall concentrations of migrating ducks and geese, the South Saskatchewan River downstream of Lake Diefenbaker, the sand bars and islands are important for goose nesting throughout the spring and summer.

Water management can affect waterfowl. For example, nesting waterfowl are sensitive to the large fluctuations in water levels that can occur above and below dams. Drainage and irrigation projects can reduce waterfowl habitat located in wetland areas away from the river. It is important to note, however, that waterfowl can benefit from irrigation projects. Outside of the irrigation season, the pumping facilities of the recently completed Luck Lake irrigation project deliver about 7 000 dam^3 of water to a nearby waterfowl project.

Waterfowl populations have been significantly reduced over the last twenty years. Management efforts are underway to increase waterfowl production in Saskatchewan and, in particular the study area. Ducks Unlimited Canada operates 78 projects in the study area. The federal government operates a number of waterfowl sanctuaries, including Duncairn Reservoir. Recently, the governments of Canada and the United States of America released the North American Waterfowl Management Plan. This plan seeks to restore duck populations to 1970s levels by the end of the century. The plan designates several areas within the study area for habitat improvement. The designated areas include the Missouri Coteau which straddles Lake Diefenbaker and the area downstream of Lake Diefenbaker.

Wildlife

The study area provides suitable habitat for a variety of wildlife. Everything from the peregrine falcon to the black bear can be found in the study area. Species are distributed throughout the study area, but the valley of the South Saskatchewan River is particularly important to wildlife. The valley acts as a travel corridor and provides important breeding and wintering habitat.

Saskatchewan Parks and Renewable Resources has identified the areas within the province which are considered critical for terrestrial wildlife. Critical wildlife habitat occurs within the study area for a number of species. In total, more than 400 000 hectares or about 11 percent of the study area is considered critical wildlife habitat. Lands identified under the *Critical Wildlife Habitat Protection Act* or its regulations are protected from significant alteration such as clearing and flooding.

Water management or water resource developments have some potential to affect wildlife in the study area. Many species rely on the river valley and its vegetated shorelines for habitat. As a result, these species could be directly affected by reservoir management and flow regulation. New water resource development also has the potential to affect wildlife. Reservoir development could inundate valuable habitat. Irrigation or drainage projects also have the potential to degrade or destroy upland nesting and feeding areas. If properly managed, however, they can enhance the habitat for some species. For example, irrigation ditches can create new habitat for ring-necked pheasants, gray partridge and white-tailed deer. Some of the crops produced under irrigation increase food supplies for deer and sharp-tailed grouse.

Much remains to be learned about the effects of water management on wildlife. Wildlife preservation is, however, very important. Surveys show that more than 85 percent of Saskatchewan residents enjoyed or used wildlife in some way. Wildlife provides direct economic benefits and enhances the quality of life.

IMPORTANT WETLANDS IN THE STUDY AREA

WETLAND	LOCATION	USE	IMPORTANCE
Luck Lake	7 km north of Lucky Lake	goose staging	national
		duck staging	local
Snipe Lake	15 km northwest of Eston	goose staging	regional
		duck staging	local
		duck moulting	local
Anerley Lakes	14 km northwest of Macrorie	duck staging	regional
		duck moulting	local
Marengo Slough	13 km northeast of Alsask	goose staging	regional
		duck staging	local
Loverna Slough	50 km northwest of Kindersley	duck staging	regional
		goose staging	local
Jumping Lakes	22 km east of Hoey	duck moulting	regional
Cabri Lake	28 km northwest of Leader	duck staging	regional
Duck Lake	3 km southwest of Duck Lake	duck staging	regional
Red Top Slough	15 km south of Kindersley	goose staging	local
		duck staging	local
Pelican Lake	2 km southeast of Domremy	duck staging	local
		duck moulting	local
Stockwell Lake	2 km west of Macrorie	duck staging	local
Indi Lake	9 km northwest of Hanley	duck moulting	local

CRITICAL WILDLIFE HABITAT IN THE STUDY AREA

SPECIES	AREA (hectares)	PERCENT OF STUDY AREA
great blue heron	778	0.02
sharp-tailed grouse	226 036	6.03
ruffed grouse	36 517	0.97
spruce grouse	642	0.06
gray partridge	17 738	0.47
ring-necked pheasant	42 192	1.13
prairie falcon	65 067	1.74
golden eagle	122 843	3.28
white-tailed deer	256 685	6.85
mule deer	185 628	4.96
elk	22 465	0.60
moose	1 096	0.03
pronghorn antelope	149 044	3.98
beaver	2 790	0.07
black bear	2 776	0.07

Endangered Species

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent body with representation from the federal and provincial governments. COSEWIC annually updates a list of wildlife, fish and plant species which are considered to be at risk.

According to COSEWIC, endangered species are threatened with extinction throughout all or a significant portion of their Canadian range. Threatened species could become endangered if the factors leading to their decline are not reversed. Vulnerable species are those which exist in low numbers or in very restricted areas.

Many species which are considered to be at risk can be found in the study area. Most of these are found primarily in upland areas. As a result, they are not particularly affected by water management activities, such as flow or reservoir operation.

One species of particular concern is the piping plover. The piping plover is a medium-sized shorebird, similar in appearance to the more common killdeer. This bird is considered endangered and can be directly affected by water management. The South Saskatchewan River Basin supports 32 percent of the North American population.

Since its creation, Lake Diefenbaker has become an important nesting area for the piping plover. Because the piping plover nests on sand or gravel beaches near the high water mark, it is very susceptible to reservoir operation during the April 25 to August 15 breeding season.

In order to ensure successful nesting by the piping plover, wildlife managers prefer stable reservoir elevations and downstream flows during the nesting season. Periodic flooding of reservoir and river beaches outside of the breeding season helps ensure that they remain free of vegetation and suitable for plover nesting. It is recognized that natural flows and reservoir operation will not allow water managers to meet the needs of the piping plover all of the time. However, awareness of the piping plover habitat requirements can help ensure that suitable habitat is maintained.

ENDANGERED SPECIES IN THE STUDY AREA

SPECIES	STATUS	CHARACTERISTIC
piping plover	endangered	summer resident
prairie long-tailed weasel	endangered	year-round resident
peregrine falcon	endangered	migrant
whooping crane	endangered	migrant
Baird's sparrow	threatened	summer resident
burrowing owl	threatened	summer resident
ferruginous hawk	threatened	summer resident
loggerhead shrike	threatened	summer resident
Cooper's hawk	vulnerable	summer resident
eastern bluebird	vulnerable	summer resident
trumpeter swan	vulnerable	migrant

Heritage Resources

Heritage resources are those sites and objects that link people with their past. They have scientific, social and educational significance. In addition, they have economic value as recreation and tourism attractions. There are three types of heritage resources: palaeontological, archaeological and historic.

The oldest type of heritage resources are the palaeontological sites. These sites contain the fossils of extinct animals such as dinosaurs. Other sites include the remains of animals like the muskox which are no longer found on the prairies. The area northeast of Saskatoon and the shores of Lake Diefenbaker have a high potential for further palaeontological discoveries.

Archaeological resources are associated with human activity from about 3 000 years ago up until about 300 years ago. Archaeological sites include camps, as well as kill, quarry, burial and ceremonial sites. Tipi rings and stone cairns are common at these sites.

Approximately 1 800 archaeological sites have been discovered in the study area. Sites are concentrated near Estuary, Swift Current, Elbow, Saskatoon and Batoche. Most notable of the archaeological sites discovered in the study area are the Roy Rivers Medicine Wheel, the Cabri Lake Human Effigy and the Swift Current Petroglyph. Wanuskewin Heritage Park, located just north of Saskatoon, contains a complex of several different archaeological site types. Its designation as a Provincial Heritage Property in 1984 and as a National Historic Site in 1987, promises to protect the park's legacy for the enjoyment and education of future generations.

Historic sites, which are associated with the arrival of European settlers, date from the 1700s and 1800s. In the study area, the historic sites are usually associated with the remnants of early trading posts, homesteads, ranches or other settlement areas; and burial sites and historic trails. Historic sites usually contain artifacts including metal objects, like nails and musketballs, glass, earthenware, crockery, china and animal bones.

There are 118 known historic sites within the study area. The best known of these is Batoche, a Metis community established in 1872, at the site of a ferry crossing on the South Saskatchewan River. Batoche, a designated National Historic Site, is also the site of the final battle of the Northwest Rebellion.

The heritage resources of the study area are nonrenewable and very fragile. As physical and very inconspicuous parts of the landscape, they are particularly vulnerable to destruction. Fluctuating water levels on Lake Diefenbaker regularly expose artifacts. Future water resource developments, like irrigation, recreation, and reservoirs, also have the potential to impact on the heritage resources of the study area.

Natural Areas

Many different natural areas occur within the study area. Forests, open prairie, rolling parkland, lakes and rivers, even desert-like sand dunes can all be found. The importance of these different, and often unique, areas has long been recognized, and measures have been taken to identify and preserve these areas.

Under the International Biological Program (IBP), all sites within Saskatchewan which preserve native plants, animal and landscapes were identified and inventoried. One hundred and one sites have been identified and accepted by the IBP committee. Fourteen IBP sites, consisting of more than 48 000 hectares, occur within the study area. These sites include Cabri Lake, Beaver Creek, the Lancer Moraine, the Great Sand Hills and Dundurn Forest.

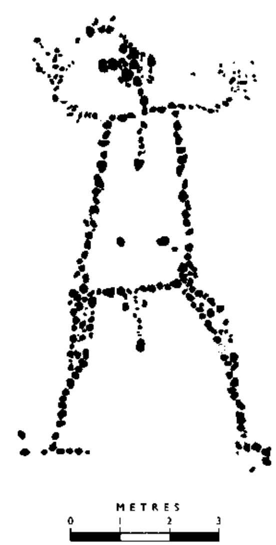
IBP sites and natural areas within the study area are not always formally declared conservation areas. Some are public or privately held lands, while others are officially protected because they fall within existing provincial parks, federal wildlife refuges or ecological reserves.

The natural areas identified contain a diversity of valuable resources most of which can be affected by water management activities. Consequently, water managers must continue to be aware of the possible impacts associated with water management activities and water resource developments.

IBP SITES IN THE STUDY AREA

NAME	LOCATION	SIZE (hectares)	FEATURES
South Saskatchewan River Loop	31 km west of Leader	1 300	- active and stabilized sand dunes - rare species - critical wildlife habitat
Hearts Hill	58 km west of Kerrobert	6 781	- native grassland - sloughs and kettle lakes
Alsask - Mantario Hills	near Alsask	16 123	- glacial moraine
Red Deer Forks	24 km west of Leader	1 425	- historically significant - critical wildlife habitat
Cabri Lake	58 km southeast of Kindersley	12 000	- archaeological resources
Great Sand Hills	23 km northeast of Fox Valley	9 600	- sand dunes - wildlife habitat
Lancer Moraine	5 km east of Lancer	1 263	- glacial moraine
Matador Moraine	61 km north of Swift Current	3 110	- glacial moraine
Matador Grassland	35 km north of Swift Current	9 096	- critical wildlife habitat
Beaver Creek	16 km south of Saskatoon	81	- mixed prairie
Dundurn Forest	34 km south of Saskatoon	2 072	- sand dunes - boreal plants
Indi Lake	50 km south of Saskatoon	680	- habitat for waterfowl
Duck Lake	west of Batoche	1 477	- historically significant
Nisbet Forest	14 km northeast of Duck Lake	486	- boreal forest bogs

CABRI LAKE HUMAN EFFIGY



5

FRAMEWORK PLAN

The valley of the South Saskatchewan River provides critical wildlife habitat

FRAMEWORK PLAN

Basin Management Strategies
Short-term Planning

Developing the framework plan was the study's third objective. The plan has three different components. The first component, basin management strategies, provides specific recommendations as to how the water resources of the study area should be managed. The second component, the project evaluation procedures, provides a variety of tools to provide a consistent way of evaluating water resource development proposals. The third and final component of the framework plan is an implementation plan to ensure that the basin management strategies are adopted and that the project evaluation procedures are maintained and used.

BASIN MANAGEMENT STRATEGIES

Short-term, long-term and system-limit planning provided the basis for developing the basin management strategies. Future conditions were forecast to the year 2000, 2020 and beyond. All three planning exercises are referenced to 1986 conditions.

Short-term Planning

The short-term planning exercise looked at the year 2000 — ten years after the study was completed. It deals with the water management issues and identifies opportunities to modify operations and programs to better meet the needs of the various water uses in the basin. The issues identified in Chapter 3 were the starting point for the short-term planning process. Analysis of each issue determined how it might change with time.

For issues which were related to water supply, the analysis was done by comparing water supply and use as forecast to the year 2000. The effects of drought on both water use and water supply were considered. The year with the lowest flow in the 75 year record was used to analyze the effect of drought on water supply.

Many of the issues were linked. The linkage was considered in formulating and evaluating strategies. For example, the issue of low water levels on Lake Diefenbaker could be solved by keeping more water in the reservoir. But, this would reduce downstream flows making conditions for a different issue worse. Analysis sought the greatest overall benefit when selecting strategies.

Many of the issues the study identified were not unique. For example, flooding and drought are common problems on the prairies. For these issues, recommendations were based on information developed elsewhere on the prairies.

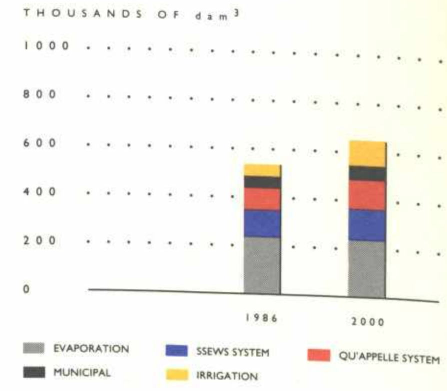
Based on this analysis, strategies to deal with the issues were formulated, evaluated and selected. The process involved several rounds of refinement. The findings of the analysis are presented below. The findings are organized according to whether the issues were basin-wide or specific to one of the three systems: the South Saskatchewan River, the SSEWS system and Swift Current Creek.

Basin-wide

Findings:

- By the year 2000, there will still be enough water to meet the needs of consumptive uses.
- By the year 2000, there will still be enough water to meet the needs of instream water uses most of the time.
- Extreme variations in water quantity and quality will continue to occur.

SOUTH SASKATCHEWAN RIVER ANNUAL WATER USE



- Under drought conditions, adaptive management strategies will continue to be necessary.
- Water use benefits can be maximized by basing reservoir operating plans on annual and seasonal forecasts for water supply and demand.
- There are a number of water quality problems within the basin which have the potential to get worse.
- There is very little information gathered which can be used to document long-term changes in the ecosystem.
- Existing programs like the Canada-Saskatchewan Flood Damage Reduction Program (FDRP) and SaskWater's Reservoir Development Area (RDA) program can help deal with many of the shoreline issues.
- The public would like to play a more active role in water management.
- There is a need to improve communication about water management issues in the basin.
- Soil and water compatibility assessment, as now practised, is an important part of making irrigation sustainable.

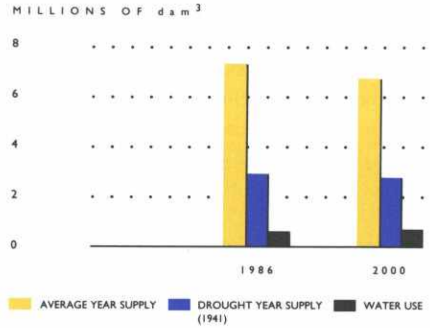
- There are more than 20 communities in the study area that experience water quantity and quality problems with their municipal supply.
- Water conservation could yield significant benefits. The users who conserve would save money by delaying or eliminating the need for costly expansion of water treatment and delivery systems.
- The awareness of the value and importance of instream uses continues to increase. However, more information is needed to quantify the benefits of instream flows.

South Saskatchewan River

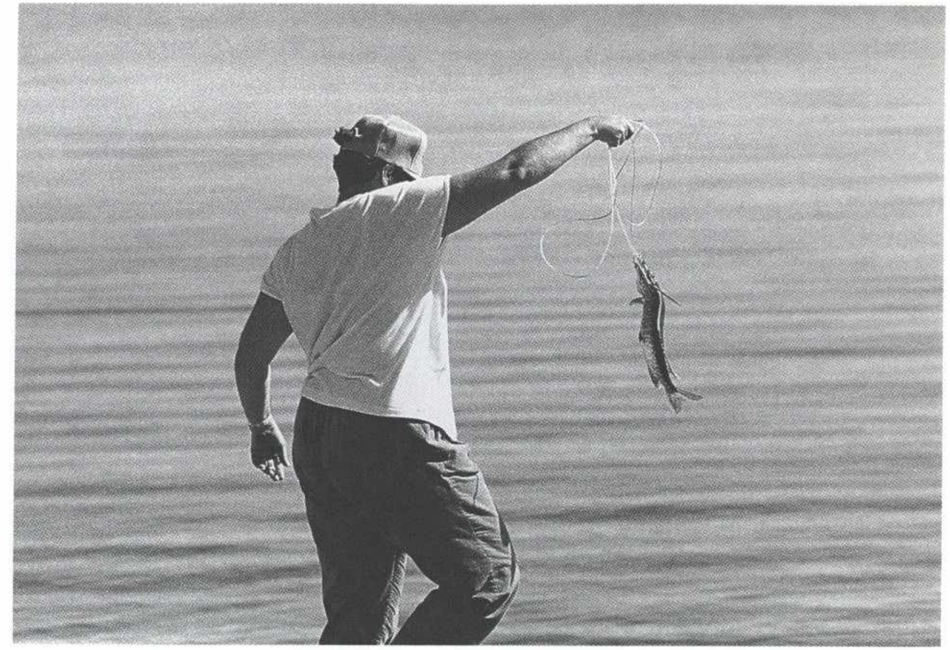
Findings:

- By the year 2000, Saskatchewan will be receiving on average about 72 percent of the natural flow from Alberta. The decrease from 78 percent in 1986 is due to increased water use in Alberta.
- Alberta will continue to consume about four times as much water from the mainstem as Saskatchewan.
- By the year 2000, Saskatchewan will be consuming about ten percent of the water it receives from Alberta — up from seven percent in 1986.
- Evaporation will continue to be the largest single use of water from the mainstem accounting for about 35 percent of all use in the year 2000.
- After evaporation, irrigation will be the next largest consumer of water from the mainstem — and will account for about 104 000 dam^3 in the year 2000.
- Conditions for ferries and recreation above Lake Diefenbaker will improve as a result of reduced flow variability caused by increased water use in Alberta.

SOUTH SASKATCHEWAN RIVER
ANNUAL WATER SUPPLY AND USE



- Some of the effects of increased consumption in Alberta and Saskatchewan can be offset by reducing winter drawdown on Lake Diefenbaker. However, this could reduce the amount of winter hydro-electric energy generation.
- Under normal conditions, a summer target flow of 60 to 150 m^3/s downstream of Lake Diefenbaker maximizes the benefits of water use above and below the lake.
- Under extreme conditions, it will be necessary to allow flows downstream of Gardiner Dam to move out of the target flow range. Under drought conditions, it will be necessary to reduce flows to a minimum of 42.5 m^3/s. Under flood conditions, flows in excess of 1 000 m^3/s may occur.
- The maintenance of high concentrations of dissolved oxygen in Lake Diefenbaker is the key to protecting Lake Diefenbaker as a source of high quality water. High oxygen levels prevent phosphorus in the sediments from causing the growth of algae and weeds.



The waters of the basin support 27 species of fish

- By the year 2000, Saskatchewan will be delivering 65 percent of the natural flow in the South Saskatchewan River to Manitoba — down from 71 percent in 1986.

SSEWS System

Findings:

- Irrigation will continue to be the biggest user of water, accounting for 91 000 dam^3 — more than 80 percent of the water delivered to the SSEWS system.
- Municipal water use will increase from 500 to 650 dam^3 per year.
- Industrial water use will increase from 2 700 to 3 600 dam^3 per year.
- The new pump and the electrical rate agreement with SaskPower should allow the SSEWS system to keep up with the demand for water as forecast to the year 2000. In drought years, short-term rationing of water could be necessary.
- The downstream end of the system would have the largest potential for further development. Significant development at the upstream end of the system would require structural improvements to the canals.
- Ground water inflow is responsible for the high concentration of salts in the SSEWS system reservoirs. Pumping additional water into the SSEWS system would not lower the salt concentrations.

Swift Current Creek

Findings:

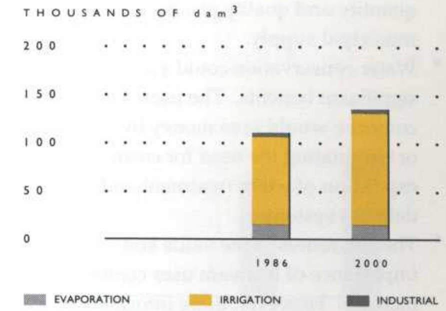
- Irrigation will consume 28 000 dam^3 — about 65 percent of all water consumed in the Swift Current Creek basin.
- In drought years, the demand for water will continue to exceed the available supply.
- If current levels of irrigation development in the Swift Current Creek basin are exceeded without making more water available within the system, the water shortage experienced by irrigators will be made worse.
- More water could be made available for use within the Swift Current Creek system by withdrawing more water from Duncairn and Highfield reservoirs. It is likely that this withdrawal could be made without jeopardizing fish habitat or municipal water use.

Short-term Planning Conclusions

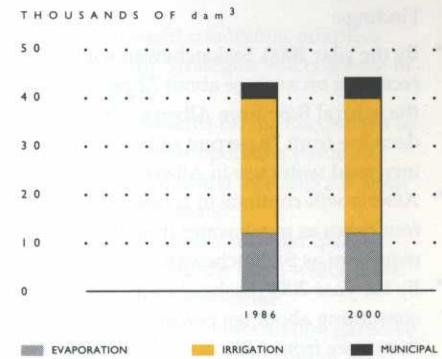
A number of general conclusions can be drawn from the short-term planning exercise carried out for the study area. The conclusions focus on the management of the water resource and how it should be modified in response to changing conditions.

- Reservoir operating plans should continue to be based on annual and seasonal forecasts for water supply and the needs of users on the reservoir and downstream.
- There is a need for a more effective way of monitoring subtle long-term changes in the health of the ecosystem.
- There is a need for more information on the benefits of instream water uses and how to quantify their benefits.
- Greater public education would help people to understand the basis for water management decisions.
- Input from all water users is required to ensure that water management decisions will serve to maximize the benefits of the water resource.
- A greater amount of public access in shoreline areas, particularly downstream of Lake Diefenbaker, would increase the potential for recreation benefit.
- Water quality objectives and a supporting water quality monitoring program would be effective in dealing with water quality issues.
- Water conservation would yield significant benefits to users that conserve.

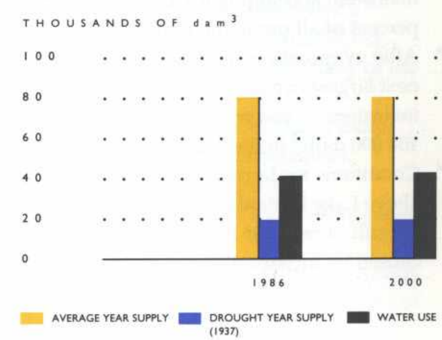
SSEWS SYSTEM ANNUAL WATER USE



SWIFT CURRENT CREEK ANNUAL WATER USE



SWIFT CURRENT CREEK ANNUAL WATER SUPPLY AND USE



- Regional water supply systems could help solve the water quantity and quality problems being experienced by some communities in the basin.
- Under average conditions, a summer target daily average flow range of 60 to 150 m^3/s downstream of Lake Diefenbaker would benefit users on the reservoir and below.
- Under extreme conditions, it will be necessary to allow flows downstream of Lake Diefenbaker to move out of the target flow range.
- Swift Current Creek is at the limit of development for irrigation if no additional water is made available.

Long-term Planning

The long-term planning exercise looks at the year 2020, about 30 years after the completion of the study. Unlike the short-term planning exercise, which focused on issues, the long-term planning identifies options for future water use. This was done by formulating and evaluating different scenarios.

The study does not recommend one type of water use or another. It simply identifies the implications of choosing one over another. These implications include the environmental benefits of selecting a particular water use. Through the long-term planning exercise, the study provides decision-makers and the public with information. This information will allow them to make informed decisions about the relative merits of emphasizing a particular type of water use.

The results of the long-term planning are organized according to the three major systems: the mainstem of the South Saskatchewan River, the SSEWS system and Swift Current Creek.

Lake Diefenbaker provides some of the best sailing in western Canada

South Saskatchewan River

Long-term planning for the South Saskatchewan River involved eight different scenarios. In Scenario 1, the base case, it was assumed that historical patterns of development continued to the year 2020. This base case was used as a benchmark against which the other long-term scenarios were compared. The other seven scenarios were formulated to show the effect of emphasizing a particular type of water use. Unless noted in the scenario, water use patterns described in Scenario 1 apply. Because the river is most sensitive to irrigation water use, scenarios based on significant growth, and no growth, were included. Many of these scenarios improve conditions.

The scenarios are not mutually exclusive. Elements of one can be combined with others. The actual future development of the water resources of the basin will probably include some growth in all water uses.

Several evaluation criteria were used. Criteria included the frequency of achieving the preferred elevation range on Lake Diefenbaker — 554 to 556 metres above sea level — during the summer months. The frequency of achieving the preferred flow range downstream of Lake Diefenbaker during the summer months — 60 to 150 m^3/s — was also considered. These preferred values represent those which generate the largest benefit from the water resource. Other evaluation criteria included the amount of hydro-electric energy generated and the amount of water consumed. The latter was included because of its relevance to the Master Agreement on Apportionment. Water quality downstream of Saskatoon was considered by looking at the concentration of phosphorus, a plant nutrient, under minimum flow conditions. The lower the concentration, the better the water quality. Several of the scenarios had environmental benefits which were noted where possible.

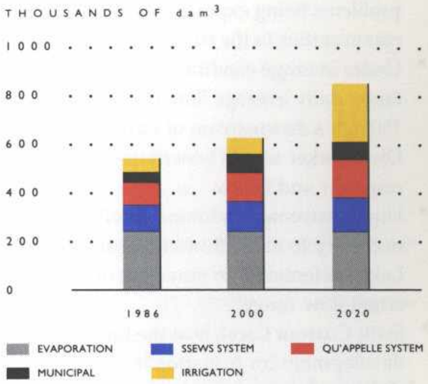
SCENARIO 1: BASE CASE

The base case scenario shows the effect of continuing the historical patterns of development for another 30 years. It provides a benchmark against which the other long-term scenarios can be compared. The findings from Scenario 1 apply to the other scenarios unless otherwise noted.

Findings:

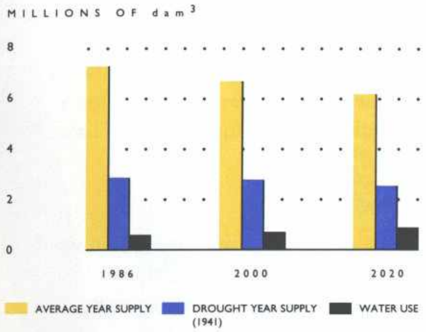
- Alberta average annual water use would increase from 22 percent in 1986, to 33 percent of the natural flow. As a result, Saskatchewan would receive on average 67 percent of the natural flow from Alberta — 6 200 000 dam^3 annually.
- Saskatchewan would be consuming about 14 percent of the water it receives from Alberta — 860 000 dam^3. This is up from eight percent or 550 000 dam^3 in 1986.
- Saskatchewan will be passing 57 percent of the natural flow in the South Saskatchewan River on to Manitoba — down from 71 percent in 1986.
- Irrigation would be the single largest consumer of water in the basin at 400 000 dam^3 — slightly more than evaporation.
- Municipal water use would increase to 80 000 dam^3, about 50 percent higher than for the year 1986.
- Industrial water use would increase but continue to represent less than one percent of water consumed from the mainstem.

SOUTH SASKATCHEWAN RIVER ANNUAL WATER USE



- The Qu'Appelle diversion used to meet municipal, industrial and recreational needs would increase from 90 000 dam^3 in 1986 to 140 000 dam^3.
- The needs of all consumptive users on the mainstem as forecast to the year 2020 can be met without difficulty, even in drought years.
- Increased development in Alberta should improve conditions for recreation and ferries upstream of Lake Diefenbaker. The frequency of achieving preferred flows would increase from 26 percent in 1986 to 38 percent by 2020.
- The frequency of achieving the preferred elevation on Lake Diefenbaker would increase from 25 percent in 1986 to 28 percent. However, there would be an increase in the frequency of extremely low water levels.
- The frequency of hitting the target flow range downstream of Lake Diefenbaker would decrease from 34 percent in 1986 to 26 percent in 2020.

SOUTH SASKATCHEWAN RIVER
ANNUAL WATER SUPPLY AND USE



- Water quality downstream of Saskatoon would deteriorate as a result of increased effluent volume. Summer phosphorus levels would increase 35 percent.
- Increasing water consumption in Alberta and Saskatchewan would lower hydro-electric energy production. Average annual power production at Coteau Creek Generating Station would fall from 1.1 million megawatt-hours in 1986 to about 0.8 million megawatt-hours in 2020. There would be additional losses in power production at the Nipawin and E.B. Campbell generating stations located downstream on the Saskatchewan River.

SCENARIO 2: WATER CONSERVATION

The water conservation scenario shows the effects of implementing an extensive water conservation program. Such a program could include public education, improvements in water distribution systems, metering and water pricing. A program involving the above could reduce consumption by up to 20 percent.

Findings:

- The volume of water lost to evaporation would be unchanged.
- Consumption of available supply would be reduced from 13 percent in Scenario 1 to about 11 percent.
- Preferred elevations on Lake Diefenbaker would not be achieved any more frequently with this scenario than with Scenario 1. However, in the conservation scenario, summer lake levels below 551 metres above sea level would occur less often.
- The preferred flows downstream of Lake Diefenbaker would occur 27 percent of the time — up from 26 percent in Scenario 1.
- Average annual hydro-electric energy production at the Coteau Creek Generating Station would increase about three percent over Scenario 1.
- The water conservation scenario would yield significant benefits. Conservation could delay or eliminate the need for costly expansion of water treatment and delivery systems. This could translate into reduced water bills for the individual user.

SCENARIO 3: WATER QUALITY

In the water quality scenario, it was assumed that Saskatoon had upgraded its sewage treatment system to include the removal of phosphorus — a plant nutrient which contributes to weeds and algal growth. This would improve water quality downstream of the city.

Findings:

- This scenario would not affect water consumption patterns.
- Despite the increase in the volume of effluent expected from Saskatoon by the year 2020, this scenario showed a 50 percent reduction in the concentration of phosphorus in the river downstream of the city.

SCENARIO 4: HIGH IRRIGATION

Scenario 4 shows the effects of significant irrigation development. It was estimated that a total of 68 000 hectares of irrigation might develop on the South Saskatchewan River — 19 000 hectares more than in Scenario 1.

Findings:

- Water use from the mainstem would increase by 90 000 dam^3 over that forecast for Scenario 1.
- Average annual water consumption would increase from 13 to 15 percent of the available supply.
- Lake Diefenbaker would achieve its preferred elevation more frequently than in Scenario 1, but this would be offset by an increase in the frequency of water levels below 551 metres above sea level where many uses would be negatively affected.
- The preferred flows downstream of Lake Diefenbaker would be achieved 24 percent of the time — down from 26 percent of the time in Scenario 1.
- Hydro-electric energy production at the Coteau Creek Generating Station would be four percent lower than in Scenario 1.

SCENARIO 5: LOW IRRIGATION

This scenario assumes that irrigation would not increase beyond that forecast for the year 2000. As a result, there would be 21 000 fewer hectares of irrigation than in Scenario 1.

Findings:

- Water use from the mainstem would decrease to 750 000 dam^3 — a decrease of almost 100 000 dam^3 from Scenario 1.
- Average annual consumption would decrease to 11 percent of the available supply.
- Lake Diefenbaker would achieve its preferred elevation slightly more often than in Scenario 1.
- The flows downstream of Lake Diefenbaker would achieve the preferred range somewhat more frequently.
- Hydro-electric energy production at the Coteau Creek Generating Station would increase about two percent over Scenario 1.

SCENARIO 6: INSTREAM USES ON LAKE DIEFENBAKER

Scenario 6 emphasizes conditions which are best for instream uses such as fisheries, recreation, boating and tourism on Lake Diefenbaker. This was done by reducing the winter drawdown on Lake Diefenbaker by four metres. This change in operation would reduce the fluctuations in water levels. More stable water levels would benefit all instream uses and some offstream uses such as irrigation.

Findings:

- Water use patterns would remain the same as in Scenario 1.
- Preferred water levels on Lake Diefenbaker would be achieved 41 percent of the time — up from 28 percent in Scenario 1.
- The frequency of achieving the preferred flows downstream of Gardiner Dam would increase to 40 percent from 26 percent in Scenario 1.
- Annual hydro-electric energy production at the Coteau Creek Generating Station would increase 1.5 percent, but 15 percent of the power generation would be shifted from the winter to the summer when it is less valuable.
- There would be an increase in the frequency of flows downstream of Lake Diefenbaker exceeding the preferred range.

SCENARIO 7: INSTREAM USES DOWNSTREAM OF LAKE DIEFENBAKER

This scenario emphasizes conditions that are best for instream uses downstream of Lake Diefenbaker. The conditions for instream uses, like boating, swimming and fishing, were improved by raising the summer minimum flow from 42.5 to 60 m^3/s.

Findings:

- Water consumption patterns did not change in this scenario.
- The preferred flow range downstream of Lake Diefenbaker would be achieved 75 percent of the time — up from 26 percent in Scenario 1.
- Conditions on Lake Diefenbaker would deteriorate. The frequency of meeting the preferred elevation range would decrease to 24 percent — down from 28 percent in Scenario 1. More significantly, the frequency of levels below 551 metres above sea level would double.
- Average annual hydro-electric energy production at the Coteau Creek Generating Station would increase seven percent while winter power production would increase one percent over that in Scenario 1.

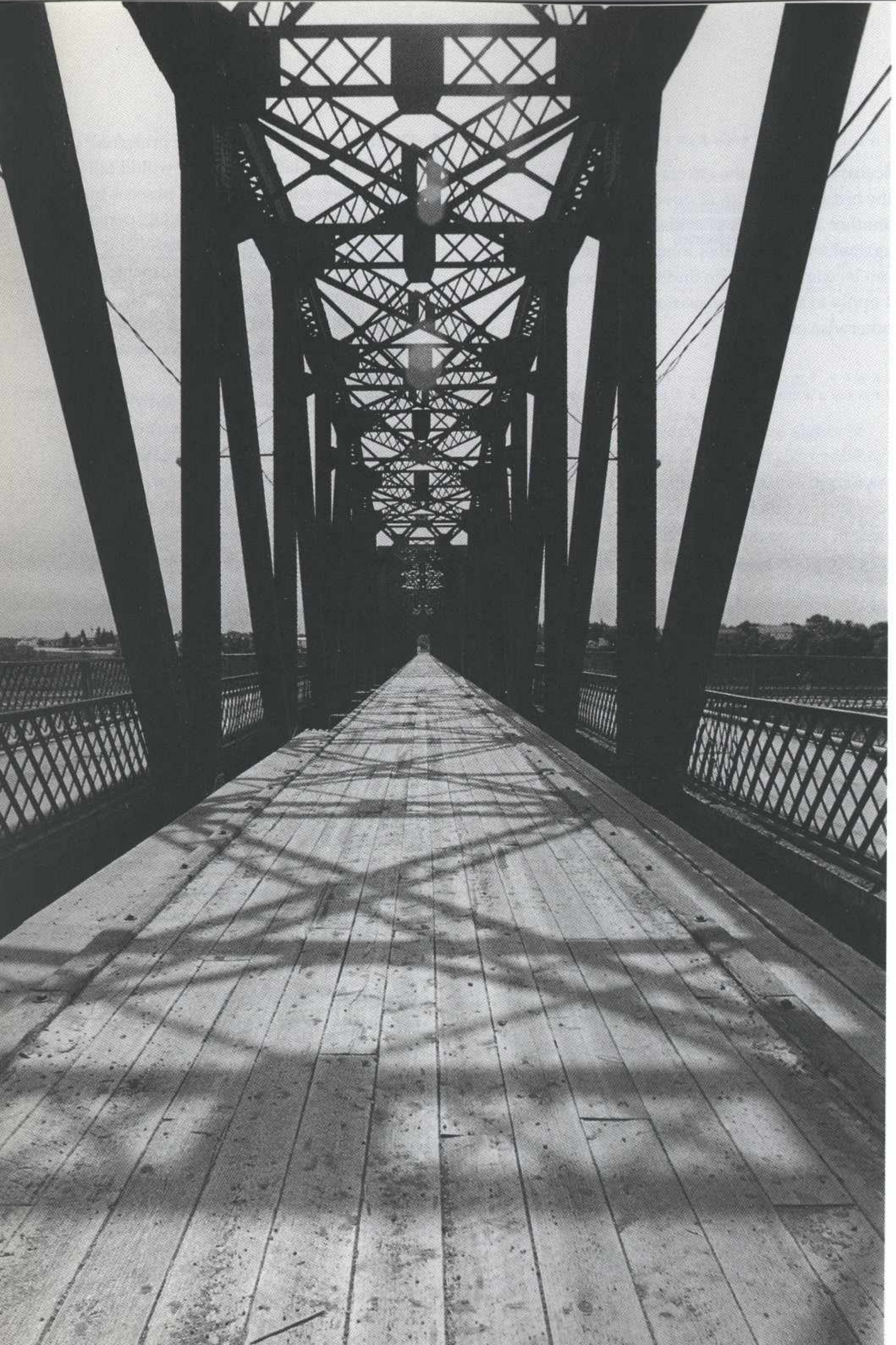
SCENARIO 8: HYDRO-ELECTRIC ENERGY PRODUCTION

Scenario 8 shows the effects of developing additional hydro-electric energy production. This was done by adding a dam and a 170 megawatt hydro-electric generating station downstream of Lake Diefenbaker.

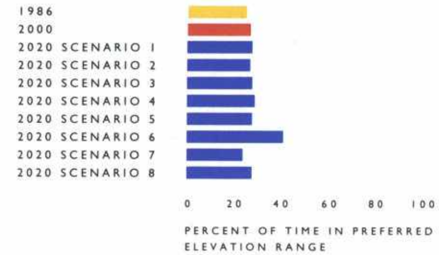
Findings:

- A slight increase in consumption would occur because of the additional evaporation losses from the new reservoir.
- The new generating station would produce an average of 0.6 million megawatt-hours of electricity each year.
- Total hydro-electric energy production for the study area would be 1.4 million megawatt-hours — up from 0.8 million megawatt-hours in Scenario 1.
- The new generating stations would eliminate about 650 000 tonnes of CO_2 annually — about five percent of SaskPower's total current CO_2 emissions — if the same amount of power were to be generated using coal.

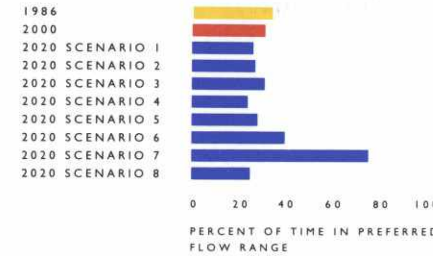
Bridges over the South Saskatchewan River, like this one near St. Louis, provide important year-round access across the river



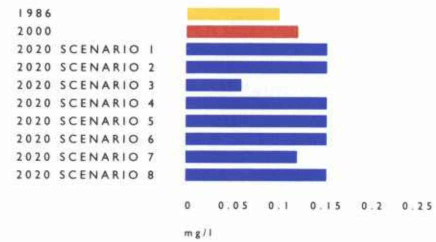
LAKE DIEFENBAKER SUMMER ELEVATIONS



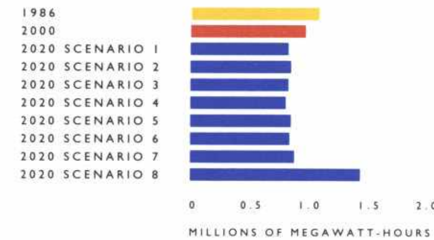
SUMMER FLOWS DOWNSTREAM OF LAKE DIEFENBAKER



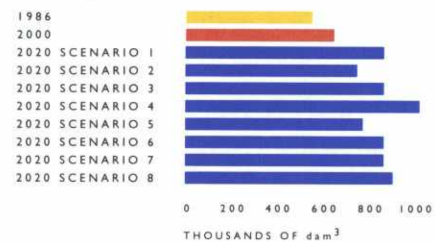
SUMMER PHOSPHORUS LEVELS AT SASKATOON



AVERAGE ANNUAL HYDRO-ELECTRIC POWER PRODUCTION



AVERAGE ANNUAL WATER CONSUMPTION



KEY

SCENARIO 1:	BASE CASE
SCENARIO 2:	WATER CONSERVATION
SCENARIO 3:	WATER QUALITY
SCENARIO 4:	HIGH IRRIGATION
SCENARIO 5:	LOW IRRIGATION
SCENARIO 6:	INSTREAM USES ON LAKE DIEFENBAKER
SCENARIO 7:	INSTREAM USES DOWNSTREAM OF LAKE DIEFENBAKER
SCENARIO 8:	HYDRO-ELECTRIC

SSEWS System

The management strategies technical committee formulated and evaluated three different long-term scenarios for the SSEWS system. In Scenario 1, the base case, it was assumed that the historical patterns of development continued to the year 2020. The base case was used as a benchmark to evaluate the other long-term scenarios. The other scenarios against which the other long-term scenarios can be compared. The other two scenarios showed the effect of conservation and increased system capacity.

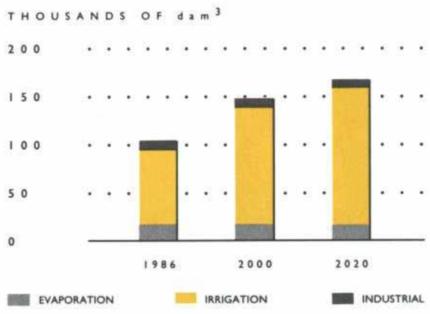
The scenarios are not mutually exclusive. Elements of one can be combined with others. For example, it might be desirable to encourage water conservation and undertake structural improvements to the system at the same time.

Evaluation criteria for the scenarios included the frequency of achieving the preferred elevations on the two reservoirs used for recreation: Blackstrap and Little Manitou lakes. The preferred elevation on Blackstrap Reservoir is from 534.47 (full supply level) to 534.2 metres above sea level. The preferred elevation range for Little Manitou Lake is from 497.20 (full supply level) to 493.47 metres above sea level. The average amount of water pumped from Lake Diefenbaker was also included because it provides an indication of possible effects on the South Saskatchewan River.

SCENARIO 1: BASE CASE

Scenario 1 shows the effects of continuing the historical pattern of development for another 30 years. It provides a reference against which the other long-term scenarios can be compared. The findings for Scenario 1 apply to the other scenarios unless otherwise noted.

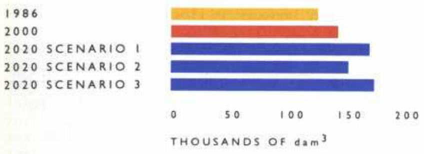
SSEWS SYSTEM
ANNUAL WATER USE



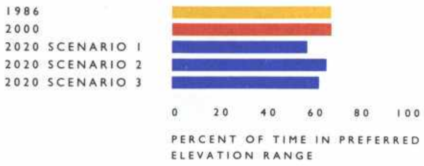
Findings:

- Irrigation will continue to be the largest water use — accounting for almost 90 percent of the water used. Irrigation water use would increase from about 90 000 dam^3 in 1986 to about 150 000 dam^3 in Scenario 1.
- The municipal demand for water would increase from about 500 dam^3 in the year 1986 to about 1 000 dam^3.
- The demand for water by the three potash mines served by the SSEWS system would increase by 50 percent from 1986 to about 4 000 dam^3. This would be about 2.5 percent of the water consumed from the SSEWS system.
- The frequency of meeting the preferred elevation on Blackstrap Lake would fall from 67 percent in 1986 to 57 percent in 2020; and 94 percent in 1986 to 83 percent in 2020 on Little Manitou Lake.
- The SSEWS system would be capable of meeting increased average monthly demands. However, the peak demands also increase, causing irrigation water shortages of a few days.
- The average diversion to the SSEWS system from Lake Diefenbaker would increase from 111 000 dam^3 in 1986 to 168 000 dam^3 in Scenario 1.

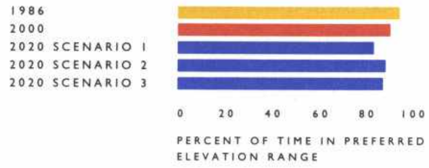
AVERAGE WITHDRAWAL FROM LAKE DIEFENBAKER



BLACKSTRAP LAKE ELEVATIONS



LITTLE MANITOU LAKE ELEVATIONS



KEY

SCENARIO 1:	BASE CASE
SCENARIO 2:	WATER CONSERVATION
SCENARIO 3:	M1 CANAL IMPROVEMENTS

SCENARIO 2: WATER CONSERVATION

This scenario shows the effects of implementing an extensive water conservation program. Such a program could include public education, improvements in water distribution systems, metering and water pricing. A program involving the above could reduce consumption by up to 20 percent.

Findings:

- The volume of water lost to evaporation would be unchanged.
- Water use would be reduced from about 152 000 dam^3 in Scenario 1 to 122 000 dam^3.
- The system would be capable of meeting all demands. The water shortages during peak periods would be eliminated.
- The frequency of meeting the preferred elevation on Blackstrap Lake would increase from 57 percent in Scenario 1 to 65 percent.
- The frequency of meeting the preferred elevation on Little Manitou Lake would increase from 83 percent in Scenario 1 to 88 percent.
- The average annual withdrawal from Lake Diefenbaker would drop from 168 000 dam^3 in Scenario 1 to 150 000 dam^3.

SCENARIO 3: M1 CANAL IMPROVEMENTS

At present, the weak link in the ability of the SSEWS system to respond to increasing peak demands is the M1 Canal — the canal which delivers water from Lake Diefenbaker to Broderick Reservoir. In this scenario it was assumed that the capacity of the M1 Canal was increased from 14 to 20 m^3/s.

Findings:

- The SSEWS system would be capable of meeting all demands. The water shortages during peak periods in Scenario 1 would be eliminated.
- The frequency of meeting the preferred elevation on Blackstrap Lake would increase from 57 percent in Scenario 1 to 62 percent.
- The frequency of meeting the preferred elevation on Little Manitou Lake would increase from 83 percent in Scenario 1 to 87 percent.
- The average annual diversion from Lake Diefenbaker would increase from 168 000 dam^3 in Scenario 1 to 172 000 dam^3.

Swift Current Creek

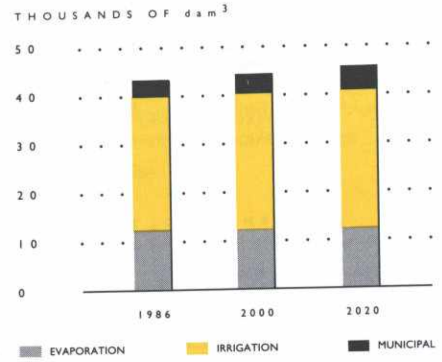
In 1986, Swift Current Creek basin was already fully developed. There will be sufficient water available to meet municipal demands as forecast to the year 2020, but there is insufficient water to meet forecast irrigation demands. As a result, the long-term planning shows the effects of increasing the amount of water available within the system through improved management. The expanded water supply was used for irrigation.

The management strategies committee formulated and evaluated seven different scenarios. Scenario 1, the base case, shows the effects of continued irrigation development. The other scenarios identify opportunities for making more water available within Swift Current Creek. These opportunities included conservation or the addition of new reservoirs and the construction of pipelines. The results of the scenarios involving the building of new reservoirs cannot be combined because each new reservoir reduces the effective yield of subsequent reservoirs.

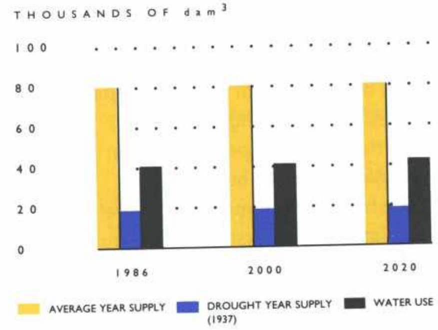
The long-term scenarios for Swift Current Creek were evaluated using three key criteria. The first was the frequency that Duncairn Reservoir achieved the preferred elevation range — 807.72 (full supply level) to 803.72 metres above sea level. The second was the frequency of irrigation water shortages, and, the total irrigated area. The last two criteria were included because additional water can be used either to reduce shortages for existing irrigators or to increase the irrigated area and keep the frequency of shortages the same. Where a choice was possible, both options were considered.

A variety of other criteria, including economic ones, would need to be looked at if any of the projects identified in the scenarios were considered for construction.

SWIFT CURRENT CREEK ANNUAL WATER USE



SWIFT CURRENT CREEK WATER SUPPLY AND USE



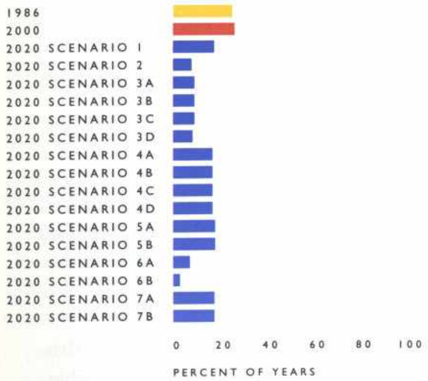
SCENARIO 1: BASE CASE

This scenario shows the effect of not allowing any irrigation development beyond that which existed in 1986. It provides a reference against which the other long-term scenarios can be compared. The findings for Scenario 1 apply to the other scenarios unless otherwise noted.

Findings:

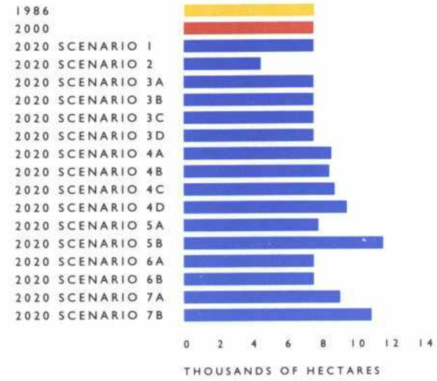
- Municipal water use is forecast to increase to about 5 500 dam^3 annually. This represents a 70 percent increase over 1986.
- Municipal supplies would not experience any water shortages.
- With irrigation development restricted, the irrigated area would remain at 7 600 hectares as it was in 1986 and 2000.
- Without any additional storage, the frequency of irrigation water shortages would increase from 15 to 17 percent.
- The frequency of meeting the preferred elevation range on Duncairn Reservoir would drop from 70 to 68 percent.
- The maintenance of an adequate depth in Duncairn Reservoir would ensure survival of the fishery.

FREQUENCY OF IRRIGATION WATER SHORTAGES



DUNCAIRN RESERVOIR ELEVATIONS

IRRIGATION AREA



KEY

SCENARIO 1:	BASE CASE
SCENARIO 2:	WATER CONSERVATION
SCENARIO 3:	ADDED STORAGE TO STABILIZE EXISTING IRRIGATION
SCENARIO 4:	ADDED STORAGE TO INCREASE IRRIGATED AREA
SCENARIO 5:	ADDED STORAGE DOWNSTREAM OF SWIFT CURRENT
SCENARIO 6:	PIPELINE TO THE CITY OF SWIFT CURRENT/STABILIZE EXISTING IRRIGATION
SCENARIO 7:	PIPELINE TO THE CITY OF SWIFT CURRENT/NEW IRRIGATED AREA

SCENARIO 2: WATER CONSERVATION

This scenario shows the effects of implementing a comprehensive water conservation program. Such a program could reduce water consumption by up to 20 percent.

Findings:

- There would be no change in the amount of water lost through evaporation.
- Water consumption would fall from 33 000 dam^3 in Scenario 1 to 27 000 dam^3.
- The frequency of irrigation water shortages would drop from 17 percent in Scenario 1 to seven percent.
- The frequency of meeting the preferred elevation range on Duncairn Reservoir would increase from 68 percent in Scenario 1 to 74 percent.

SCENARIO 3: ADDED STORAGE TO STABILIZE EXISTING IRRIGATION

This scenario shows the effect of adding storage and using the additional water to reduce water shortages to irrigation projects. Four options were considered: (a) raising Duncairn Dam to increase the storage from 103 000 to 120 000 dam^3; (b) adding a new reservoir upstream of Duncairn Reservoir with a capacity of 60 000 dam^3; (c) adding a new reservoir upstream of Duncairn Reservoir with a capacity of 100 000 dam^3; and, (d) adding a new reservoir upstream of Duncairn Reservoir with a capacity of 160 000 dam^3. The results of the latter three options cannot be combined.

Findings:

- The frequency of shortages would drop from 17 percent in Scenario 1 to nine percent in Scenarios 3a, 3b and 3c. The frequency of shortages would drop to eight percent in Scenario 3d.
- The frequency of meeting the preferred elevation range on Duncairn Reservoir would increase from 68 percent in Scenario 1 to 76, 80, 81 and 83 percent in Scenarios 3a, 3b, 3c and 3d, respectively.

SCENARIO 4: ADDED STORAGE TO INCREASE IRRIGATED AREA

This scenario shows the effects of using the same increases in storage described in Scenario 3 to develop new irrigated area. These scenarios are referred to as 4a, 4b, 4c and 4d. In all cases, the frequency of shortage was kept the same as that experienced in 1986.

Findings:

- The frequency of shortages would remain constant at about 17 percent.
- The frequency of meeting the preferred elevation range on Duncairn Reservoir would decrease from 68 percent in Scenario 1 to 61 in Scenario 4a and increase to 71, 71 and 72 percent in Scenarios 4b, 4c and 4d, respectively.
- The irrigated area would increase from 7 600 hectares in Scenario 1 to 8 500, 8 600, 9 000 and 9 200 hectares in Scenarios 4a, 4b, 4c and 4d, respectively.

SCENARIO 5: ADDED STORAGE DOWNSTREAM OF SWIFT CURRENT

This scenario was formulated to determine the effect of adding a reservoir downstream of the city of Swift Current. Because such a reservoir would be located downstream of existing irrigation, it could be used to support new irrigation but not to stabilize existing irrigation as in Scenario 3. It was assumed that the new irrigation would be expected to incur the same frequency of water shortages as in 1986. In Scenario 5a, a 1 240 dam^3 reservoir was added, while in Scenario 5b, a 14 000 dam^3 reservoir was added.

Findings:

- The frequency of meeting the preferred elevation range on Duncairn Reservoir stays at 68 percent, the same as in Scenario 1.
- Scenarios 5a and 5b would yield enough water to develop 7 600 and 11 600 hectares, respectively, of new irrigation.

SCENARIO 6: PIPELINE TO SWIFT CURRENT TO STABILIZE EXISTING IRRIGATION

This scenario shows the effect of meeting the city of Swift Current's water needs by a pipeline. In Scenario 6a, the pipeline would run from Duncairn Reservoir. This would make more water available by reducing channel losses associated with using Swift Current Creek to deliver water to the city. In Scenario 6b, the pipeline would run from Lake Diefenbaker. This would make more water available by removing the city's demands from Swift Current Creek entirely. In both cases, the additional water was used to reduce the frequency of irrigation water shortages experienced in 1986.

Findings:

- The frequency of irrigation water shortages would be reduced from 17 percent in Scenario 1 to seven and three percent in Scenarios 6a and 6b, respectively.
- The frequency of meeting the preferred elevation range on Duncairn Reservoir would increase from 68 percent in Scenario 1 to 74 and 88 percent in Scenarios 6a and 6b, respectively.

SCENARIO 7: PIPELINE TO SWIFT CURRENT TO ADD NEW IRRIGATED AREA

Scenario 7 shows the effects of using the same pipelines described in Scenario 6, to develop new irrigated area. In scenario 7a, the pipeline would run from Duncairn Reservoir to the city. In scenario 7b, the pipeline would run from Lake Diefenbaker to the city. Irrigation water shortages were held at 1986 frequencies.

Findings:

- The frequency of meeting the preferred elevation range on Duncairn Reservoir would stay the same as Scenario 1.
- Scenarios 7a and 7b would yield enough water to develop 1 500 and 3 300 hectares, respectively, of new irrigation.
- The irrigated area would increase from 7 600 hectares in Scenario 1 to 9 100 and 10 900 hectares, in Scenarios 7a and 7b, respectively.

Long-term Planning Conclusions

A number of general conclusions can be drawn from the long-term planning process carried out for the South Saskatchewan River, SSEWS system and Swift Current Creek.

- Water use in Alberta will continue to have a more significant impact on the water resources of the Saskatchewan portion of the basin than water use in Saskatchewan.
- Instream uses, such as recreation, fish and wildlife are generally compatible. The consumptive uses, like municipal, irrigation and industrial, are generally not compatible with each other or with instream uses.
- While there is sufficient water available on the mainstem to improve the conditions for instream water uses, improvement could only come at the expense of future consumptive uses.
- There is sufficient water in the South Saskatchewan River to meet the needs of existing uses as forecast to the year 2020 without difficulty.
- None of the long-term development scenarios for the mainstem consume more than 50 percent of the natural flow, even in the driest year. This means the South Saskatchewan River can continue to contribute its full share of the flow that Saskatchewan is required to deliver to Manitoba on the Saskatchewan River.
- Water conservation scenarios for the South Saskatchewan River show very small benefits to instream uses. Potentially significant benefits,

- particularly in the form of delayed or eliminated costly expansion to water treatment and delivery systems, accrue to those users who conserve.
- Conservation scenarios would offer significant benefits through reduced water shortages or expanded water supply on Swift Current Creek and the SSEWS system.
- The capacity of the SSEWS system must be increased, if irrigation is allowed to expand beyond that forecast for the year 2020.
- Without conservation, additional storage capacity is required on Swift Current Creek if further irrigation is allowed in this area.

System-Limit Planning

The system-limit planning identifies the absolute limits of the study area with respect to each major water use. The management strategies committee did this by formulating and evaluating scenarios. These system-limit scenarios help put the long-term scenarios into perspective.

The scenarios are not intended to represent likely paths of development; they are provided only to help define the development limits of the basin. Such information is useful to decision-makers as they make future plans for the study area.

The system-limit planning combines the SSEWS system with the mainstem. They were combined because the SSEWS system is an extension of the mainstem. The limiting factor to development on both is the amount of water in the mainstem. Therefore, the system-limit planning is organized into two sections: South Saskatchewan River/SSEWS system and Swift Current Creek.

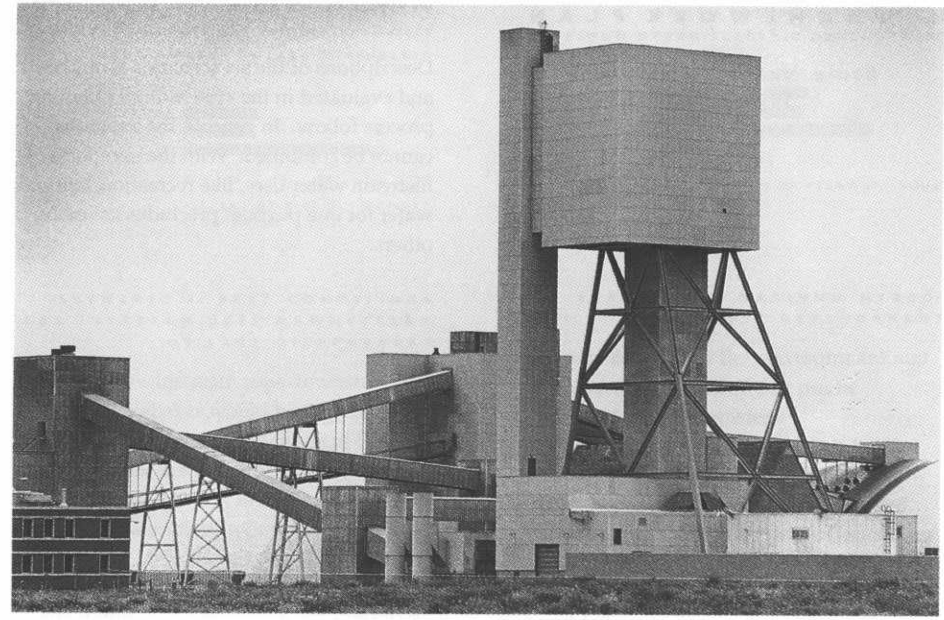
South Saskatchewan River and SSEWS System

The system-limit scenarios formulated for the South Saskatchewan River and SSEWS system identify the limits for each type of water use including irrigation, instream and hydro-electric energy generation.

In order to make sure that the scenarios did not overestimate the development potential, Alberta inflows were set as low as is permitted under the Master Agreement on Apportionment — 50 percent of the natural flow. Saskatchewan uses were set at the year 2000 level because of existing commitments to particular developments and water uses. Beyond the year 2000, the full range of opportunities exist.

The limits were identified by determining the water available after the needs of users as forecast to the year 2000 were met. The remaining water was then devoted to a specific type of development.

The impacts of the scenarios on existing users were not identified. Instead, the scenarios were evaluated in terms of how much more of a particular water use was possible or how much further conditions for a particular use could be improved. The results of the scenarios have been summarized in graphs. In order to assist with the interpretation, the conditions for the years 1986, 2000 and 2020 Scenario 1 have been included.

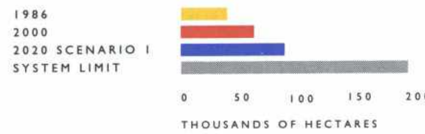


Potash mines use more than 500 litres of water to produce one tonne of potash

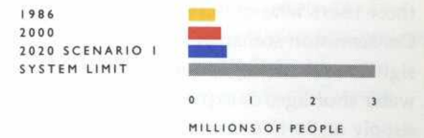
SCENARIOS

Descriptions of the six scenarios formulated and evaluated in the system-limit planning process follow. In general, the scenarios cannot be combined. With the exception of instream water uses, like recreation, using water for one purpose precludes its use by others.

SOUTH SASKATCHEWAN RIVER AND SSEWS SYSTEM
MAXIMUM IRRIGATION DEVELOPMENT



SOUTH SASKATCHEWAN RIVER AND SSEWS SYSTEM
MAXIMUM MUNICIPAL DEVELOPMENT



SCENARIO 1: MAXIMUM IRRIGATION DEVELOPMENT

In this scenario, irrigation was given its full allocation of water — irrigation did not incur any shortages or rationing.

Findings:

- The mainstem could support a total of 192 000 hectares of irrigation — 153 000 hectares beyond that which was present in 1986 and 130 000 hectares beyond that which is forecast to occur by the year 2000.

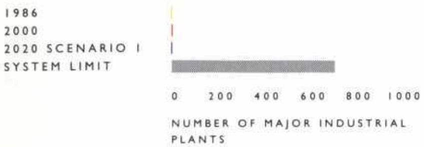
SCENARIO 2: MAXIMUM MUNICIPAL DEVELOPMENT

This scenario shows how much municipal development the South Saskatchewan River could support. In formulating this scenario, it was assumed all water withdrawn from the system for municipal purposes would be lost — with no return flow in the form of effluent that could be reused further downstream. This assumption simplified the calculation but produced a significant underestimate of the municipal development potential of the mainstem.

Findings:

- The river could support a total population of about 3 000 000 people. This represents a seven-fold increase over the 400 000 people who relied on the river for municipal water in 1986.

SOUTH SASKATCHEWAN RIVER
AND SSEWS SYSTEM
MAXIMUM INDUSTRIAL DEVELOPMENT



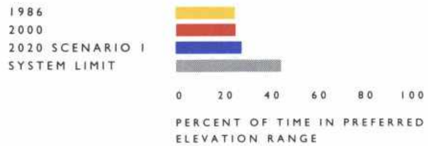
SCENARIO 3: MAXIMUM INDUSTRIAL DEVELOPMENT

This scenario shows the industrial development limits of the South Saskatchewan River. Again, in order to simplify the calculation, it was assumed that there would be no water returned to the river. This assumption produced a conservative estimate of the development potential.

Findings:

- The mainstem could support an industrial base about 100 times larger than in 1986. In 1986, there were seven major industrial plants which relied on water from the mainstem. There would be sufficient water to support up to 700 similar industrial facilities.

SOUTH SASKATCHEWAN RIVER & SSEWS SYSTEM
IMPROVED CONDITIONS FOR INSTREAM USES
ON LAKE DIEFENBAKER



SCENARIO 4: IMPROVED CONDITIONS FOR INSTREAM USES ON LAKE DIEFENBAKER

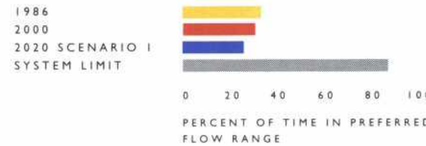
Conditions for instream uses on Lake Diefenbaker would be improved if the preferred elevation range of 554 to 556 metres above sea level was achieved more frequently.

This was accomplished in this scenario by modifying the operating plan for the reservoir to reduce winter drawdown.

Findings:

- The preferred elevation range on Lake Diefenbaker could be achieved 44 percent of the time — up from 25 percent in 1986.
- This means that with adjustments in its operating plan Lake Diefenbaker could offset the impacts on reservoir instream uses caused by the reduced apportionment flows from Alberta that were assumed for the system limit scenarios.

SOUTH SASKATCHEWAN RIVER & SSEWS SYSTEM
IMPROVED CONDITIONS FOR INSTREAM USES
DOWNSTREAM OF LAKE DIEFENBAKER



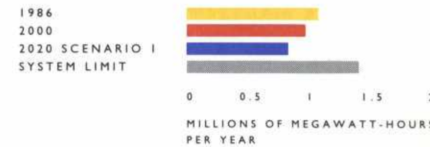
SCENARIO 5: BEST CONDITIONS FOR INSTREAM USES DOWNSTREAM OF LAKE DIEFENBAKER

Conditions for instream uses downstream of Lake Diefenbaker would be improved if the preferred summer flow range of 60 to 150 m^3/s were achieved more frequently. This was accomplished in this scenario by establishing a minimum flow of 60 m^3/s.

Findings:

- The frequency of achieving the preferred flow range increased from 35 percent of the time in 1986 to 88 percent of the time.
- With adjustments in its operating plan, Lake Diefenbaker could offset the impacts on instream uses downstream of Lake Diefenbaker of 50 percent inflow from Alberta — down from 78 percent in 1986.

SOUTH SASKATCHEWAN RIVER
MAXIMUM HYDRO-ELECTRIC DEVELOPMENT



SCENARIO 6: MAXIMUM HYDRO-ELECTRIC DEVELOPMENT

Scenario 6 identifies the maximum amount of hydro-electric energy that can be generated on the mainstem.

It was assumed that in addition to the Coteau Creek Generating Station, two new hydro-electric sites have been developed. In addition to the Coteau Creek Generating Station, and the site added in the long-term hydro scenario, one additional site would be added.

Findings:

- The mainstem would produce an average of 1.5 million megawatt-hours of electricity per year. Despite a 150 percent increase in generating capacity, there would be only a 35 percent increase in energy output.
- The reduced inflow from Alberta would result in reduced energy output.
- If the 35 percent increase in power were to be produced by burning coal instead of using hydro-electric, it would result in about 500 000 tonnes of CO_2 being released into the atmosphere each year.

FRAMEWORK PLAN

Basin Management Strategies
System-limit Planning

Swift Current Creek

The system-limit scenarios identify the limit of Swift Current Creek to support specific water uses. The management strategies committee formulated and evaluated three different scenarios. Each emphasizes a particular type of water use including irrigation, municipal and instream uses.

In order to identify the development limits of Swift Current Creek, all of the storage options identified in the long-term scenarios were added to the system. The total storage in the basin was increased from 110 000 dam^3 in 1986 to 300 000 dam^3. Sufficient water was set aside to meet the needs of the existing uses as forecast to the year 2000. The remaining water was then devoted to a specific type of development.

Because the system-limit scenarios are not intended to represent realistic options for development, the impacts of the scenarios on existing uses were not identified. Instead, the scenarios were evaluated in terms of how much more of a particular use was possible or how further conditions for a particular use could be improved. The results of the scenarios have been summarized in graphs. To assist with the interpretation, the conditions for the years 1986 and 2000 have been included.

SCENARIOS

Descriptions of the three system-limit scenarios formulated and evaluated for Swift Current Creek are provided below. In general, the scenarios cannot be combined. Using water for one type of development prevents use by other types of development.

SWIFT CURRENT CREEK
MAXIMUM IRRIGATION DEVELOPMENT

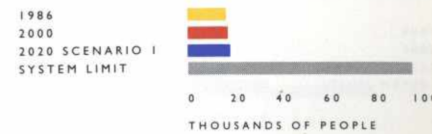
SCENARIO 1: MAXIMUM IRRIGATION DEVELOPMENT

This scenario shows how much irrigation Swift Current Creek could support. In this scenario, the frequency of irrigation water shortages experienced in 1986 was allowed to continue.

Findings:

- Swift Current Creek could support a total of 12 000 hectares of irrigation — up from 7 600 in 1986.

SWIFT CURRENT CREEK
MAXIMUM MUNICIPAL DEVELOPMENT



SCENARIO 2: MAXIMUM MUNICIPAL DEVELOPMENT

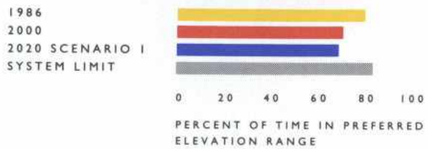
This scenario shows how large a population Swift Current Creek could support. In this scenario, all water withdrawn for municipal use was lost to the system. This assumption produced a conservative estimate of the municipal development potential.

Findings:

- Swift Current Creek could support a total population of 95 000 people — up from 16 000 in 1986.

Blackstrap Lake is a popular fishing location in the study area

SWIFT CURRENT CREEK
IMPROVED CONDITIONS FOR INSTREAM USES ON DUNCAIRN RESERVOIR



SCENARIO 3: IMPROVED CONDITIONS FOR INSTREAM USES ON DUNCAIRN RESERVOIR

Conditions for instream uses on Duncairn Reservoir can be improved by increasing the frequency of achieving the preferred elevation range — 803.72 to 807.72 metres above sea level. In this scenario, this was accomplished by adding an upstream reservoir with a capacity of 150 000 dam^3 and using it to stabilize water levels on Duncairn Reservoir.

Findings:

- The frequency of achieving the preferred elevation range could be increased from 36 percent in 1986 to 83 percent.

System-Limit Planning Conclusions

A number of general conclusions can be drawn from the system-limit planning exercises for the South Saskatchewan River and SSEWS system, and Swift Current Creek.

- All of the water in the study area is being used, whether for irrigation, hydro-electric energy generation or for instream uses like fisheries and waterfowl.
- Beyond the year 2020, there should be sufficient water available to allow increased use by municipalities, industries or irrigation projects, or improve the conditions for instream water uses like recreation or fish and wildlife.
- Of the consumptive uses, industry has the most room for growth while irrigation is the closest to reaching its limits of development.
- To improve conditions for any one type of water use would result in lost opportunities for other uses.

Recommendations

The basin management strategies include recommendations regarding the management of the water resources of the study area. While the water resources are well managed, and there is sufficient water to meet the needs of users as forecast to the year 2020, there are opportunities for improved management. The reduced supply and increased demand, particularly during the drought years, has the potential to make the difficulties experienced by some users more frequent and more severe in the future.

Based on the short-term, long-term and system-limit planning exercises, it is possible to make some recommendations. These recommendations were organized into three groups: public information, water management and research.

Public Involvement

- Develop and implement a public information program to assist the public in understanding the water resource management issues of the study area and a process to make their input possible.
- Continue to inform existing users about extreme variations in water quantity and quality that may affect their use of the water.
- Make new water users aware of the extreme variations in water levels that can occur to ensure that water use activity and associated structures can cope with the extremes.
- Encourage water conservation by all users, particularly those on the SSEWS system and Swift Current Creek, where water shortages already occur.

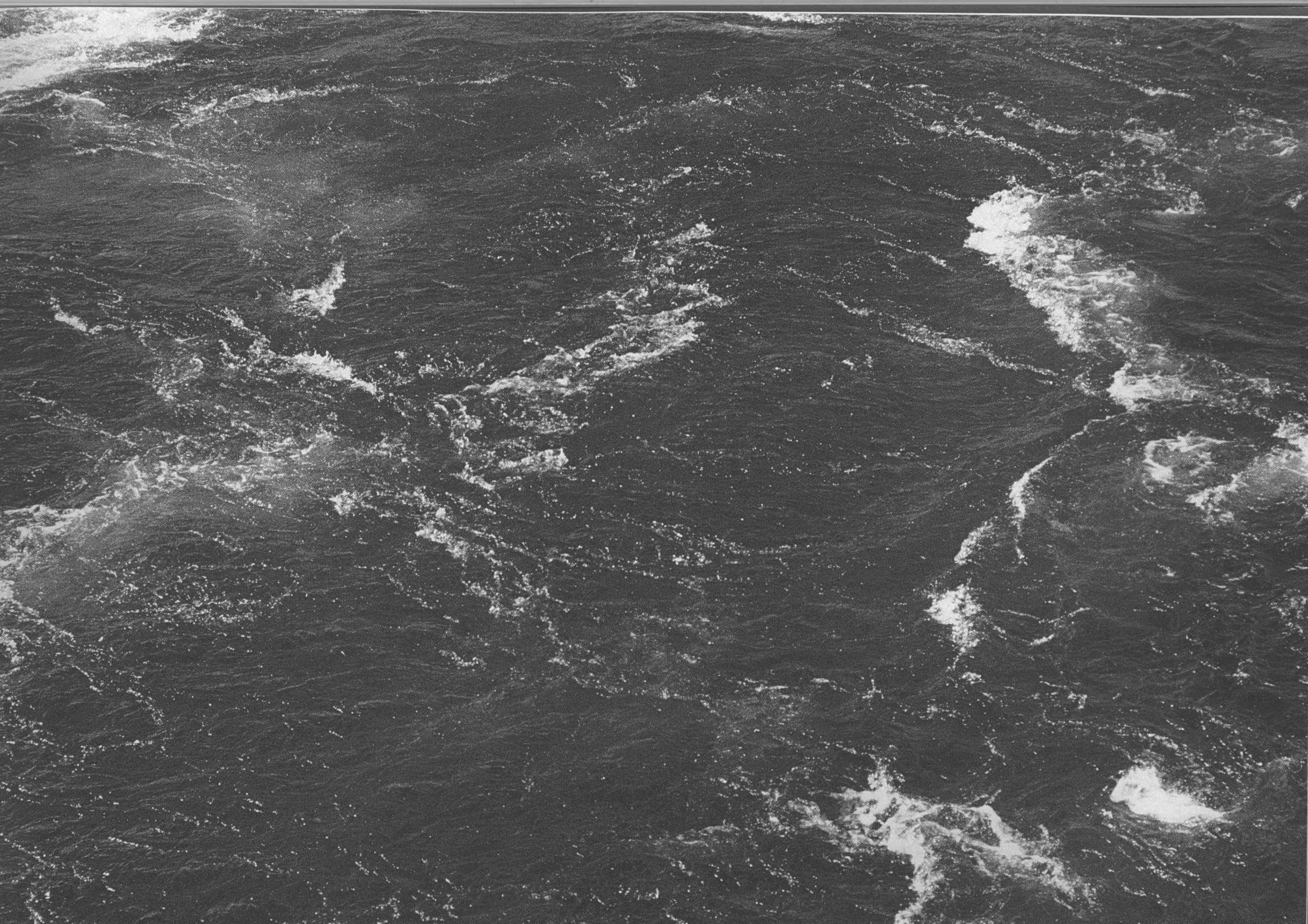
Water Management

- Implement the basin specific water quality objectives developed through the study and implement the monitoring program designed to ensure that the objectives are met. This will help protect the designated water uses.
- Encourage appropriate development, including appropriate public access, in shoreline areas. This can be accomplished through the Saskatchewan *Planning and Development Act* and programs such as the Canada/Saskatchewan Flood Damage Reduction Program (FDRP) and SaskWater's Reservoir Development Area (RDA) program.
- Reservoir operating plans should continue to be based on annual and seasonal forecasts for water supply and the needs of users on the reservoir and downstream.
- Establish a summer target daily average flow of 60 to 150 m^3/s for the South Saskatchewan River downstream of Gardiner Dam.
- Continue the practice of maintaining minimum daily average flows above 42.5 m^3/s downstream of Gardiner Dam.
- Apply the target and minimum flow criteria for the South Saskatchewan River from Gardiner Dam to confluence with the North Saskatchewan River.
- Do not exceed the current levels of irrigation development in the Swift Current Creek system unless more water is made available through conservation, changes in reservoir operation or the development of new storage.
- Consider modifying the operating plans for Duncairn and Highfield reservoirs to make more water available in the Swift Current Creek system.
- Investigate the feasibility of developing regional water supply systems for municipalities and other users that currently experience water quantity or water quality problems.

Research

- Encourage research aimed at quantifying the benefits of instream water uses.
- Encourage research aimed at developing a monitoring system capable of detecting subtle long-term changes in the health of the ecosystem.

The water released from Lake Diefenbaker is of very high quality



EVALUATION TOOLS

The framework plan has three parts: basin management strategies, an implementation plan and the evaluation tools which are discussed in this section.

Existing Evaluation Processes

There are three main evaluation processes which may apply to water resource development proposals. They include SaskWater's water use permitting process and the provincial and federal environmental assessment processes.

According to its legislation, SaskWater must consider the water management aspects of all water resource development proposals. A developer must apply to SaskWater for an approval to construct any project which uses water. SaskWater reviews the proposal to determine if the project will affect any other water users. If SaskWater determines that the proposal is acceptable, an approval to construct the project is issued. Once completed and inspected to confirm that the original plans were followed, an approval to operate is issued. SaskWater may not approve any project without first receiving clearance from Saskatchewan Environment and Public Safety.

Saskatchewan Environment and Public Safety considers the environmental implications of developments covered by the *Environmental Assessment Act* before allowing development to proceed. The level of intensity of the environmental review depends on the magnitude and potential for environmental impacts. At the time this report was being prepared, Saskatchewan was reviewing the *Environmental Assessment Act* in order to ensure that consistent and appropriate assessment of future proposals occurs.

When a project undertaken by a federal department, has effects on an area of federal responsibility, involves federal funds or is located on federal lands, the federal Environmental Assessment and Review Process must be applied. Under this process, the project is screened to determine if there are significant environmental impacts. If significant impacts are identified, the department must refer the project to the Minister for public review by a panel. The developer or agency prepares an Environmental Impact Statement (EIS) for the project in accordance with guidelines developed by the panel. The EIS is circulated for government and public scrutiny. After a public hearing phase, the panel reviews the EIS and the public input and makes recommendations to the Minister regarding the project. This process was established by Order in Council and was under review at the time this report was prepared. New legislation to define the process had been introduced in Parliament.

Evaluation Tools

The South Saskatchewan River Basin Study compiled baseline information and developed computer models which can be used to help ensure that projects are evaluated in a consistent and thorough manner. These tools can assist in the evaluation of projects from three different perspectives: environmental, social and economic. These evaluation tools are meant to be used within the context of the existing evaluation processes.

The following section provides a brief description of some of the databases and evaluation tools developed over the course of the study. The maintenance and updating of these tools is discussed in the implementation plan.

Water Resources Management Model (WRMM)

The WRMM is a water balance computer model that predicts the effects of changes in system operation or water supply on both the quantity of water available and water uses. It can be used in the evaluation of all types of water resource development projects.

Hydraulic Model

The HEC - II model was calibrated for the South Saskatchewan River upstream and downstream of Lake Diefenbaker. These computer models identify the velocity, discharge and depth for any flow and location on the river. They are useful in determining the effect of water management on instream and offstream uses.

Hydro System Simulation Model (HYDSIM)

This SaskPower computer model was configured for the study area. It can help determine the effect of proposed water management developments on hydro-electric energy production at Coteau Creek and the two hydro-electric generating stations located downstream on the Saskatchewan River.

Flood Impact Curves

These damage curves provide an estimate of the crop damages associated with flooding downstream of Lake Diefenbaker. The curves take into account flood duration and elevation and crop mix. These curves help evaluate proposed changes in Lake Diefenbaker operation.

Water Use Analysis Model (WUAM)

This water balance model determines the effect of a change in the economy on water use and supply. It can also be used to determine the effect of a major water resource development project on the economy and employment of the study area.

Drought Impact Model

This computer model predicts the financial impact of drought on irrigation farm enterprises. The model includes a variable for the degree of water shortage, the frequency of water shortage, the crop mix, the crop price and the level of farm indebtedness. It reports on net worth at the end of a ten-year cycle.

The model can be used to help evaluate the effect of water allocation policies and developments on irrigation.

Residential Water Use Model

This model documents past and present levels of residential and municipal water use in the South Saskatchewan River Basin. It establishes a relationship between water use and price, and can be used to evaluate the effect of price-based conservation programs on residential water use.

Water Intake and Outfall Survey

This list identifies the location and elevation of all known permanent intakes and outfalls located on the South Saskatchewan River and Swift Current Creek. This information can help to determine the impacts of proposed development of existing offstream water users.

Travel Cost Model

This model was developed from data collected in a recreation survey. The travel cost model determines the value of existing parks. This information is useful when making decisions about future investment in recreation facilities. The model can also be used to help determine the expected number of visitors to any proposed parks.

Instream Flow Requirements

This list identifies the preferred, maximum and minimum reservoir elevations and river flow requirements of all known instream users. This information helps determine the possible effects of a particular type of development on ferries, effluent disposal, waterfowl, wildlife and recreational uses.

Fisheries Survey

This list identifies the fish species commonly found in the waters of the study area. It includes the South Saskatchewan River, Swift Current Creek and SSEWS system. In conjunction with known information on habitat requirements for each species, the list will help ensure that fish are considered in project evaluation.

Wildlife Habitat Maps

These maps identify the most important habitat areas for wildlife, including endangered species, in the South Saskatchewan River Basin. They can be used to guide development to areas where the impacts on wildlife will be minimized.

Heritage Resource Maps

The heritage resource maps show the probability of finding archaeological or palaeontological artifacts in a particular location. Along with the accompanying guidelines for development, these maps can be used to minimize the impact of development on heritage resources.

Lake Diefenbaker Nutrient Model

This water quality computer model determines the concentration of phosphorus in Lake Diefenbaker. It can be used to evaluate the impact of land use changes, or changes in phosphorus loadings from the river, on the overall water quality of the lake.

River Water Quality Models

Water quality models for the South Saskatchewan River upstream and downstream of Lake Diefenbaker address nutrients, dissolved oxygen, salts and metals. They can be used to determine the effect of specific proposals on any one of the preceding water quality characteristics of the river.

SSEWS System Water Quality Model

This model predicts the water quality of the system reservoirs. It would help determine the effect of proposed expansions, changes in operation or water use on water quality.

Conclusions and Recommendations

The study has increased the number of databases and evaluation tools available for the evaluation of projects in the South Saskatchewan River Basin. As a result, the evaluation of projects is more complicated. For example, not all developers or regulatory agencies are aware of the evaluation tools available. In addition, the data in the databases are not always compatible. In most cases, the data cannot be related geographically to one another. This makes the consistent evaluation of projects more difficult.

Based on this analysis, the following can be concluded:

- The development of data bases needs to be harmonized with the requirements of analytical tools for project evaluation. Based on the above conclusion, the following recommendation was developed:

- Work toward more compatible databases and tools to help ensure a more consistent approach to project evaluation.

Implementation Plan

IMPLEMENTATION PLAN

An implementation plan was included as part of the framework plan because no single agency has the mandate or authority to implement the entire framework plan. The implementation plan is based on a co-operative multi-agency approach.

The implementation plan considers the recommendations developed from the management strategies and the maintenance of the evaluation tools. It also considers updating the entire South Saskatchewan River Basin Study.

WATER MANAGEMENT AGENCIES AND LEGISLATION

	AGENCIES AND PRINCIPLE LEGISLATION
	FEDERAL AGENCIES AND LEGISLATION
ENVIRONMENT CANADA	GOVERNMENT ORGANIZATION ACT CANADA WATER ACT CANADIAN ENVIRONMENTAL PROTECTION ACT FISHERIES ACT MIGRATORY BIRDS CONVENTION ACT CANADA WILDLIFE ACT NATIONAL PARKS ACT
FISHERIES AND OCEANS CANADA	FISHERIES ACT
PRAIRIE FARM REHABILITATION ADMINISTRATION (PFRA)	PRAIRIE FARM REHABILITATION ACT
	PROVINCIAL AGENCIES AND LEGISLATION
SASK WATER	WATER CORPORATION ACT CONSERVATION AND DEVELOPMENT ACT ENVIRONMENTAL MANAGEMENT AND PROTECTION ACT WATERSHED ASSOCIATION ACT WATER USERS ACT IRRIGATION DISTRICTS ACT SOUTH SASKATCHEWAN RIVER IRRIGATION ACT GROUNDWATER CONSERVATION ACT WATER POWER ACT
SASKATCHEWAN ENVIRONMENT AND PUBLIC SAFETY	ENVIRONMENT MANAGEMENT AND PROTECTION ACT ENVIRONMENTAL ASSESSMENT ACT
SASKATCHEWAN PARKS AND RENEWABLE RESOURCES	PARKS ACT FISHERIES ACT
SASKATCHEWAN RURAL DEVELOPMENT	PLANNING AND DEVELOPMENT ACT
	LOCAL AGENCIES AND LEGISLATION
MEEWASIN VALLEY AUTHORITY	MEEWASIN VALLEY AUTHORITY ACT
CONSERVATION AND DEVELOPMENT AUTHORITIES	CONSERVATION AND DEVELOPMENT ACT
WATER USERS ASSOCIATIONS	WATER USERS ACT
IRRIGATION DISTRICTS	IRRIGATION DISTRICTS ACT THE SOUTH SASKATCHEWAN RIVER IRRIGATION ACT
WATERSHED ASSOCIATIONS	WATERSHED ASSOCIATIONS ACT
URBAN MUNICIPALITIES	URBAN MUNICIPALITIES ACT WATER CORPORATION ACT ENVIRONMENTAL MANAGEMENT AND PROTECTION ACT PLANNING AND DEVELOPMENT ACT

Water Management Responsibilities

More than 15 different agencies have responsibilities that affect water management. These agencies include private and crown corporations, as well as federal, provincial and municipal government departments. In order to assign responsibilities for implementation of the framework plan, an understanding of agency legislation and responsibilities was essential.

The advisory committee played a key role in identifying the water management agencies, their legislation and areas of responsibility.

Water management is a provincial responsibility. SaskWater, a crown corporation that allocates water, is responsible for the operation of all water management structures including Gardiner Dam, and represents Saskatchewan in the area of interjurisdictional water management. Saskatchewan Environment and Public Safety's relevant responsibilities are water quality monitoring and effluent standards enforcement. Saskatchewan Parks and Renewable Resources is responsible for managing the provincial parks and fish and wildlife resources.

Although water management is a provincial responsibility, federal agencies play a supporting role. Environment Canada has responsibilities for water quantity and quality monitoring, national parks, and interjurisdictional waters. PFRA participates in system operation and soil and water conservation programs.

Other agencies at both the federal and provincial levels have fewer and more narrow responsibilities that may affect water management.

AGENCY/RESOURCE MANAGEMENT ACTIVITIES MATRIX

AGENCIES	FEDERAL				PROVINCIAL							OTHER			
RESOURCE MANAGEMENT ACTIVITIES	ENVIRONMENT CANADA	PRAIRIE FARM REHABILITATION ADMINISTRATION	AGRICULTURE CANADA	DEPARTMENT OF FISHERIES AND OCEANS	SASK WATER	SASKATCHEWAN ENVIRONMENT AND PUBLIC SAFETY	SASKATCHEWAN AGRICULTURE AND FOOD	SASKATCHEWAN COMMUNITY SERVICES	SASKATCHEWAN RURAL DEVELOPMENT	SASKATCHEWAN PARKS AND RENEWABLE RESOURCES	SASKATCHEWAN WETLAND CONSERVATION CORPORATION	PRAIRIE PROVINCES WATER BOARD	MUNICIPALITIES	MEEWASIN VALLEY AUTHORITY	DUCKS UNLIMITED
WATER ALLOCATION															
SYSTEM OPERATION															
WATER QUANTITY MONITORING															
WATER QUALITY MONITORING															
POLLUTION CONTROL															
LAND USE CONTROL															
FISHERIES															
WILDLIFE															
FERRIES															
PARKS / RECREATION															
AGRICULTURE															
WETLANDS															
INTERJURISDICTIONAL WATERS															
PUBLIC INFORMATION															
RESEARCH															

Recommendations and Implementing Agencies

Based on the short-term, long-term and system-limit planning exercises, 15 recommendations were developed. They were organized into three categories: public information, water management and information needs.

In the implementation plan, these recommendations have been assigned to agencies according to their respective responsibilities. In most cases, a single agency has the primary responsibility for implementation with one or two other agencies acting in support.

Public Involvement

- Develop and implement a public information program to assist the public in understanding the water resource management issues of the study area and a process to facilitate their input.

  Lead: SaskWater
  Supporting: all agencies

- Continue to inform users about extreme variations in water quantity and quality that may affect their use of the water.

  Lead: SaskWater, Saskatchewan Environment and Public Safety

- Make new water users aware of the extreme variations in water levels that can occur to ensure that water use activity and associated structures can cope with the extremes.

  Lead: SaskWater
  Supporting: Meewasin Valley Authority

- Encourage water conservation by all users, particularly those on SSEWS system and Swift Current Creek, where water shortages already occur.

  Lead: SaskWater, municipalities
  Supporting: Saskatchewan Environment and Public Safety, Saskatchewan Community Services, Environment Canada, PFRA

Water Management

- Implement the basin specific water quality objectives developed through the study and the monitoring program designed to ensure that the objectives are met.

  Lead: Saskatchewan Environment and Public Safety, Environment Canada
  Supporting: Prairie Provinces Water Board

- Encourage appropriate development, including the provision of sufficient public access, in shoreline areas.

  Lead: municipalities
  Supporting: SaskWater, Environment Canada, Saskatchewan Community Services, Saskatchewan Rural Development, Meewasin Valley Authority

- Continue to develop reservoir operating plans based on the seasonal forecasts for water supply and the needs of users on the reservoir and downstream.

  Lead: SaskWater
  Supporting: PFRA, SaskPower, Saskatchewan Parks and Renewable Resources

- Establish a summer target daily average flow of 60 to 150 cubic metres per second for the South Saskatchewan River downstream of Gardiner Dam.

  Lead: SaskWater

- Continue the practise of maintaining a minimum daily average flows above 42.5 cubic metres per second downstream of Gardiner Dam.

  Lead: SaskWater

- Apply the target and minimum flow criteria for the South Saskatchewan River from Gardiner Dam to the confluence with the North Saskatchewan River.

  Lead: SaskWater

- Do not exceed the current levels of irrigation development in the Swift Current Creek system unless more water is made available through conservation, changes in reservoir operation, or the development of new storage.

  Lead: SaskWater, PFRA

- Consider modifying the operating plans for Duncairn and Highfield reservoirs to make more water available in the Swift Current Creek system.

  Lead: SaskWater
  Supporting: PFRA

- Investigate the feasibility of developing regional water supply systems for municipalities and other users that currently experience water quantity or water quality problems.

  Lead: SaskWater
  Supporting: PFRA, Saskatchewan Community Services, Saskatchewan Rural Development, municipalities

Research

- Encourage research aimed at quantifying the benefits of instream water uses.

  Lead: SaskWater
  Supporting: Saskatchewan Parks and Renewable Resources, Environment Canada

- Encourage research aimed at developing a monitoring system capable of detecting subtle long-term changes in the health of the natural ecosystem.

  Lead: Environment Canada
  Supporting: all agencies

Evaluation Tools

The implementation plan also addresses the project evaluation tools. These tools were developed to help water managers evaluate projects in a consistent and thorough manner. In order to do this, these tools must be kept current and maintained in good working order.

Based on the review of agency responsibilities, the project evaluation procedures have been assigned to agencies which will assume responsibility for their maintenance. In most cases, the agency identified was responsible for developing the tool.

The implementation plan also provides a suggestion as to how often the particular tool should be revised. The suggestions are based on several factors. Most important is how fast the South Saskatchewan River Basin in changing. For example, water use patterns in the basin are changing quickly. As a result, the water balance models will require frequent updates if they are to provide accurate results. Other tools, particularly the water quality models, represent the current state of the science. These models will not require revisions until scientific advances will allow improvements.

The following list of evaluation tools developed by the study, identifies an agency to assume responsibility for maintenance and a suggested frequency for revision.

Water Resources Management Model (WRMM)
Maintenance: SaskWater
Revision Frequency: annual

Hydro System Simulation Model (HYDSIM)
Maintenance: SaskPower
Revision Frequency: five years

Hydraulic Model (HEC-II)
Maintenance: SaskWater
Revision Frequency: five years

Flood Impact Model
Maintenance: SaskWater
Revision Frequency: ten years

Water Use Analysis Model (WUAM)
Maintenance: Environment Canada
Revision Frequency: five years

Drought Impact Model
Maintenance: SaskWater
Revision Frequency: ten years

Residential Water Use Model
Maintenance: SaskWater
Revision Frequency: ten years

Water Intake and Outfall Survey
Maintenance: SaskWater
Revision Frequency: annual

Travel Cost Model
Maintenance: Saskatchewan Parks and Renewable Resources
Revision Frequency: ten years

Instream Flow Requirements
Maintenance: SaskWater
Revision Frequency: five years

Fisheries List
Maintenance: Saskatchewan Parks and Renewable Resources
Revision Frequency: ten years

Wildlife Habitat Maps
Maintenance: Saskatchewan Parks and Renewable Resources
Revision Frequency: ten years

Heritage Resource Maps
Maintenance: Saskatchewan Culture, Multiculturalism and Recreation
Revision Frequency: ten years

Lake Diefenbaker Trophic State Model
Maintenance: Saskatchewan Environment and Public Safety
Revision Frequency: five years

River Water Quality Models
Maintenance: Saskatchewan Environment and Public Safety
Revision Frequency: one to two years

SSEWS Water Quality Model
Maintenance: Saskatchewan Environment and Public Safety
Revision Frequency: ten years

Experience with previous river basin planning studies has shown that there is little, if any, consistency in how long they remain useful. Some studies, such as the Saskatchewan-Nelson River Basin Study finished in 1972, have remained useful for many years after their completion. Others have gone out of date very quickly. This section of the implementation plan discusses the timing for a follow-up Canada-Saskatchewan South Saskatchewan River Basin Study.

The results of the South Saskatchewan River Basin Study are most sensitive to the forecast for inflows from Alberta used to run the various scenarios. Alberta water use was forecast to increase from 22 percent of the natural flow in 1986 to 33 percent of the natural flow in 2020. This forecast is based on the assumption that Alberta will not exceed irrigation development limits that it established. Alberta should reach these limits by the year 2010. Based on the fact that Alberta inflows are critical to the results of the study, it would be wise to consider a new South Saskatchewan River Basin Study around 2010 — approximately 20 years after the completion of this study. By the year 2010, it should be possible to determine whether Alberta will adhere to the limits.

While 2010 is recommended as the year when a new study should be considered, a number of factors could make it necessary to consider a follow-up study sooner. If there were indications before the year 2010 that Alberta would be exceeding the development limits it would be appropriate to consider whether a new study in Saskatchewan would be warranted.

Although not as important as Alberta water use, water use patterns in the study area have some effect on the results of the study. Therefore, if water use in the Saskatchewan portion of the basin showed signs of significantly exceeding the levels identified in the long-term planning scenarios, it might be worth considering a new study.

As noted previously in this report, climate change could have a significant effect on water supply and use in the South Saskatchewan River Basin. However, at the time of this study, experts were unable to say what the impact might be on the study area. If more accurate estimates of the impacts of climate change emerge, and they suggest either decreases in water supply or increases in use, it would be appropriate to consider whether a new study is warranted.

Conclusions and Recommendations

In an attempt to ensure that the recommendations of the study are implemented, the recommendations have been assigned to specific agencies. However, a more formal process to continue after the completion of the study would help ensure that the recommendations of the study are in fact implemented. Furthermore, such a process would allow the results of the recommendations and implementation efforts to be monitored. Such monitoring would allow for adjustments to help ensure that the work of the study realizes its full potential.

It would be reasonable to consider a new study of the Saskatchewan portion of the South Saskatchewan River Basin around the year 2010. At this time, it will probably be possible to determine whether the water supply and use forecasts used by the study were accurate. Similarly, better information on the effects of climate change should be available. If water use patterns change significantly or if new information on climate change becomes available, it may be necessary to consider a follow-up study at an earlier date.

Based on the implementation plan, the following conclusions can be drawn:

- A procedure to ensure the implementation, and to monitor the results, of the study's recommendations should be put in place.
- By the year 2010 it should be possible to determine if the water use forecasts used to carry out the study were accurate, and therefore, whether a follow-up study is needed.

Based on the above conclusions, the following recommendations were made:

- Establish a procedure to ensure the implementation and to monitor the results of the study's recommendations.
- Consider carrying out a follow-up study of the Saskatchewan portion of the South Saskatchewan River Basin in the year 2010.

The operation of control structures on reservoirs is an important part of water management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6

APPENDICES

Shoreline habitat is favoured by a variety of birds and animals

APPENDIX I

Study Participants

STUDY BOARD			
Co-Chair	Robert Halliday	Environment Canada	1986 to 1991
	Wayne Dybvig	SaskWater	1987 to 1991
	Richard Kellow	SaskWater	1986 to 1987
Alternates	Derek Bjonback	Environment Canada	1986 to 1991
	Don Fast	Saskatchewan Environment and Public Safety	1988 to 1989
	Wayne Dybvig	SaskWater	1986 to 1987
STUDY OFFICE			
Director	Brad Fairley	South Saskatchewan River Basin Study	1988 to 1991
	Stephen Kendall	South Saskatchewan River Basin Study	1986 to 1988
Assistant Director	Brad Fairley	South Saskatchewan River Basin Study	1987 to 1988
	Esther Kienholz	South Saskatchewan River Basin Study	1986
Research Officer	Ron Blackwell	South Saskatchewan River Basin Study	1989 to 1991
	Jim Engel	South Saskatchewan River Basin Study	1986 to 1989
Secretary	Karen Mayson	South Saskatchewan River Basin Study	1990 to 1991
	Sharon Monkhouse	South Saskatchewan River Basin Study	1988 to 1990
	Carol Regimbald	South Saskatchewan River Basin Study	1988
	Linda Cheyne	South Saskatchewan River Basin Study	1986 to 1988
Technical Consultant	Ray Pentland	Water Resource Consultants Ltd.	1988 to 1991
ADVISORY COMMITTEE			
Chair	Derek Bjonback	Environment Canada	1986 to 1991
Members	Hans Foerstel	Environment Canada	1986 to 1991
	William Gummer	Environment Canada	1986 to 1991
	Brian Abrahamson	Prairie Farm Rehabilitation Administration	1987 to 1991
	Fred Heal	Meewasin Valley Authority	1988 to 1991
	Jim Atcheson	Agriculture Canada	1989 to 1991
	Randy Winnitowy	Western Economic Diversification	1989 to 1991
	Ken Panchuk	Saskatchewan Agriculture and Food	1989 to 1991
	Dave Richards	SaskWater	1989 to 1991
	Bob Ruggles	Saskatchewan Environment and Public Safety	1989 to 1991
	Trent Good	Saskatchewan Rural Development	1990 to 1991
	Stuart Kramer	Saskatchewan Agriculture and Food	1986 to 1990
	Wayne Pepper	Saskatchewan Parks and Renewable Resources	1986 to 1990
	Lloyd Talbot	Saskatchewan Rural Development	1989 to 1990
	David James	Western Economic Diversification	1986 to 1989
	Jim Lowe	Agriculture Canada	1986 to 1989
	Don Fast	Saskatchewan Environment and Public Safety	1986 to 1989
	Jon Jonsson	Saskatchewan Rural Development	1986 to 1988
	Bert Lukey	Prairie Farm Rehabilitation Administration	1986 to 1987

WATER QUANTITY COMMITTEE	Fred Martin	Prairie Farm Rehabilitation Administration	1986 to 1991
	Larry Wiens	Environment Canada	1986 to 1991
	Alex Banga	SaskWater	1986 to 1991
	Vipin Prasad	SaskPower	1986 to 1991
WATER QUALITY COMMITTEE	Bob Ruggles	Saskatchewan Environment and Public Safety	1986 to 1991
	William Sawchyn	Saskatchewan Parks and Renewable Resources	1986 to 1991
	Randy Munch	City of Saskatoon	1986 to 1991
	Diane Blachford	Environment Canada	1987 to 1991
	Barney Kenney	National Hydrology Research Institute	1989 to 1991
	Ken Weagle	Saskatchewan Environment and Public Safety	1986 to 1990
	Walter Nicholaichuk	National Hydrology Research Institute	1986 to 1989
	Patricia Tones	Saskatchewan Research Council	1986 to 1988
	Ken Thomson	Environment Canada	1986 to 1987
WATER USE COMMITTEE	Jim Atcheson	Agriculture Canada	1986 to 1991
	David Donald	Environment Canada	1986 to 1991
	James Rogers	Environment Canada	1986 to 1991
	Don Tate	Environment Canada	1986 to 1991
	Vipin Prasad	SaskPower	1986 to 1991
	Larry Sukava	Saskatchewan Parks and Renewable Resources	1986 to 1991
	Glen Grismer	Meewasin Valley Authority	1986 to 1991
	Murray Jones	Prairie Farm Rehabilitation Administration	1988 to 1991
	Henry Epp	Saskatchewan Environment and Public Safety	1988 to 1991
	Carlos Germann	Saskatchewan Recreation, Culture and Multiculturalism	1988 to 1991
	Larry Ward	SaskPower	1988 to 1991
	Hasu Naik	Environment Canada	1988 to 1990
	Tom Olson	SaskWater	1988 to 1990
	Michael Kowalchuk	Environment Canada	1986 to 1988
	George Pearson	Prairie Farm Rehabilitation Administration	1986 to 1988
	Harvey Fjeld	Saskatchewan Agriculture and Food	1986 to 1988
	Tom McIntosh	SaskWater	1986 to 1987
PUBLIC INVOLVEMENT COMMITTEE	Rod McLean	SaskWater	1986 to 1991
	Meta Perry	Environment Canada	1989 to 1991
	Sharon Dominik	Environment Canada	1986 to 1989
MANAGEMENT STRATEGIES COMMITTEE	Brian Abrahamson	Prairie Farm Rehabilitation Administration	1988 to 1991
	William Gummer	Environment Canada	1988 to 1991
	Alex Banga	SaskWater	1988 to 1991
	Brian Ireland	SaskWater	1988 to 1991
	Ross Herrington	Environment Canada	1990 to 1991
	Dave Fairbairn	Environment Canada	1988 to 1989
	Tom Olson	SaskWater	1988 to 1989

APPENDIX 2

Glossary

COLD CONTINENTAL
a climate classification that may be applied to the interior areas of continents, characterized by low amounts of rainfall, and daily and seasonal temperature extremes

EUTROPHICATION
a natural process by which a body of water becomes richer in plant nutrients which can be accelerated by human activities

FULL SUPPLY LEVEL
the level at which a reservoir is considered to be full

MORAINE
the pile of rock and debris that collects in front of an advancing glacier and is left behind when the glacier retreats

INTER-BASIN TRANSFER
the relocation of water from its natural drainage basin to another basin usually requiring the construction of dams or the operation of pumps

KETTLE LAKE
a small round lake created by retreating glaciers

MIXED PRAIRIE
a vegetation classification that is characterized by a mixture of tall and short grasses

MOULTING
occurs when waterfowl shed their old feathers and grow new ones usually after breeding season

NATURAL FLOW
the flow that would have occurred in a river if there had been no human intervention

NUTRIENT
elements like nitrogen and phosphorus which stimulate plant growth

PESTICIDE
a substance, including both insecticides and herbicides, used to destroy pests

RIP RAP
large rocks of a specific size placed on the face of a dam or other shoreline to prevent wave erosion

SLOUGH
a depression or low spot formed by a retreating glacier which frequently collects spring runoff

STAGING
an activity carried out by migrating waterfowl where they tend to collect in large numbers

TRIBUTARY
a creek, stream or river that contributes its water to a larger river

Metric Conversion Table

METRIC-IMPERIAL CONVERSION TABLE

	QUANTITY NAME	SI SYMBOL	EQUIVALENT
LENGTH	1 millimetre	mm	0.0393701 inches
	1 centimetre	cm	0.393701 inches
	1 metre	m	3.28084 feet
	1 kilometre	km	0.621371 miles
AREA	1 hectare (10 000 m^2)	ha	2.47105 acres
	1 square kilometre	km^2	0.386102 square miles
VOLUME	1 litre	l	0.219969 Imperial gallons
	1 cubic metre	m^3	35.3147 cubic feet
	1 cubic decametre	dam^3	0.810713 acre-feet (1 000 m^3)
TEMPERATURE	degrees Celsius	oC	(degrees Fahrenheit - 32 x 0.56)
FLOW	1 cubic metre per second	m^3/s	35.3147 cubic feet per second

MULTIPLES AND SUB-MULTIPLES

UNITS	PREFIXES
1,000,000 = 10^6	mega
1,000 = 10^3	kilo
100 = 10^2	hecto
10 = 10	deca
0.1 = 10^{-1}	deci
0.01 = 10^{-2}	centi
0.001 = 10^{-3}	milli

APPENDIX 4:

Technical Appendices

Technical appendices to the final report provide additional detail about the study. These technical appendices present the working details of the study and as such are intended for the water resource management professional. In general, they elaborate or provide more detail on information presented in the final report. The technical appendices are organized according to the objectives of the study in the following manner.

Appendix I
Issues Documentation

Appendix II
Resource Assessment

A. Water Quantity
B. Water Quality
C. Water Use
D. Environment
E. Water Management

Appendix III
The Framework Plan

A. Basin Management Strategies
B. Evaluation Tools
C. Implementation Plan

The Final Report along with accompanying Technical Appendices can be found in the following libraries:

Environment Canada
300 - 2365 Albert Street
Regina, Saskatchewan
S4P 4K1

National Hydrology Research Centre
11 Innovation Boulevard
Saskatoon, Saskatchewan
S7N 3H5

Prairie Farm Rehabilitation Administration
1901 Victoria Avenue
Regina, Saskatchewan
S4P 0R5

Prairie Provinces Water Board
201 - 2050 Cornwall Street
Regina, Saskatchewan
S4P 2K5

SaskWater
Head Office
111 Fairford Street East
Moose Jaw, Saskatchewan
S6H 7X5

SaskWater
Southwest Regional Office
350 Cheadle Street
Swift Current, Saskatchewan
S9H 4G3

SaskWater
West Central Regional Office
410 Saskatchewan Avenue West
Outlook, Saskatchewan
S0L 2N0

Saskatchewan Legislative Building
Room 234
2405 Legislative Drive
Regina, Saskatchewan
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3085 Albert Street
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Meewasin Valley Authority
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University of Regina
3737 Wascana Parkway
Regina, Saskatchewan
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University of Saskatchewan
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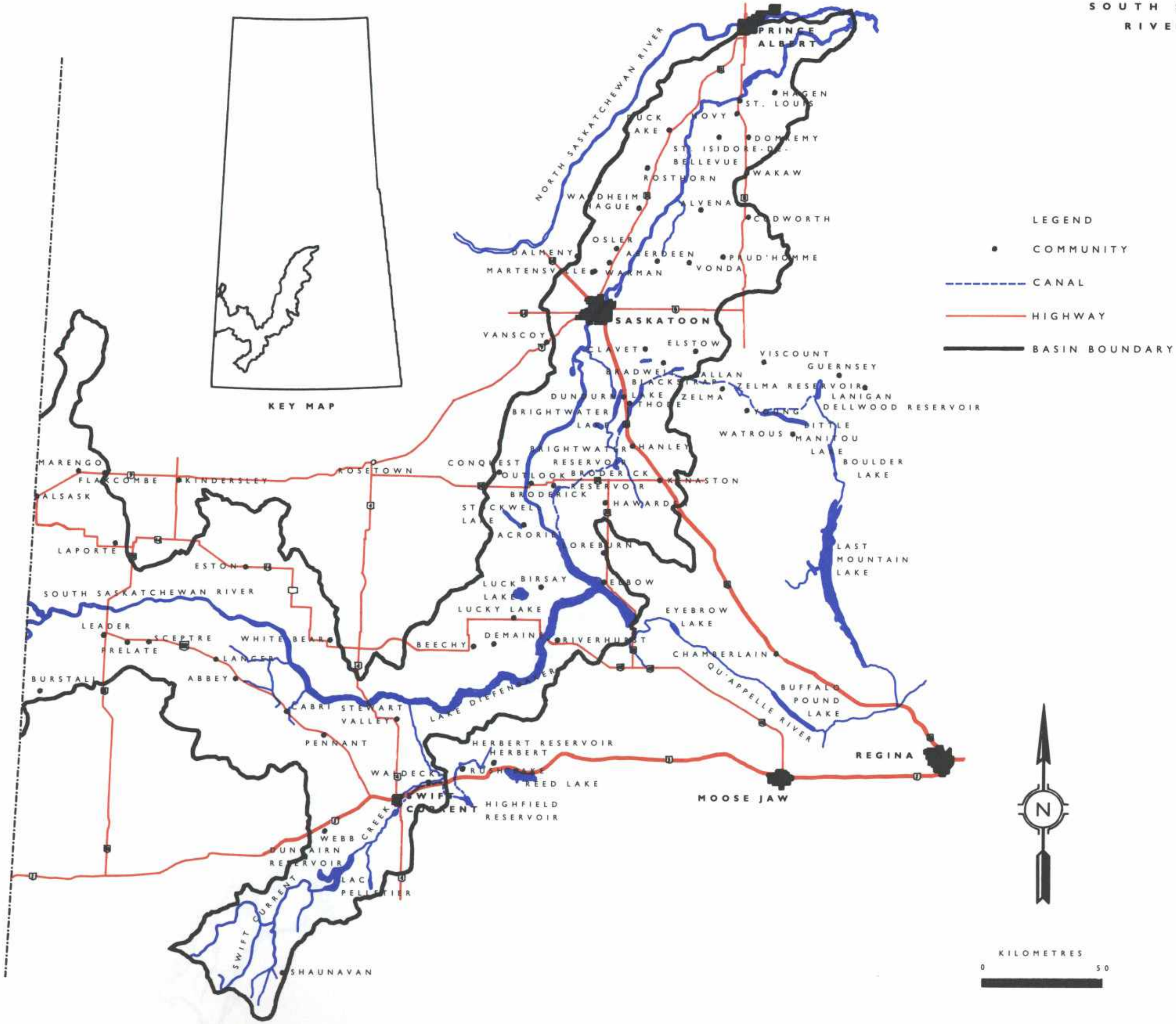
Saskatoon, Saskatchewan
S7N 0W0

APPENDIX 5

CANADA – SASKATCHEWAN
SOUTH SASKATCHEWAN
RIVER BASIN STUDY

BASE MAP



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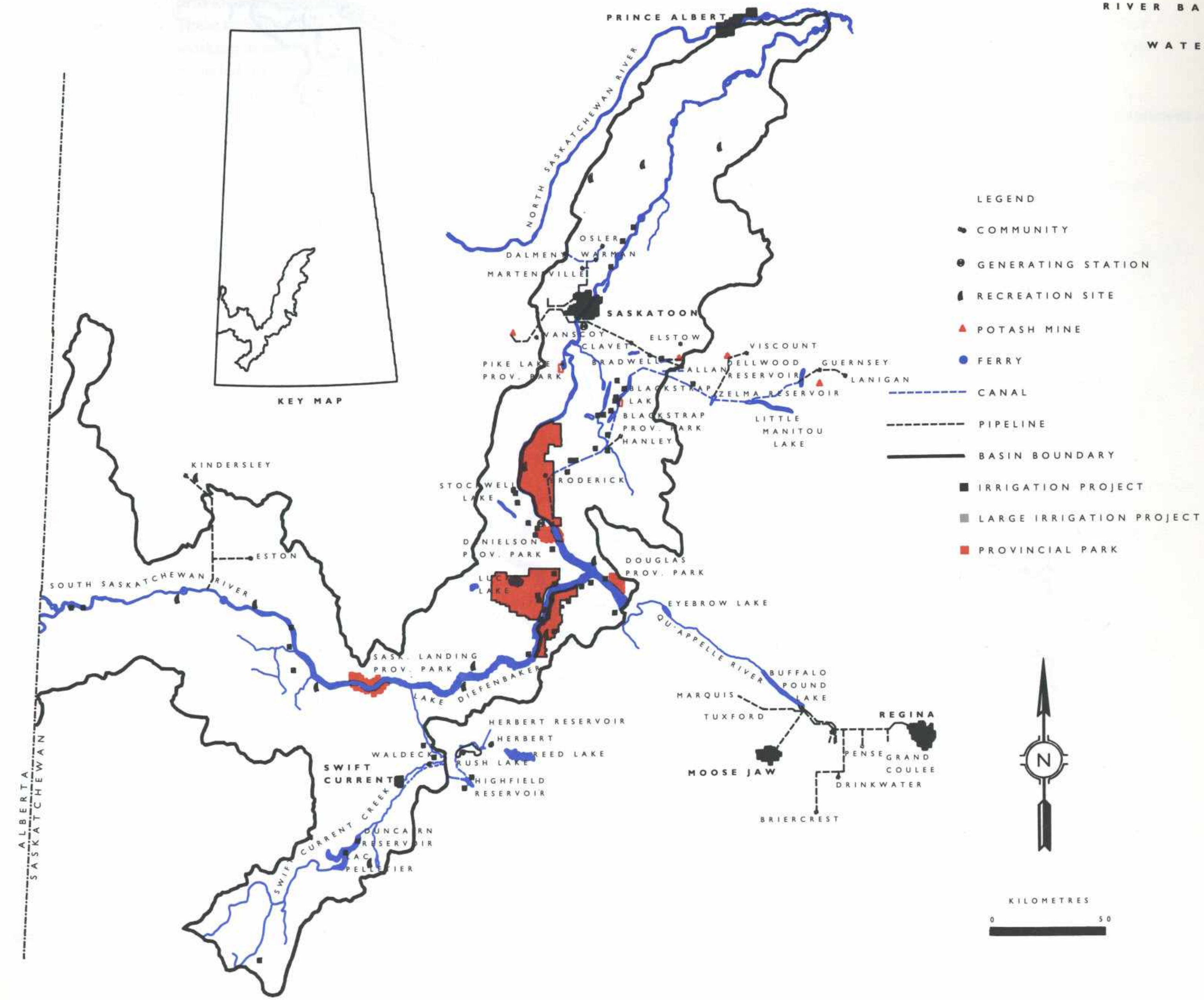
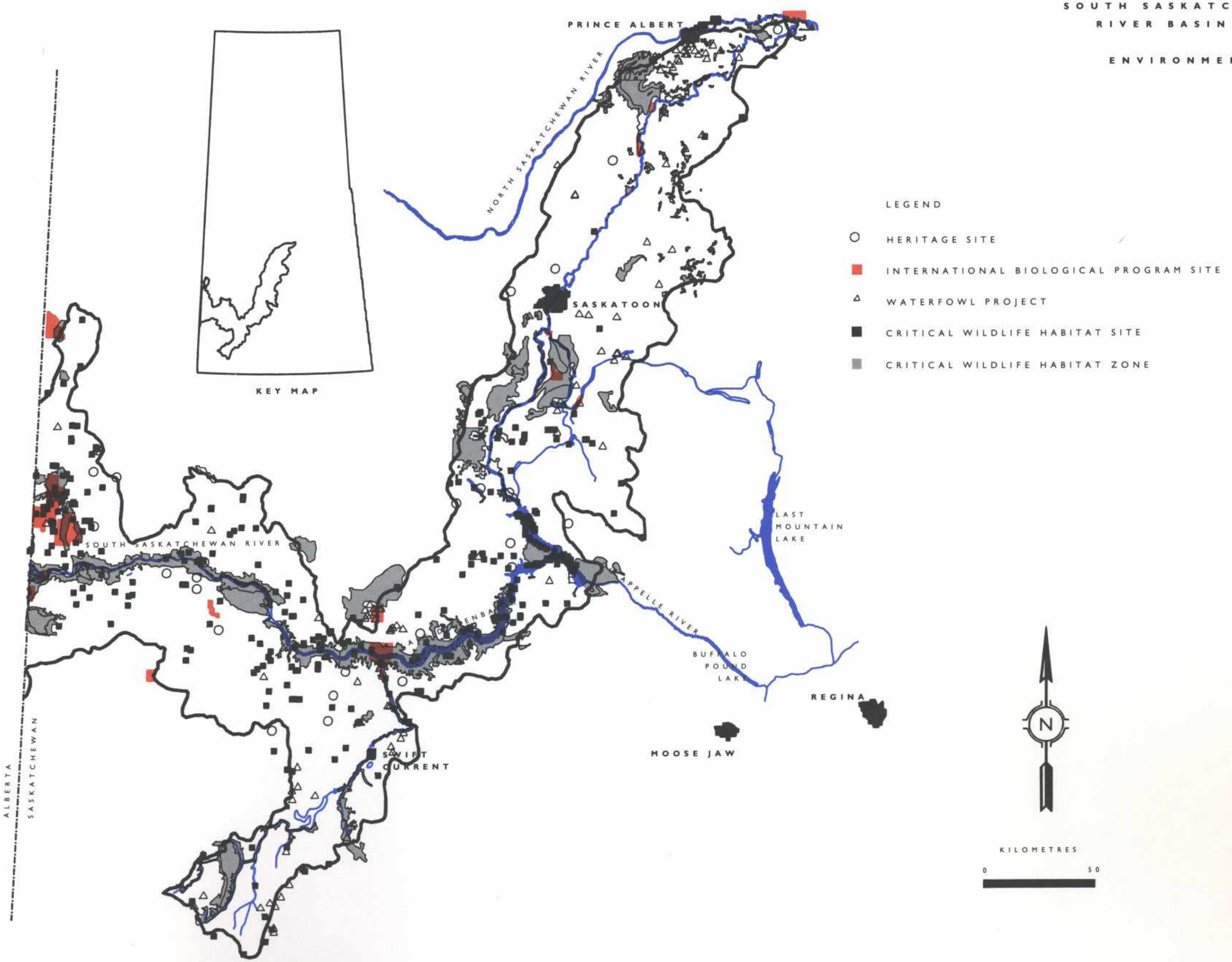
CANADA – SASKATCHEWAN
SOUTH SASKATCHEWAN
RIVER BASIN STUDY

WATER USE MAP



CANADA - SASKATCHEWAN
SOUTH SASKATCHEWAN
RIVER BASIN STUDY

ENVIRONMENT MAP



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(306) 780-6002

or

SaskWater
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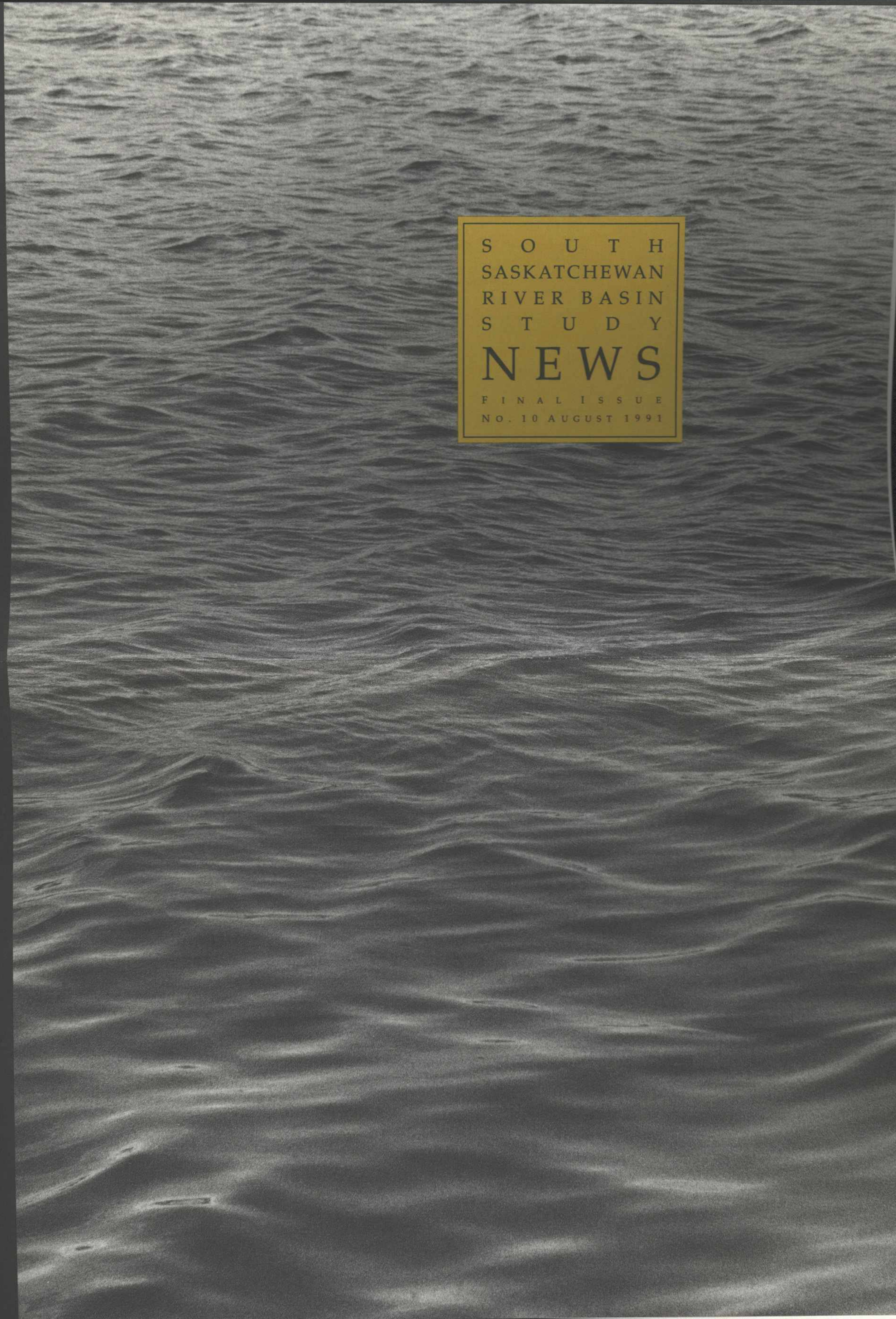
Design: Bradbury Design
Photography: Keith Moulding
Printing: Merit Printing Ltd.
Production: PolMac Communications Inc.



SOUTH SASKATCHEWAN RIVER BASIN STUDY NEWS

FINAL ISSUE
No. 10 AUGUST 1991

STUDY COMPLETED

On May 16, 1986, the Ministers responsible for Environment Canada and SaskWater signed the $1.6 million Canada-Saskatchewan South Saskatchewan River Basin Study Agreement. The South Saskatchewan River represents the most reliable supply of good quality water in the southern half of Saskatchewan. As a result, it contributes significantly to the social and economic well-being of the people of the region.

The Canada-Saskatchewan South Saskatchewan River Basin Study was undertaken to provide information to guide water management, and will help ensure that the water resources of the region can meet the needs of existing and future users.

The final report, along with its supporting technical appendices and working reports, is available in the following libraries:

Environment Canada
300 - 2365 Albert Street
Regina, Saskatchewan
S4P 4K1

National Hydrology Research Centre
11 Innovation Boulevard
Saskatoon, Saskatchewan
S7N 3H5

Prairie Farm Rehabilitation Administration
1901 Victoria Avenue
Regina, Saskatchewan
S4P 0R5

Prairie Provinces Water Board
201 - 2050 Cornwall Street
Regina, Saskatchewan
S4P 2K5

SaskWater
Head Office
111 Fairford Street East
Moose Jaw, Saskatchewan
S6H 7X5

SaskWater
Southwest Regional Office
350 Cheadle Street
Swift Current, Saskatchewan
S9H 4G3

SaskWater
West Central Regional Office
410 Saskatchewan Avenue West
Outlook, Saskatchewan
S0L 2N0

Saskatchewan Legislative Building
Room 234
2405 Legislative Drive
Regina, Saskatchewan
S4S 0B3

Saskatchewan Environment and Public Safety
3085 Albert Street
Regina, Saskatchewan
S4S 0B1

Meewasin Valley Authority
402 - 3rd Avenue South
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S7K 3G5

University of Regina
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University of Saskatchewan
College Drive
Saskatoon, Saskatchewan
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This newsletter summarizes the findings and recommendations presented in the final report of the study. The findings and recommendations are organized according to the three objectives of the study:

1. DOCUMENT THE WATER MANAGEMENT ISSUES
2. ASSESS THE WATER AND RELATED RESOURCES
3. DEVELOP A FRAMEWORK PLAN FOR WATER MANAGEMENT

STUDY OBJECTIVE 1: DOCUMENT THE ISSUES

The first objective of the study agreement was to document the water management issues in the study area. For the purposes of the study, issues were considered to be any matter about which there was some concern. The public, interest groups, and water management professionals identified more than 30 different issues. They are presented below, organized by geographic region.

Basin-Wide Issues

- Quantity of water coming from Alberta
- Quality of water coming from Alberta
- Ecosystem health
- Climate change
- Waterfowl staging
- Weed growth
- Organic contaminants
- Salinity
- Mercury
- Inter-basin transfers
- Municipal water supply
- Soil salinity
- Soil conservation
- Wetlands/drainage

Issues Upstream Of Lake Diefenbaker

- Flow and water level fluctuations

Issues Associated With Lake Diefenbaker

- Fluctuating water levels
- Eutrophication
- Shoreline management
- Qu'Appelle Dam releases

Issues Downstream Of Lake Diefenbaker

- Flow and water level fluctuations
- Summer flow
- Public access
- Municipal and industrial effluent
- Erosion and sedimentation

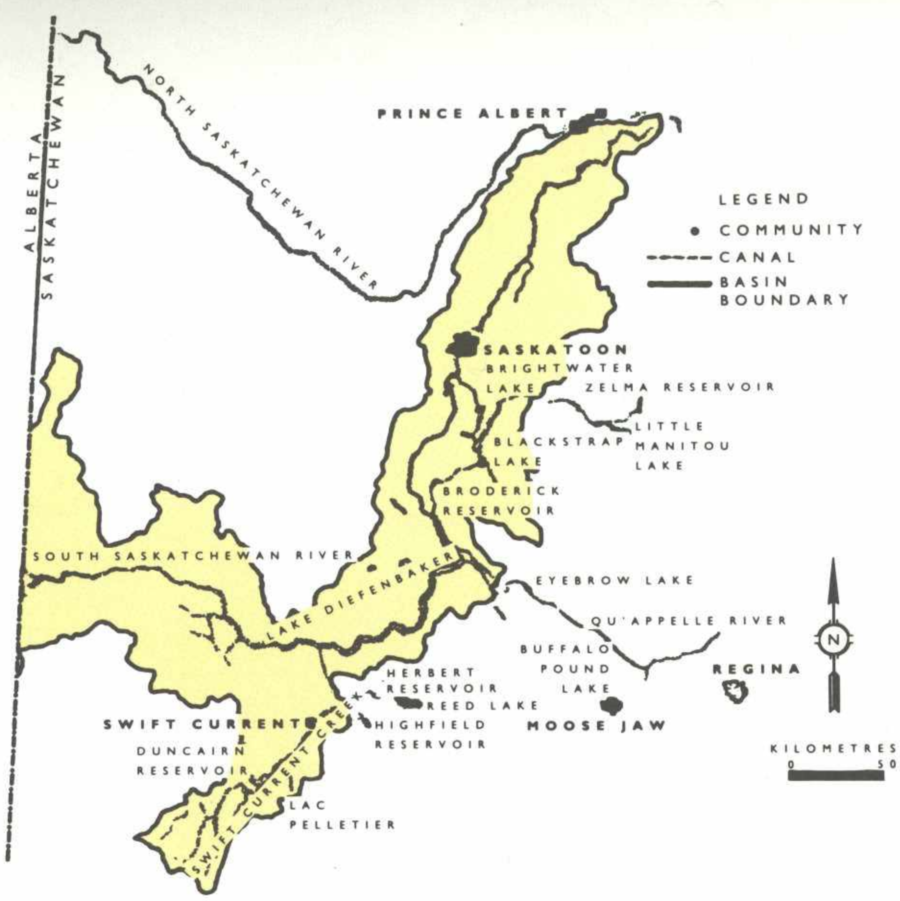
Issues In The Swift Current Creek Sub-Basin

- Municipal water supply
- Irrigation water supply
- Flooding
- Shoreline management

Issues Associated With The Saskatoon Southeast Water Supply (SSEWS) System

- Water supply
- Water quality-salinity

SOUTH SASKATCHEWAN RIVER BASIN IN SASKATCHEWAN



STUDY OBJECTIVE 2: ASSESS THE RESOURCE

The second objective of the study was to assess the water and related resources of the South Saskatchewan River Basin in Saskatchewan. To effectively manage water, it is important that the resource be well understood. The water resources were assessed from four different perspectives: water quantity, water quality, water use and environment.

Water Quantity

A clear understanding of the amount of water in the basin is needed so that the supply can be compared with the needs of water users.

WATER QUANTITY MEASUREMENTS

Water managers measure volume in cubic decametres (dam^3) — a ten metre cube. A standard farm dugout has a capacity roughly equal to one cubic decametre.

The rate of flow is another common way of measuring water quantity. Flow measures the volume of water that moves past a point in a given period of time. Flow is commonly measured in cubic metres per second (m^3/s). It would take about 1 000 garden hoses to produce a flow equal to one cubic metre per second. A flow of 1 m^3/s would fill a farm dugout in about 15 minutes.

The ongoing monitoring of streamflow and lake elevations provided information on the amount of water available. The study, therefore, focused on extreme events like floods and droughts and the variability in the supply of water. In addition, studies of erosion, sedimentation and ground water were also undertaken.

Summary of Water Quantity Findings:

- More than 95 percent of the water arriving at Lake Diefenbaker comes from Alberta and most of this water originates in the Rocky Mountains.
- Under the terms of the Master Agreement on Apportionment, administered by the Prairie Provinces Water Board, Alberta must pass 50 percent of the natural flow of the South Saskatchewan River to Saskatchewan each year. At present, Alberta passes an average of 78 percent of the natural flow arising in Alberta to Saskatchewan. Saskatchewan in turn passes well in excess of its obligation to Manitoba under the Master Agreement on Apportionment.
- About 90 percent of the water flowing into Lake Diefenbaker is released and flows down the South Saskatchewan River for use downstream.
- The flow on the South Saskatchewan River is highly variable from year to year. The average natural annual discharge of the South Saskatchewan River is 9 400 000 cubic decametres (dam^3) but highs of more than 16 000 000 dam^3 and lows of less than 5 000 000 dam^3 have occurred.
- The mean annual flow in the South Saskatchewan River below Gardiner Dam is about 220 cubic metres per second (m^3/s). Winter flows are generally in the 200 - 350 m^3/s range. Summer flows are generally in the 60 - 150 m^3/s range. During drought years, it is sometimes necessary to reduce flows to about 50 m^3/s for extended periods.

- Swift Current Creek, the only major tributary in the study area, contributes on average 80 000 dam^3 to the South Saskatchewan River — less than one percent of the flow in the South Saskatchewan River.

- The main withdrawals from Lake Diefenbaker occur at the Qu'Appelle Dam, Gardiner Dam and East Side Pump Plant.

- Despite the presence of upstream dams, flooding is possible within the communities of Swift Current and Saskatoon.

- Ground water is an important source of water for many farms and communities, but the use potential of this resource is limited due to poor water quality.

- The shores of Lake Diefenbaker are actively eroding, as was predicted when the lake was created, but the lake has significantly reduced the natural rate of erosion downstream of Gardiner Dam.

- Drought is a recurring problem in the study area. It has significant impacts on water supply and water demand.

Water Quality

Water quality is important because it affects almost every type of water use. It affects the suitability of water for uses by people (e.g. municipal use and recreation). It also affects the natural uses of the system such as fisheries and wildlife.

The study focused on the quality of water coming from Alberta and the water quality in Lake Diefenbaker. A comprehensive set of water quality objectives was designed to protect all existing water uses.

Summary Of Water Quality Findings:

- The water quality of the South Saskatchewan River is among the best in southern Saskatchewan. It can be used for everything, except drinking, without treatment.

- Based on a review of historical water quality information, the quality of the water coming from Alberta is not deteriorating.

- There is some excessive weed growth occurring at the upstream end of Lake Diefenbaker. This weed growth is the result of natural erosion and human activities in Alberta.

- Lake Diefenbaker helps purify the water. As a result, the cleanest water in the basin is directly downstream of Gardiner Dam.

- The most significant deterioration in water quality in the basin occurs at Saskatoon. Municipal and industrial effluent are responsible for this deterioration.

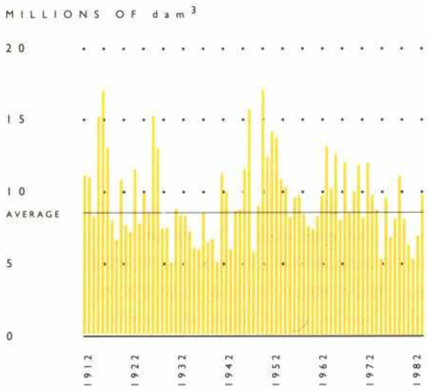
- The water in Swift Current Creek is not as clean as that in the South Saskatchewan River, but is still suitable for most uses.

- The quality of the water deteriorates as it moves from Lake Diefenbaker through the Saskatoon Southeast Water Supply (SSEWS) system. This is due partially to evaporation from the reservoirs and agricultural activity along the system.

- There are a number of pesticides regularly used in the basin for which there is no regular water quality monitoring. Work is underway to develop suitable monitoring techniques for these pesticides.

- Mercury is no longer a problem in the basin.

SOUTH SASKATCHEWAN RIVER ANNUAL NATURAL DISCHARGE



Water Use

In order to protect the water uses in the study area, a clear understanding of how the water is used is essential. As a result, the study staff collected information on the water quantity and quality requirements of all users. Information on where and when water is used was also needed. Major water uses studied included: irrigation, municipal, industrial, hydro-electric power generation, recreation and ferries.

Summary of Water Use Findings:

- All water uses in the study area, plus evaporation, consume about 580 000 dam^3 each year. This represents about six percent of the average annual supply in the South Saskatchewan River.

- Evaporation accounts for about 296 000 dam^3 of water each year, about 50 percent of the 580 000 dam^3 consumed each year. Most of this evaporation is from Lake Diefenbaker.

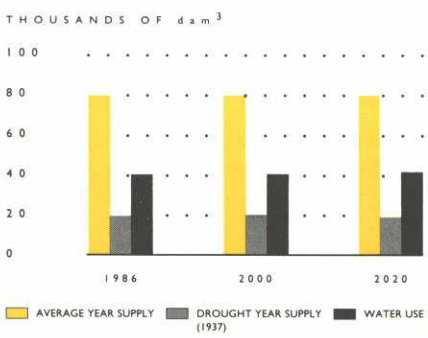
- After evaporation, irrigation is the largest use, accounting for about 196 000 dam^3 annually — approximately 34 percent of the water used in the basin.

- Irrigators withdraw water through more than 400 separate intakes along the river system.

- Irrigation water use varies considerably by crop type. Irrigators apply 30 percent more water to forage crops than to cereal crops.

- The depth of water applied each year by irrigators ranges from a high of 350

SWIFT CURRENT CREEK WATER SUPPLY AND USE



millimetres in the dry western extremity of the basin to a low of 250 millimetres in the wetter areas near St. Louis.

- Twenty-six communities use approximately 79 000 dam^3 annually — about 14 percent of the water used in the basin.

- The largest municipal user is the City of Saskatoon at about 40 000 dam^3 annually. Approximately 80 percent of this water is returned to the river as treated effluent.

SUMMER PHOSPHORUS LEVELS IN THE SOUTH SASKATCHEWAN RIVER

Phosphorus is a nutrient that contributes to weed and algae growth in lakes and rivers.

- Annual water use by municipalities ranges from about 200 to 650 litres per person per day.

- Municipal use can double during the summertime due to lawn and garden watering.

- Industrial water use accounts for approximately 9 000 dam^3 annually, or about two percent of the water used each year in the basin.

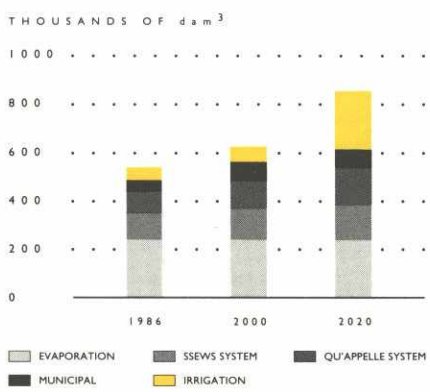
- More than 90 percent of the water that flows into Lake Diefenbaker flows through the Coteau Creek Generating Station located at Gardiner Dam.

- The Coteau Creek Generating Station produces about 770 000 megawatt-hours of electricity each year, approximately five percent of SaskPower's total annual generation.

- While Coteau Creek Generating Station provides a small proportion of SaskPower's total power requirement, it is used to meet seasonal and daily peak demands, those which are most expensive to meet.

- Flow regulation provided by Coteau Creek Generating Station and Gardiner Dam enhances power generation at the Nipawin and E.B. Campbell Generating Stations located downstream on the Saskatchewan River.

SOUTH SASKATCHEWAN RIVER ANNUAL WATER USE



- The South Saskatchewan River is an important source of water for uses outside the basin including municipal use by the Cities of Regina and Moose Jaw. Combining these communities with those in the basin means that about 40 percent of the province's population obtains its drinking water from the South Saskatchewan River.

- Less than one percent of the average flow on the South Saskatchewan River is released from Lake Diefenbaker into the Qu'Appelle River.

- Approximately one percent of the flow of the South Saskatchewan River is pumped out of Lake Diefenbaker to the South Saskatchewan River Irrigation District #1 and the Saskatoon Southeast Water Supply system.

- The fourteen provincial and regional parks located on the South Saskatchewan River or its tributaries provide more than a half million user days of recreation.

- In addition to the parks, the waters of the basin support or enhance a variety of year-round recreational activities throughout the basin.

- Nine ferries provide transportation across the river from mid-April to mid-November.

Environment

The environmental resources of the study area include wildlife, waterfowl, fish and heritage resources. Several investigations were undertaken to develop a better understanding of these resources and their links to water management.

Summary Of Environment Findings:

- The environmental resources of the study area provide significant economic benefit to the residents of the province.

- The heritage resources of the study area include hundreds of sites and objects with palaeontological, archaeological and historic significance.

- There have been few systematic heritage resource surveys carried out. Therefore, it is assumed that more sites will be found in the future.

- Prong-horned antelope, white-tailed deer, mule deer, and a variety of other wildlife are common in the study area.

- Eleven percent of the study area is considered critical wildlife habitat.

- Fourteen International Biological Program Sites are found in the study area. These sites have unique plants, animals and geographic features.

- The shores of Lake Diefenbaker provide ideal nesting habitat for the piping plover, the only endangered species of wildlife found in the study area that can be directly affected by water management.

- The areas immediately upstream and downstream of Lake Diefenbaker are very important for migrating waterfowl, particularly ducks and geese.

- It is unlikely that future water management will have a significant effect on migrating waterfowl upstream of Lake Diefenbaker.

- Walleye and pike are common throughout the basin. Lake Diefenbaker also supports whitefish and lake trout, while the river supports sauger and goldeye.

- Small populations of river sturgeon, a rare species, also occur upstream and downstream of Lake Diefenbaker.

STUDY OBJECTIVE 3: DEVELOP A FRAMEWORK PLAN

The third objective of the study was to develop a framework plan for the conservation and management of the water in the study area. The framework plan is flexible and will assist decision-makers, water managers, and the public to effectively manage and develop the water resources of the basin. It was also meant to assist in the evaluation of water resource projects. The framework plan has three parts: Basin Management Strategies, Project Evaluation Procedures and an Implementation Plan.

Basin Management Strategies

The Basin Management Strategies provide information and recommendations to encourage effective management and appropriate development of the water resource. In developing the basin management strategies, three separate planning exercises were completed: short-term, long-term, and system-limit.

Short-term Planning

Short-term planning focused on the year 2000. It dealt with the water management issues in the basin. It focused on identifying opportunities to modify existing operations and programs to better meet the needs of the various users.

There is enough water in the South Saskatchewan River system to meet the needs of users to the year 2000 and beyond. However, a number of measures are required in order to adapt to changing conditions.

Summary Of Short-Term Planning Findings:

- Evaporation will continue to consume more water than any other single use. The amount lost to evaporation will remain largely unchanged.
- Water use in Alberta will have a more significant impact on the water users in Saskatchewan than water use within Saskatchewan.
- By the year 2000, Saskatchewan will receive, on average, approximately 72 percent of the natural flow from Alberta, as compared to 78 percent received at present.
- By the year 2000, Saskatchewan use, including evaporation, will be consuming approximately ten percent of the water received from Alberta.
- Irrigation will continue to be the next biggest consumer of water after evaporation in Saskatchewan — accounting for some 35 percent of the 645 000 dam^3 consumed annually by the year 2000.

Long-term Planning

The long-term planning exercise looked at the year 2020. Unlike the short-term planning, which focused on issues, the long-term planning focused on development opportunities. The long-term planning process identified and evaluated the effects of emphasizing irrigation, hydro-electric and recreation development. The study does not recommend one type of development. Rather, it points out the effects of emphasizing one type of development versus another. In this way, it provides decision-makers and the public with the information needed to make informed decisions about managing the water resources of the basin.

Summary Of Long-Term Planning Findings:

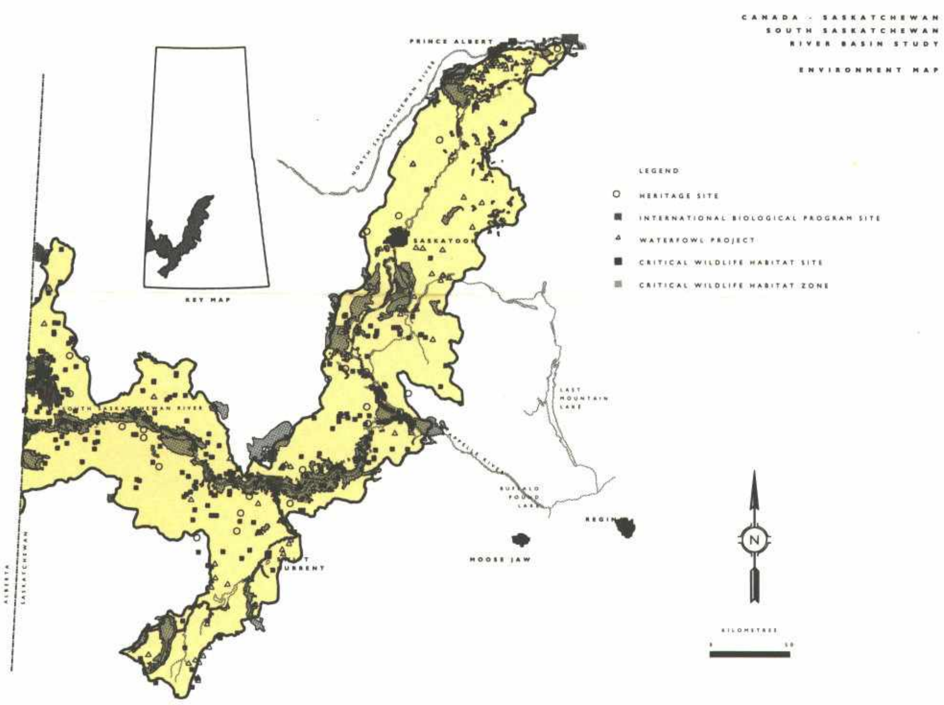
- The water requirements of all existing uses as forecast to the year 2020 can be met without difficulty. There will likely be an increase in the frequency of low flows, but it is unlikely to significantly affect the viability of any uses.
- By the year 2020, Saskatchewan will be consuming approximately 14 percent of the water received from Alberta — up from eight percent at present.
- Irrigation will become the biggest consumer of water — accounting for some 47 percent of the 860 000 dam^3 forecast to be used annually in the basin by the year 2020.
- Even with an optimistic forecast for irrigation development, water demand by all uses in the study area would never exceed 50 percent of supply, even in the worst drought year.
- By the year 2020, water consumption in Alberta is expected to level off because of an Alberta government policy limiting irrigation development.
- Water use in Alberta will continue to have a more significant impact on the water users in Saskatchewan than the Saskatchewan users themselves.
- The effects of increased consumption in Alberta and Saskatchewan on instream users can be offset by reducing the amount of water withdrawn from Lake Diefenbaker each winter. However, this could reduce the benefits that could be achieved by hydro-electric power generation.
- Recreation and hydro-electric power generation are generally compatible types of development. Municipal, industrial and irrigation development are generally not compatible with each other or recreation or hydro-electric development.
- Conditions for recreation and ferries upstream of Lake Diefenbaker will improve as a result of reduced flow variability caused by increased water use in Alberta.
- The Saskatoon Southeast Water Supply (SSEWS) system will be fully developed by the year 2020. The addition of a significant amount of water use in the future would require considerable redevelopment of the project.
- The most significant benefits resulting from water conservation are delays or the elimination of costly expansions to water treatment and delivery systems.

System-limit Planning

System-limit planning was carried out to determine the development limits of the basin. In order to do the system-limit planning, it was assumed that Saskatchewan would receive only 50 percent of the natural flow of the South Saskatchewan River — that which it is guaranteed under the Master Agreement on Apportionment. From this 50 percent, the water required by all existing users as forecast to the year 2000 was set aside. The remaining water was then devoted to a single type of development. Industrial, irrigation, municipal, recreation and hydro-electric developments were considered.

It should be noted that the idea of devoting all the water to a single type of use is unrealistic, as is the assumption of receiving only 50 percent of the natural flow each and every year. This type of analysis is only useful in so far as it provides some measure of how much of the development potential has already been used and how much remains.

ENVIRONMENTAL RESOURCES



Summary Of System-Limit Findings:

- In all cases, devoting all available water to a single use results in lost opportunities for other uses.
- There is a sufficient water supply to support any one of the following:

  - a seven-fold increase in the population relying on South Saskatchewan River water to three million people; or,
  - a one hundred-fold increase in the industrial base; or,
  - a four-fold increase in irrigation acreage to 204 000 ha.

  Development of this magnitude could only be achieved with significantly increased frequency of low flows below Lake Diefenbaker, and reduced hydro-electric power generation, particularly during the winter season.

- Conditions for recreation on Lake Diefenbaker or downstream can be significantly improved. The preferred water levels and flows can be achieved about 70 percent more frequently than at present. Development of this type could only be achieved if upstream development opportunities for irrigation, industrial and municipal uses are foregone.
- With the addition of two more hydro-electric generating stations, the South Saskatchewan River would yield an average of 1.5 million megawatt-hours of electricity annually — approximately 45 percent more energy output than is currently produced by the Coteau Creek Generating Station. This type of development would have a variety of effects on the other uses. These effects would depend on the details of the hydro-electric developments.
- The water resources of Swift Current Creek would be fully developed if the amount of storage on Swift Current Creek was tripled. This additional storage could support a 58 percent increase in irrigated area.

Project Evaluation Procedures

The second part of the Framework Plan is a set of procedures to assist in evaluating water resource development proposals. Presently, there is a complex process for evaluating water resource development proposals. The South Saskatchewan River Basin Study focused on developing new ways to make this process more effective.

The following is a list of some of the databases and computer models developed by the study which should help to ensure a more effective project evaluation process for any proposed water resource developments in the study area.

Water Resources Management Model (WRMM): The WRMM is a water balance computer model that predicts the effects of changes in system operation or water supply on both the quantity of water available and water uses. It can be used in the evaluation of all types of water resource development projects.

Hydraulic Models: The HEC-II model was calibrated for the South Saskatchewan River upstream and downstream of Lake Diefenbaker. These computer models identify the velocity, discharge and depth for any flow and location on the river. They are useful in determining the effect of water management on instream and off-stream uses.

Water Quality Models: Water quality models for the South Saskatchewan River upstream and downstream of Lake Diefenbaker predict the concentration of a range of pollutants. They can also be used to determine the effect of specific development proposals on the water quality of the river.

Instream Flow Requirements: This database identifies the preferred, maximum and minimum reservoir elevations and river flow requirements of all known instream users. This information helps determine the possible effects of a particular type of development on ferries, effluent disposal, waterfowl, wildlife and recreational uses.

Water Use Analysis Model: This water balance model determines the effect of a change in the economy on water use and supply. It can also be used to determine the effect of a major water resource development project on the economy and employment of the study area.

Parks in the study area provide recreation for more than one million visitors each year.

Heritage Resource Maps: The heritage resource maps show the probability of finding heritage resources in a particular area. Along with the accompanying guidelines for development, these maps can be used to minimize the impact of development on heritage resources.

Wildlife Habitat Maps: These maps identify the most important habitat areas for wildlife, including endangered species, in the South Saskatchewan River Basin. They can be used to guide development to areas where the effects on wildlife will be minimized.

IMPLEMENTATION PLAN

The third part of the Framework Plan is the Implementation Plan. Because no single agency has the legislative authority to implement a comprehensive water resource management plan, an implementation plan was developed for the study.

The Implementation Plan has three parts. The first deals with the implementation of the recommendations. The second part looks at the maintenance of the project evaluation procedures. The third and final part of the Implementation Plan examines the question of when a new study should be carried out.

The recommendations of the Canada-Saskatchewan South Saskatchewan River Basin Study are intended to make significant improvements in the management of the water resources of the study area. They are organized according to four general categories: public involvement, water management, research, and implementation.

AGENCY/RESOURCE MANAGEMENT ACTIVITIES MATRIX

Resource Management Activities	Environment Canada	Prairie Farm Rehabilitation Administration	Agriculture Canada	Department of Fisheries and Oceans	Sask Water	Saskatchewan Environment and Public Safety	Saskatchewan Agriculture and Food	Saskatchewan Community Services	Saskatchewan Rural Development	Saskatchewan Parks and Renewable Resources	Saskatchewan Wetland Conservation Corporation	Prairie Provinces Water Board	Municipalities	Meewasin Valley Authority	Ducks Unlimited
Agencies	Federal				Provincial							Other			
Water Allocation					■										
System Operation					■										
Water Quantity Monitoring	■				■										
Water Quality Monitoring	■					■									
Pollution Control	■					■									
Land Use Control					■			■	■				■		
Fisheries				■						■					
Wildlife	■									■					■
Ferries									■						
Parks / Recreation	■									■				■	
Agriculture			■				■								
Wetlands	■	■			■	■	■			■	■				■
Interjurisdictional Waters	■				■	■						■			
Public Information	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Research	■	■	■		■		■								

RECOMMENDATIONS

Public Involvement

- Develop and implement a public information program to assist the public in understanding the water resource management issues of the study area and a process to make their input possible.
- Continue to inform existing users about extreme variations in water quantity and quality that may affect their use of the water.
- Make new water users aware of the extreme variations in water levels that can occur to ensure that water use activity and associated structures are designed to cope with the extremes.
- Encourage water conservation by all users, particularly those on the SSEWS system and Swift Current Creek, where water shortages already occur.

Water Management

- Implement the basin specific water quality objectives developed through the study and the monitoring program designed to ensure that the objectives are met.
- Encourage appropriate development, including the provision of appropriate public access, in shoreline areas.
- Continue to base reservoir operating plans on annual and seasonal forecasts for water supply and the needs of users on the reservoir and downstream.
- Establish a summer target daily average flow range of 60 to 150 cubic metres per second for the South Saskatchewan River downstream of Lake Diefenbaker.
- Maintain the minimum daily average flow above 42.5 cubic metres per second downstream of Lake Diefenbaker.
- Apply the target and minimum flow criteria for the South Saskatchewan River from Gardiner Dam to the confluence with the North Saskatchewan River.
- Do not exceed the current levels of irrigation development in the Swift Current Creek system unless more water is made available through conservation, changes in reservoir operation, or the development of new storage.
- Consider modifying the operating plans for Duncairn and Highfield reservoirs to make more water available in the Swift Current Creek system.
- Investigate the feasibility of developing regional water supply systems for municipalities and other users that currently experience water quantity or water quality problems.

Research

- Encourage research aimed at quantifying the benefits of instream water uses.
- Encourage research aimed at developing a monitoring system capable of detecting subtle long-term changes in the health of the ecosystem.

Implementation

- Work toward making databases and tools more compatible to help ensure a consistent approach to project evaluation.
- Establish a procedure to ensure the implementation, and to monitor the results, of the study's recommendations.
- Consider carrying out a follow-up study of the Saskatchewan portion of the South Saskatchewan River Basin in the year 2010.

More than 15 different agencies have responsibilities that affect water management. These agencies include private and crown corporations, as well as federal, provincial and municipal government departments. In order to assign responsibilities for implementation of the framework plan, an understanding of agency legislation and responsibilities was essential. The study carried out a review of the applicable legislation, regulations, policies and programs of more than a dozen different agencies. The results of this study are summarized in the accompanying chart.

Based on this review, the implementation plan matches the recommendations of the study and maintenance of project evaluation procedures with the appropriate agency. SaskWater will be the lead agency for implementation of most of the recommendations. Environment Canada, Saskatchewan Environment and Public Safety and PFRA will be the lead on some and will provide support for most of the recommendations. The other agencies will play a smaller but equally important role in implementing the framework plan. When implemented, the framework plan will help ensure that the water resources of the study area can meet the needs of users into the next century.

Update on the South Saskatchewan Basin Study

The results of the Canada-Saskatchewan South Saskatchewan River Basin Study are most dependent on the forecast for inflows from Alberta used for the short-term and long-term planning. The inflows from Alberta were based on the assumption that Alberta will not exceed irrigation water use limits that it has established. Alberta is expected to reach these limits by the year 2010. It would be reasonable to consider a new study of the South Saskatchewan River Basin in Saskatchewan at that time.

By the year 2010, it will likely be possible to determine whether the Alberta inflow forecasts used by the Canada-Saskatchewan South Saskatchewan River Basin Study were accurate. Similarly, better information on the possible effects of climate change should be available by then. If water use patterns change significantly, or if new information on climate change becomes available, it may be necessary to consider a follow-up study sooner than 2010.

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