Rafferty-Alameda Project

REPORT OF THE ENVIRONMENTAL ASSESSMENT PANEL

Moose Mountain Creek Valley looking downstream of the Alameda Dam site (photo credit: The Souris Basin Development Authority).

September 1991

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RAFFERTY-ALAMEDA PROJECT

ENVIRONMENTAL ASSESSMENT PANEL

The Honourable Jean Charest
Minister of the Environment
House of Commons
Ottawa, Ontario

Dear Minister:

I am pleased to inform you that the Panel has completed its review of the Rafferty-Alameda Project in accordance with the terms of reference issued 5 February, 1991 and the Order of Mr. Justice Muldoon issued 8 February, 1991. The Panel respectfully submits this final report for your consideration.

Sincerely

John Archer
Chairman
Rafferty-Alameda Project
Environmental Assessment Panel

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Rafferty-Alameda Project

EXECUTIVE SUMMARY

The Project setting is the Souris River basin extending from Saskatchewan south into North Dakota and then northeast into Manitoba. The hardships caused by periodic drought and flooding in this basin have prompted the completion of several water management studies and proposals, including the Rafferty-Alameda Dam Project. In February 1986, the Government of Saskatchewan announced that, subject to environmental and regulatory approvals, it intended to construct the Rafferty and Alameda dams in southeastern Saskatchewan. The reservoirs created by these dams were intended to alleviate problems caused by the extremely variable and unpredictable flows of the Souris River. It was also anticipated that the dams would provide opportunities for regional economic and industrial diversification.

The Project consists of two large earth-filled dams and associated structures in the Souris River basin in southeastern Saskatchewan. Rafferty Dam is located on the Souris River to the west of Estevan, and the Alameda Dam is on Moose Mountain Creek near the Town of Oxbow. The reservoirs to be created by these dams represent a five-fold increase in surface water storage capacity in the basin. This storage is intended to provide flood control for Saskatchewan and North Dakota, to supply cooling water for a new thermal power generation facility, to supply water for irrigation and to create new water-based recreation opportunities.

The Souris Basin Development Authority (SBDA) was created and given the responsibility for planning and building all of the facilities associated with the Project. From the first announcement of the Project in 1986 until 1991, the SBDA and other agencies from the federal and provincial governments have been involved in a complex series of events related to its implementation. These include:

- The SBDA prepared an environmental impact statement (EIS) under the provincial environmental assessment process;
- A provincial Board of Inquiry held a review and public hearings;
- The Province of Saskatchewan approved the Rafferty Dam portion of the Project;
- The federal Minister of the Environment issued a licence for the Rafferty-Alameda Project under the *International River Improvements Act* (IRIA);
- A challenge was mounted to the licence, the Federal Court quashed the licence and directed the federal Minister of the Environment to conduct a Project review under the federal Environmental Assessment and Review Process (EARP);
- Environment Canada prepared an initial environmental evaluation (IEE) under the EARP;
- A second, more stringent, licence was issued by the federal Minister of the Environment in 1989;
- The governments of Canada and the United States signed an agreement on transboundary water management issues in the Souris River basin in that year and the United States agreed to pay Canada $41 .1 million (1985 U.S. dollars) for flood control storage provided by the Project;
- A second court action resulted in a requirement for an independent panel review of the Project under the EARP;
- The Panel was appointed in 1990 and an interim federal/provincial agreement was reached that allowed some construction activity to proceed on the Rafferty Dam; and
- While the EARP review progressed, a dispute over the allowable amount of construction activity eventually led to the resignation of the first Panel.

In February 1991, another three-member Panel was appointed by the federal Minister of the Environment to conduct a review of the Project under provisions of the EARP.

The Panel's mandate, issued by the Minister, was "to undertake a review of the environmental and directly related social impacts (resulting from changes to the biophysical environment) of the Rafferty-Alameda Dam Project." The Panel also had the mandate to review and make recommendations concerning mitigation measures and the operation and structure of the dams.

On February 8, 1991, Mr. Justice Muldoon of the Federal Court issued an order requiring that the Panel include in its public review the significant and moderate impacts that could not be mitigated with known technology or for which no mitigation was provided as stipulated in Environment Canada's IEE.

Project impacts that were considered by the Panel included those intended and beneficial impacts that relate to the Project's water management objectives, and other beneficial or adverse impacts not directly related to the objectives.

There are several specific Project objectives related to flood control, water supply and recreation. Some of these objectives are in direct conflict with each other (e.g., flood control argues for keeping the reservoir levels low, whereas water supply argues for keeping the reservoir levels high). The conflicting nature of some of the objectives, the extreme variability of flows in the Souris basin and the apparent scarcity of water to meet consumption, evaporative losses and targets for apportionment to North Dakota, means that there is not much latitude in reservoir operations to meet all objectives. Consequently, some of these objectives must be assigned a higher priority than others.

Many local residents have expressed their optimism to the Panel about the Project-related benefits such as improved flood control, recreation, irrigation and water quantity and quality.

After reviewing the available information, the Panel has concluded that:

- Flood control objectives in North Dakota will be satisfied, although occasional flooding just downstream of the Rafferty Dam may occur if a flow path through the ice cannot be maintained.
- Legal obligations assure that required flows for the North Dakota apportionment will be met with regularity, even if annual shortfalls must be made up in subsequent years. There is considerable uncertainty regarding the timing of releases for apportionment which has an important bearing on the realization of project benefits in Saskatchewan.
- Cooling water for the Shand and Boundary power stations will be supplied from the Rafferty and Boundary reservoirs much of the time. In the event this demand cannot be met by the reservoirs, the alternative of pumping groundwater for this purpose is available. The impact of such pumping is not known.
- There is considerable uncertainty regarding the ability of reservoir operations to meet lower priority objectives. These include the fulfillment of future irrigation demands, achievement of water quality objectives at the international border or upstream, and provision of water for wildlife habitat and recreation.

The Panel has concluded that proper water management in the **Souris** River basin can only be accomplished within the framework of a comprehensive basin-wide water management plan. It recommends that the existing water management plan developed by the Project proponent be expanded to encompass the entire **Souris** basin, including North Dakota and Manitoba. To assure effective implementation of the plan, appropriate institutional arrangements and delegation of authority to other levels of government should be considered.

Given the scarcity and variability of water supplies in the region, the Panel recommends that no commitments be made to new consumption in the basin until the hydrologic characteristics are better understood. Reservoir operations could be improved if more were known about the magnitude of evaporative and seepage losses. An operating regime that remains flexible about the timing of releases and which assigns higher priority to wildlife and recreation would generate greater benefits for Saskatchewan.

Other recommendations are made in the body of the report concerning specific mitigation and monitoring measures, cumulative impacts, the possible effects of global warming and the need for ongoing research.

The Panel is aware that many Canadians are concerned about the possible diversion of water from Canada to the United States. The wording of the ***International River Improvements Act*** licence for the Project could be more specific in its prohibition of water diversion. The Panel recommends, therefore, that the **IRIA** licence be revised to reflect clearly the intent of not allowing the diversion of water from Canada to the United States.

The Panel is of the opinion that had land-based conservation and flood-plain zoning been practised in the past the Rafferty and Alameda dams might not have been necessary. Land-use practices are, in large part, determined by the current agricultural policies of various levels of government. The adoption of better land-use and flood-plain zoning practices is needed and will ultimately lead to better protection of headwaters and wetlands, reduce the magnitude of the flood/drought cycles, promote soil and water conservation and enhance water quality.

The Panel recommends that a conservation-oriented approach to water resources planning be adopted in future.

The Panel also notes some of the deficiencies in the environmental impact assessment process associated with this project. Environmental impact assessment should be applied early in project planning. That is the intent of both provincial and federal processes. The Project was **well-**advanced, however, when both the first and this Panel became involved. This put some limits on the usefulness of the review. The Panel considers it of great importance that federal and provincial environmental assessment processes be more closely coordinated so that the legitimate interests of both governments may be considered as early in the project history as possible.

1.0 INTRODUCTION

Environmental impact assessment (EIA) is a developing field but its importance as a tool in the design of economic development is difficult to overstate. There are, however, a number of obstacles which need to be overcome in order to conduct EIA in a comprehensive and effective manner. This is well illustrated by the history of the Rafferty-Alameda Project. For instance, the interrelationship between various levels of government with respect to environmental assessment was relatively undefined and proved to be one such obstacle.

This Panel has struggled with this and other issues associated with the Project. The purpose of this report is to provide the Panel's conclusions and recommendations. It should be noted that the Project information provided to the Panel began with an environmental impact statement (EIS) prepared in 1987 followed by more detailed technical studies. These culminated in a "Water Management Plan for the Souris River basin in Saskatchewan" (1990) and an accompanying "Technical Report" prepared by the Souris Basin Development Authority (SBDA). It was basically left to the Panel to synthesize these diverse documents to achieve an integrated sense of the environmental impacts of the Project. The Panel did not have the benefit of a synthesis by the SBDA which identified the residual effects once the operating plan and mitigation measures would be in place.

This Panel was appointed on February 5, 1991. Much work had been done by the first Rafferty -Alameda environmental assessment panel before its resignation in October 1990. That work helped to expedite the work of this panel so that its self-imposed goal, agreed on during initial meetings, of completion of the report by September 1991, could be met. The help of the technical support committee and the secretariat was invaluable.

The remainder of this chapter presents the history of the Project and the environmental review. In Chapter 2, the general setting of the Project is outlined. This includes a general overview of the Project, its physical setting and its objectives. In Chapter 3, a summary is given of the views that have been formally expressed by governmental agencies and by the public during various project reviews. Chapter 4 contains the Panel's evaluation of the ability of the Project to meet its stated objectives. In Chapter 5, the Panel assesses the potentially significant impacts of the Project and Chapter 6 presents an evaluation of the mitigation and monitoring measures advanced by the SBDA. In Chapter 7, the Panel sets forth its recommendations for mitigation and monitoring measures. The report concludes in Chapter 8 with general observations and recommendations from the Panel.

1.1 Background

Streamflows in the Souris basin are highly variable and unpredictable, the highest annual flow on record for the Souris River itself being about 600 times greater than the smallest one! Since pioneers first settled the basin, the erratic water supply of the Souris has been a source of concern and frustration. Water management was seen as the key to economic prosperity. As early as 1907, a dam was proposed for Moose Mountain Creek. Projects on the scale of the Rafferty-Alameda were suggested as early as the 1930's.

Major water resource management studies on the Souris River system were initiated in 1940, 1957 and in the 1970's. In 1984, the Province of Saskatchewan began planning the Rafferty-Alameda Project.

The consequences of building in a flood plain (photo credit: The SBDA).

Summer fallowing, a common land-use practice in the region (photo credit: The SBDA).

In March 1986, the Government of Saskatchewan created the SBDA as a Crown corporation. The SBDA was given the responsibility for planning and building all facilities associated with the Project. As the Project proponent responsible for construction of the dams and ancillary facilities, the SBDA prepared an EIS and submitted it to the Province for review and approval in August 1987. In September, a provincial Board of Inquiry held public hearings to review the EIS. Early in 1988, the Board recommended that the Project proceed, subject to 34 conditions. The Government of Saskatchewan authorized the SBDA to proceed with construction of the Rafferty Dam portion of the Project.

The Project also required federal approval. Because the Souris is an international river, the Project has the potential to affect water quality and quantity beyond international boundaries (Saskatchewan/ North Dakota and North Dakota/Manitoba). Under the Boundary Waters Treaty (1909), Canada and the United States share mutual obligations with respect to transboundary water issues. The application of the 1955 *International River Improvements Act* (I RIA) ensures that Canada can meet its obligations.

Under the IRIA, the federal Minister of the Environment has the authority, by issuing a licence, to control water management for projects upstream from the international boundary. During the process of issuing an IRIA licence for the Rafferty-Alameda Project, Environment Canada reviewed the potential impacts at the two international border crossings. Following this assessment and after consultations with government officials from agencies in Saskatchewan, Manitoba and the United States, the Minister issued the licence, with 13 conditions, in June 1988.

In January 1989, the Canadian Wildlife Federation (CWF) and two area residents filed an application with the Federal Court to set aside the IRIA licence. They contended that the federal Environmental Assessment and Review Process (EARP) had not been properly applied in the decision to issue the licence. The federal government argued that the Province of Saskatchewan had already conducted a review in 1987 and 1988 under the provincial environmental assessment process that, in the opinion of the federal Minister of the Environment, had satisfied the EARP requirements. The federal government also argued that, before issuing the IRIA licence, it had conducted its own review of the Project.

After considering these arguments, the Federal Court concluded that the provincial review had not adequately addressed areas of federal responsibility, especially potential impacts outside the Province of Saskatchewan. These impacts, the Court decided, must be addressed under the EARP and, in April 1989, it quashed the licence and ordered the federal Minister of the Environment to conduct a review of the Project under the EARP.

The federal government initiated a review of the Project in the summer of 1989 as required by the Court. In the role of initiating department under the EARP, Environment Canada prepared an initial environmental evaluation (IEE) which addressed possible environmental impacts of the Project in areas of federal responsibility. Public meetings concerning the IEE were held in Manitoba, Saskatchewan and North Dakota between June 22 and 29, 1989. Based on recommendations contained in the IEE and input from the public meetings, the federal Minister of the Environment issued a new IRIA licence with 22 conditions in August 1989.

In addition to these activities under the EARP, negotiations were under way between Canadian and U.S. officials to arrive at a joint understanding about Souris River water management issues affecting both jurisdictions. On October 26, 1989, the negotiations culminated in the signing of an agreement between the governments of Canada and the United States setting out terms related to both water apportionment and water quality at the border. The United States also agreed to pay Canada $41 .1 million (1985 U.S. dollars) for flood control storage provided by the Rafferty and Alameda dams.

At this point, in the view of the federal government, its responsibilities with respect to review and approval of the Project had been met. The second phase of the EARP, a public review by an independent environmental assessment panel, was not considered necessary by the federal Minister of the Environment. CWF and two affected residents, however, initiated a second court action in October 1989. This resulted in a Federal Court decision requiring an independent panel review.

A five-member environmental assessment panel was appointed by the Minister of the Environment on January 29, 1990, to review the Rafferty-Alameda Project. Mr. Robert Connelly was appointed Panel Chairman. The other Panel members were Dr. Donald Gray, Dr. Eric Moodie, Mr. Robert Bell and Mr. Hugh MacKay. The Federal Environmental Assessment and Review Office (FEARO) organized a team of experts to give the Panel technical assistance. The team members included: Dr. Husain Sadar (Chairman), and members Mr. David Cressman, Mr. Michel For-tin, Mr. Kenneth Dance, Dr. Herman Dirschl and Dr. Edward McBean. FEAR0 also provided the Panel with an administrative Secretariat through Ms. Linda Jones (Executive Secretary) and Ms. Marlene Dyck (Information Officer).

The first Panel's mandate was to undertake a review of the environmental and related social impacts of the Rafferty-Alameda Dam Project, and to make recommendations concerning the operation of the dams including possible structural modifications if necessary.

At the time of this Panel's appointment, an agreement was signed between the governments of Canada and Saskatchewan to suspend work on the Project while the review was carried out. The federal government agreed to pay the province $1 million per month to compensate for delays in the Project's completion. The agreement did allow the continuation of construction activities on the Rafferty Dam until the safety of the structure was secured.

Prior to the appointment of this Panel, documentation on Project impacts and mitigation measures had been prepared by various departments of the provincial and federal governments in Canada and by state and federal agencies in the United States. This work had been completed in accordance with the *Saskatchewan Environmental Assessment Act,* the United States *National Environmental Policy Act* and the EARP Guidelines Order.

The first Panel began its work by reviewing all of these existing documents (Appendix I lists key documents). Upon completing this review, the Panel concluded that it needed additional information before it could proceed to the public hearings phase of the process. On May 25, 1990, the Panel released a draft "Information Request" for public review and comment. After considering 24 public submissions, the Panel finaiized this document and gave it to Environment Canada, the initiating federal department, on August 1, 1990. The document contained questions related to project issues and impacts such as water quantity and quality, fisheries and wildlife. The SBDA provided responses to these questions ("Responses to Final Questions from the Rafferty-Alameda Project Environmental Review Assessment Panel") in September 1990 .

As the review progressed, it became evident that various parties in the review process had a different interpretation of the intergovernmental agreement limiting construction, specifically with respect to the construction activity that would be allowed to assure the safety of the Rafferty Dam. After repeatedly expressing its concerns about continued construction activity to the federal Minister of the Environment, the Panel decided to suspend its operations on October 11, 1990. Then, on the 12th, following an announcement by the Saskatchewan government that construction on all aspects of the Project would proceed without delay, the Panel resigned.

Subsequently, the federal government announced that it would seek an injunction against the Province to halt work on the Project. On November 15, 1990, the Saskatchewan Court of Queen's Bench delivered its ruling denying the government's request.

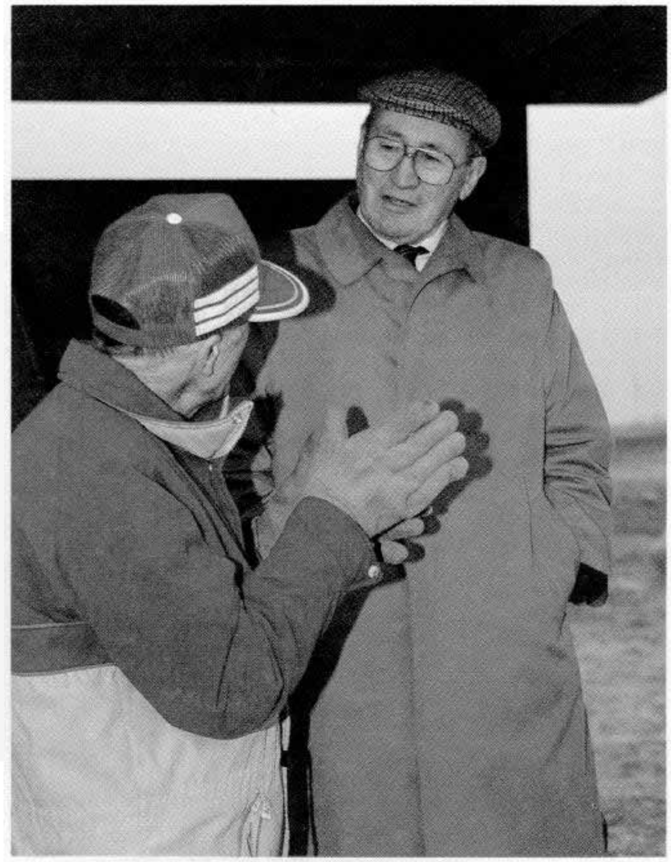
A new three-member Panel was appointed by the federal Minister of the Environment on February 5, 1991. The Panel's mandate required it "to undertake a review of the environmental and directly related social impacts (resulting from changes to the biophysical environment) of the Rafferty-Alameda Dam Project". In addition, the Panel had the mandate to:

- Review plans to mitigate the effects of both the construction and operation of the Project;
- Make recommendations concerning the mitigation of these impacts;
- Provide advice to the Minister on the adequacy of the mitigation plans prepared by the proponent pursuant to the *International River Improvements Act* licence; and
- Make recommendations concerning the operation of the dams, including possible structural modifications if necessary.

(The full text of the Terms of Reference issued by the Minister of the Environment to the Panel is contained in Appendix II.)

On February 8, 1991, the Federal Court, in response to an application filed by two affected landowners, directed the Minister to include certain terms and conditions from the earlier court order of December 28, 1989, in the mandate of the new Panel. The Minister then wrote to the Panel Chairman, drawing this requirement to his attention. In particular, the Panel was directed to include in its review the significant and moderate impacts that cannot be mitigated with known technology or for which no mitigation is provided, as stipulated in the IEE.

The Chairman of the new Panel was Dr. John Archer. The other Panel members were Dr. William Stolte and Dr. Roderick Riewe. (Biographies of the Panel members are contained in Appendix III). The Panel was assisted by the same Secretariat and team of experts with the addition of Ms. Patsy Cross, Dr. Peter Ward, Mr. Richard Roberts, Ms. Dianne Damman and Dr. Nick Novakowski. (A complete list of the technical experts is presented in Appendix IV.)



John Archer, Chairman of the Panel, listening to the concerns of a local resident, April 1991 (photo credit: R. Riewe).

On February 14, 1991, the Panel requested public review and comment on the Response Document which the SBDA had submitted to the first Panel. In April, the Panel and its experts toured the Project and the Souris basin. On May 30, the Panel announced the schedule and locations for its final public hearings. The Panel noted in its announcement that a number of technical issues still required clarification from the proponent. This information was received before the hearings began.

The Panel also announced that a social issues survey, under the direction of Mr. Richard Roberts of the consulting firm Praxis in Calgary, would be administered to a sample of residents in the Souris basin in Saskatchewan and Manitoba. The Panel commissioned the study in order to better understand the social impacts and public perception of the Project.

The Panel held public hearings (general and community sessions) in Saskatchewan and Manitoba from June 24 to June 28, 1991. (Appendix V provides the dates, locations and list of presenters at the hearings.) During the eight scheduled sessions, the Panel heard from individuals, interest groups, businesses and representatives of government departments. Representatives from the SBDA, Saskatchewan Water Corporation and Environment Canada were present throughout the hearings. Transcripts of the proceedings and compilations of the written submissions were made available to the public.

Some of the questions posed by the Panel to the SBDA and Environment Canada during the hearings were too detailed to be answered at the time. Written replies were submitted to the Panel during the week of July 1, 1991, and the public was invited to comment on the information by July 26, 1991.

A public file containing letters and other information exchanged between the Panel and the public was maintained throughout the review at the information office in Estevan, Saskatchewan, and the FEAR0 office in Hull, Quebec.

There are a number of constraints on future operations of the Project. These are the conditions approved by the Saskatchewan Minister of the Environment, the IRIA licence issued by the federal Minister of the Environment and the 1989 Agreement between Canada and the United States for water supply and flood control in the Souris basin.

Panel tour of the Alameda Dam site, April 1991
(photo credit: R. Riewe).

2.0 THE SETTING

The purpose of this chapter is to give the reader a brief overview of the Project and its setting. It provides a general context for the discussion of impacts and impact mitigation that appears in following chapters. The discussion begins with an overview description of the Souris River watershed, and of the issues and problems that have led to development of the Project. The Project's various water management structures are briefly described and the water management objective/$ established by the Government of Saskatchewan for the Project are presented.

2.1 Watershed Description

The Souris River is a tributary of the Nelson River system draining into Hudson Bay (see Figure 2.1). Originating in undulating prairie lands southeast of Regina, it flows past Estevan and into North Dakota. It loops back to the northeast near the city of Minot and crosses the North Dakota/Manitoba border near Westhope. It then meanders north across southwestern Manitoba until it joins the Assiniboine River southeast of Brandon. About one-third of its 62,120 km^2 drainage basin above this junction lies within Saskatchewan (see Figure 2.2).

Long Creek and Moose Mountain Creek are the principal tributaries in the-Saskatchewan portion of the Souris watershed. These creeks and the main stem of the Souris River meander through flat valleys incised into the gently rolling prairie landscape of the basin. Des Lacs, Wintering and Deep rivers are important North Dakota tributaries. In Manitoba, major tributaries are Plum Creek, Gainsborough Creek and Antler River.

A semi-arid continental climate prevails throughout much of the watershed. Drought, occasional thunderstorms and intense temperature variations are typical of the climate. Snow melt in the spring can generate over 80 per cent of the annual streamflow and causes most of the flooding. At times, periodic droughts eliminate streamflows altogether.

The Souris basin ecology reflects the semi-arid prairie climate and topography. The natural upland vegetation of the Souris basin is a mixed grass prairie, although some species that are characteristic of tall grass prairie vegetation are found in certain locations. There are trembling aspen groves in depressional upland, especially in the eastern portion of the area. Manitoba maple, green ash and various shrubs grow on river levees and in sheltered locations at the edge of the flood

Upper Souris River, Saskatchewan, April 1991 (photo credit: R. Riewe) plain. Wetlands are found along the shores of rivers, creeks, small lakes and reservoirs in the basin. Most of the uplands and parts of the valleys are now under intensive cultivation, while most of the remainder is used as hayland or pasture.

Segments of the local population and some provincial agencies have been promoting water-based development to diversify the local economy and to strengthen the economic base of rural communities. Since the turn of the century, coal has been a major contributor to the local economy. Oil production, since the 1950's has added further to the industrial base.

There are eight smaller reservoirs in the Souris River basin upstream of the North Dakota border which provide municipal, agricultural and industrial water supplies, as well as some recreation. The total combined storage of these and about 4,900 farm dugouts is 116,100 dam^3. This is about one-fifth of the combined storage of the Rafferty and Alameda reservoirs. The largest existing reservoir, created by Boundary Dam on Long Creek, is southwest of the Rafferty Reservoir. It supplies cooling water for thermal power generation and municipal water to the City of Estevan. The next largest reservoir in the study area, Nickle Lake, is downstream of Weyburn and supplies water to that city.

Important developments in the North Dakota portion of the basin include the Upper Souris (Lake Darling) and J. Clark Salyer national wildlife refuges. Lake Darling is a valued local fishery and both refuges provide important habitat for a variety of migratory waterfowl. The City of Minot, south of the refuges, is built on a flood plain and has been subject to severe flooding from the Souris in the past.

In Manitoba the Souris is a source of municipal water and is used for recreation, including fishing.

2.2 Project Description

The storage provided by Rafferty Dam on the Souris River and the Alameda Dam on Moose Mountain Creek is principally intended to provide downstream flood control in Saskatchewan and North Dakota, to supply cooling water for the Shand Power Station, to supply water for irrigation and to create new water-based recreation opportunities. The Project, once completed, will be managed by the Saskatchewan Water Corporation (SaskWater).

Rafferty Dam, the larger of the two dams, is virtually complete now. It is a 20-m-high earth-fill dam located 6 km northwest of Estevan. When full, Rafferty Reservoir will stretch 57 km upstream, have a surface area of 4,900 ha and store 440,000 dam^3 of water. Weirs in three areas upstream of the main dam will be used to control water levels for waterfowl and fish production.

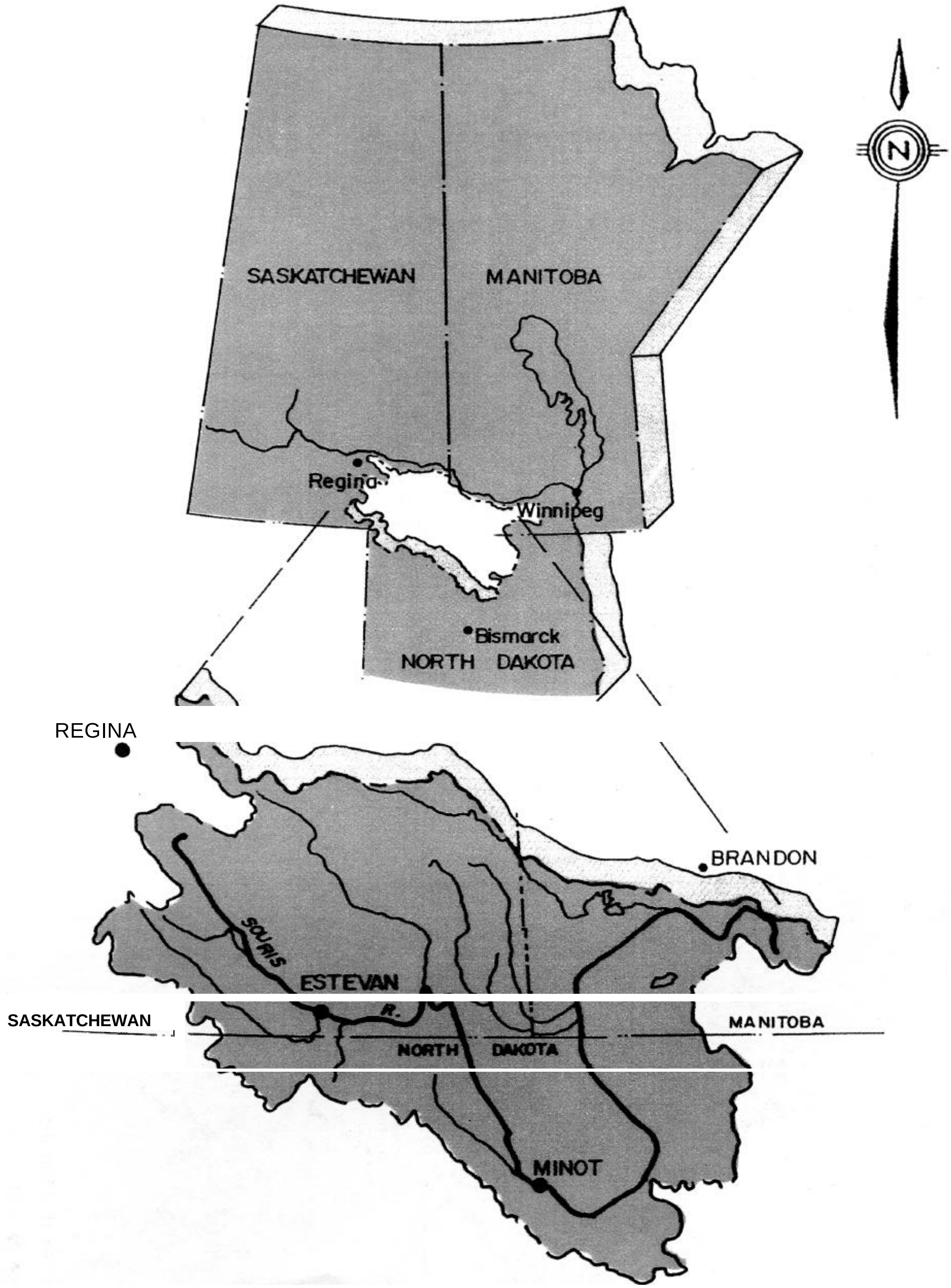
Construction on the Alameda Dam has commenced. When finished, it will be a 38-m-high earth-fill dam on Moose Mountain Creek north of the Town of Oxbow, relatively near the border with North Dakota. It will eventually create a 105,000 dam^3, 1,240 ha reservoir extending 25 km upstream from the dam. This reservoir, though smaller than Rafferty Reservoir, will be considerably deeper. Consideration is being given to using weirs to promote development of waterfowl habitat at four upstream locations.

There are a number of other projects associated with the development of the two dams (see Figure the nearby Boundary Reservoir to allow movement of water in either direction and joint operation of the two reservoirs. In addition, a pipeline from the Rafferty Reservoir will supply cooling water to two turbines at the new Shand power station 10 km southeast of Estevan. Channelization of 16 km of the meandering river course below Rafferty Dam is intended to alleviate local flooding problems and to reduce losses of water to seepage or evaporation.

The present Dr. Mainprize Regional Park, south of Midale, will be inundated by reservoir waters. The park is being relocated, therefore, to an area further upstream on the Dead Lake channel (see Figure 2.4). Weirs will be used to prevent flooding of the new site by reservoir waters. A weir upstream of the Rafferty Dam will supply municipal water to Midale.

An important feature of the overall project is its operating complexity. The two new reservoirs are to be operated in concert with the existing Boundary Reservoir to meet a number of objectives. The scheme involves inter-reservoir water transfers, a multi-reservoir operating regime, two national, one state and two provincial governments, and their respective agencies.

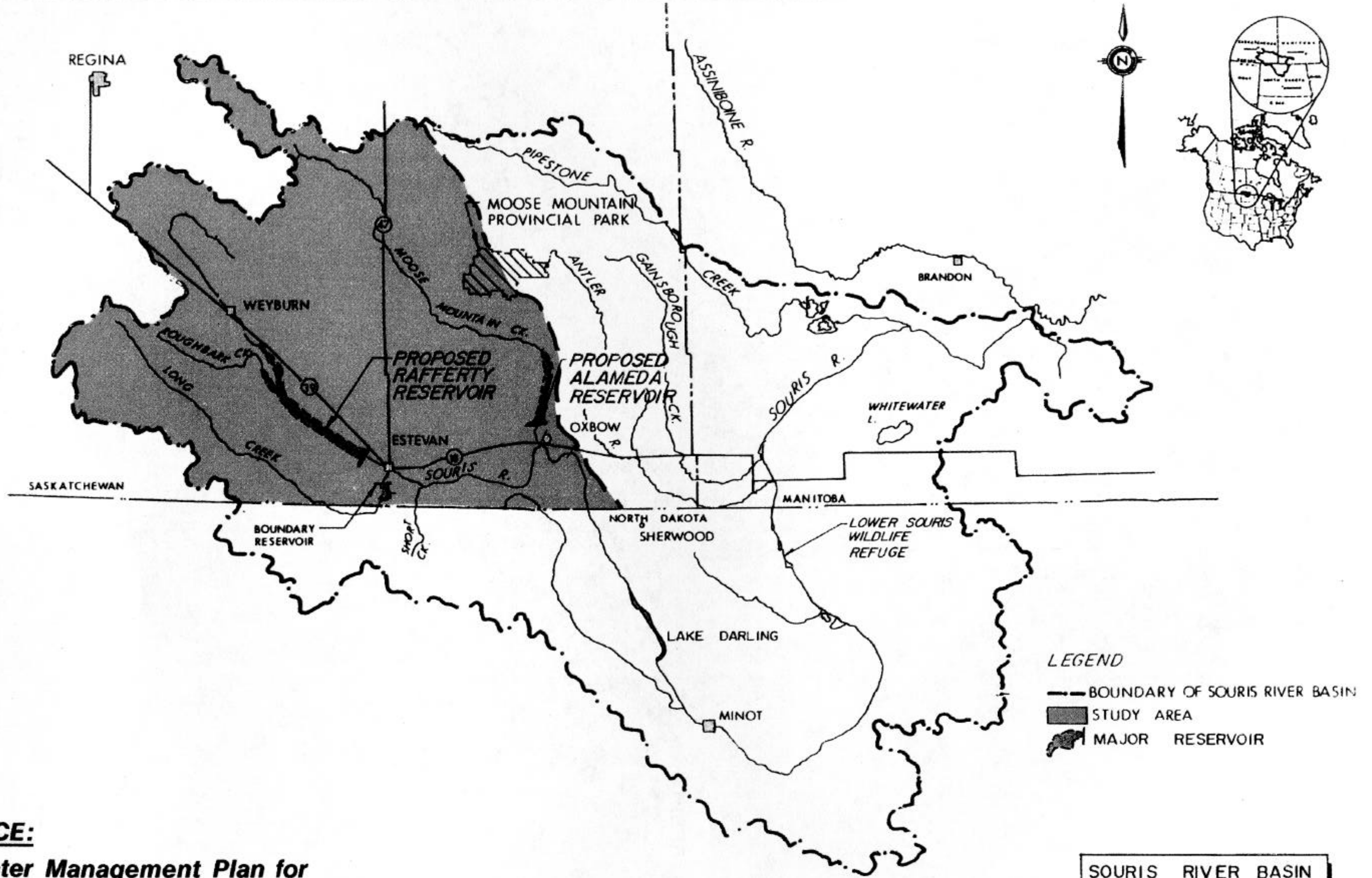
Rafferty Dam: low-level outlet and downstream channelization, April 1991 (photo credit: R. Riewe).



SOURCE:

"Water Management Plan for the Souris River Basin, Saskatchewan". April, 1990.

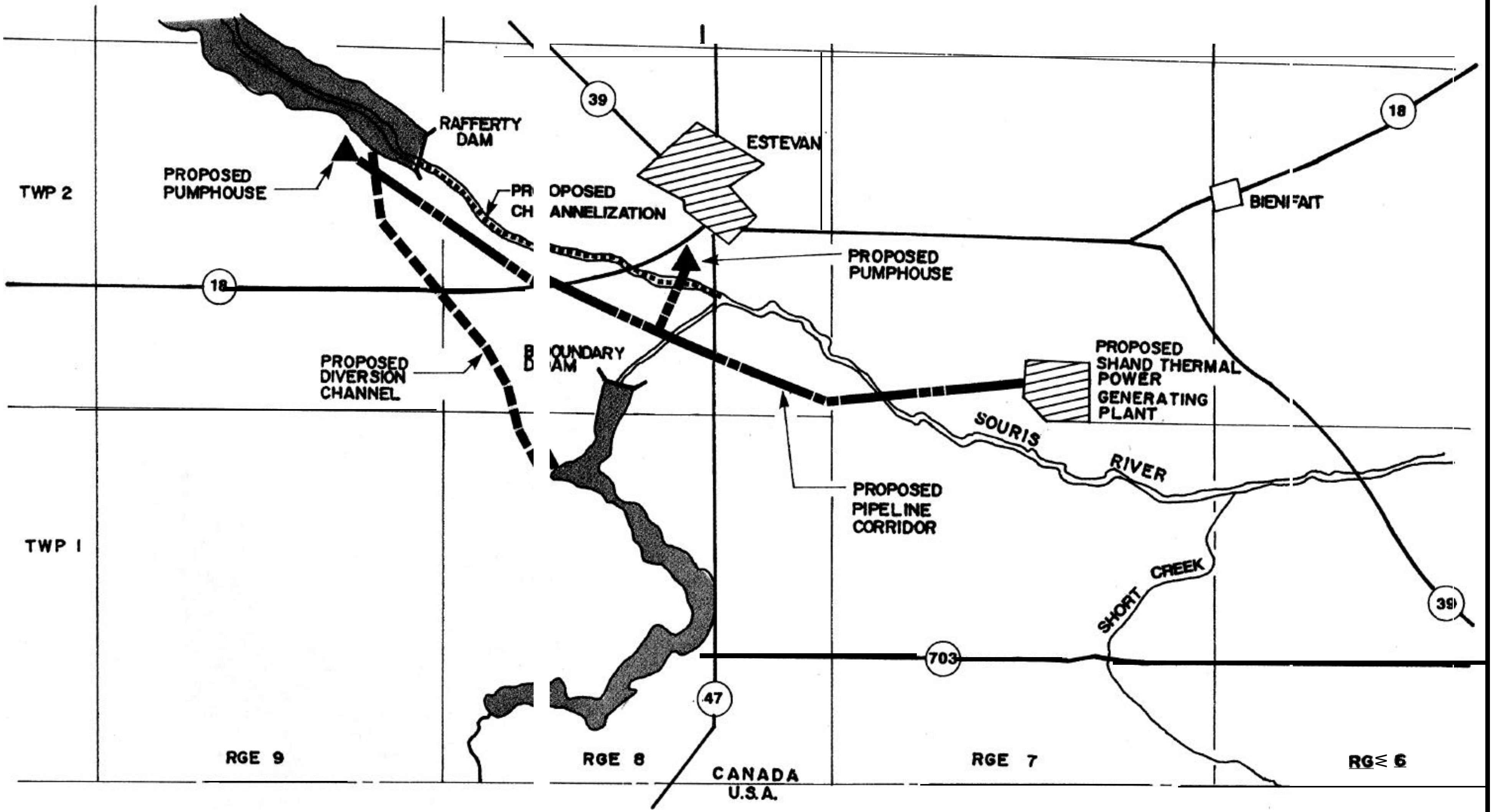
LOCATION PLAN
SOURIS RIVER BASIN
FIGURE 2.1



SOURIS RIVER BASIN
FIGURE 2.2

SOURCE:

"Water Management Plan for the Souris River Basin, Saskatchewan". April, 1990.



SOURCE:

"Water Management Plan for the Souris River Basin, Saskatchewan". April, 1990.

NEW FACILITIES ASSOCIATED WITH RAFFERTY RESERVOIR
FIGURE 2.3

2.3 Project Objectives

The SBDA has proposed that the Rafferty-Alameda Project be managed to achieve a series of objectives established by the Government of Saskatchewan. The specific objectives are:

- Comply with the terms of the 1989 Agreement between Canada and the United States of America for water supply and flood control in the Souris River basin. This agreement covers water management criteria and reservoir operating criteria for apportionment and flood control including flood protection at Minot, North Dakota, for the 100-year flood.

- Provide an assured long-term water supply to the Shand power station.

- Provide an adequate water supply for existing authorized water users in Saskatchewan, including existing municipal, irrigation, domestic and industrial water users.

- Provide an adequate water supply for new developments in the Souris River basin which could include up to 4,800 ha of new irrigation development.

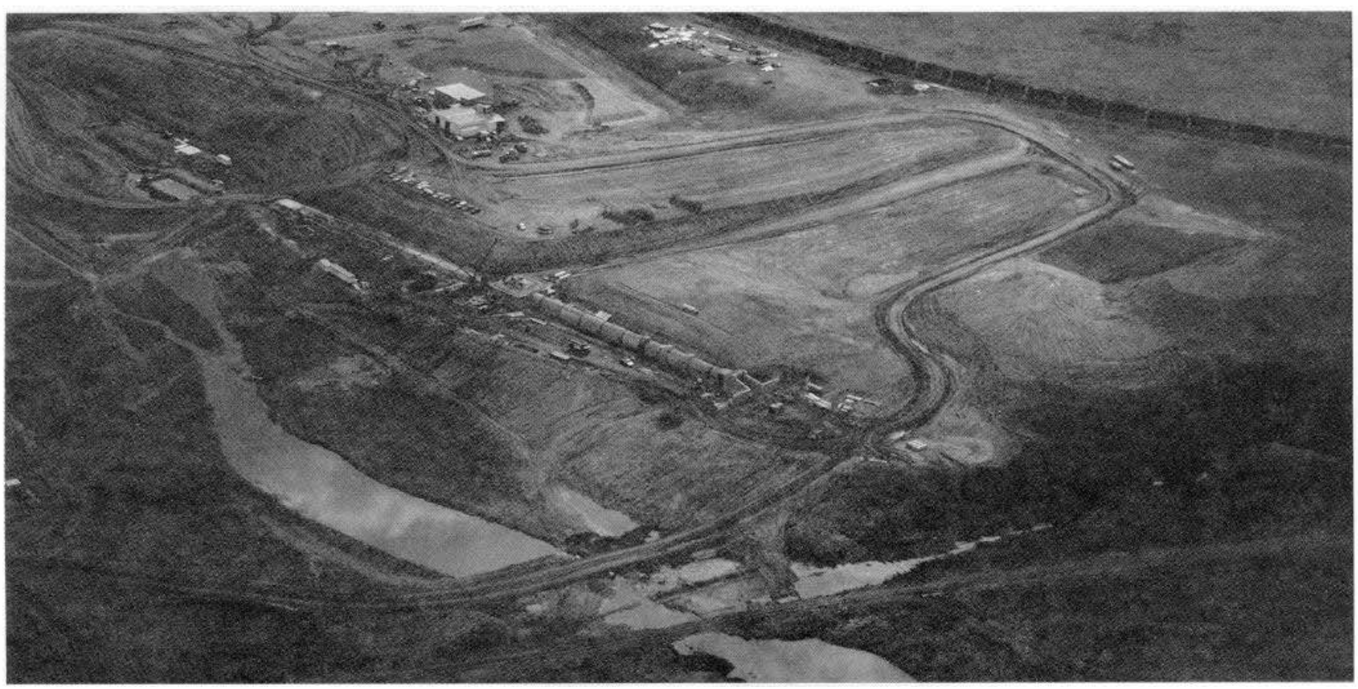
- Operate the Rafferty Reservoir and the Alameda Reservoir to provide recreational benefits;

  - water supply to the Dead Lake channel and the new Dr. Mainprize Regional Park.
  - minimum water level of 545.5 m at the upper portion of the Rafferty Reservoir above the proposed causeway and control structure along Highway 606.
  - maximum 1.5 m drawdown of the Rafferty Reservoir between June 1 and August 31.
  - minimum level of 542 m at the main body of the Rafferty Reservoir.
  - minimum level of 551.8 m at the Alameda Reservoir.
  - maximum 2.0 drawdown of the Alameda Reservoir between June 1 and August 31.

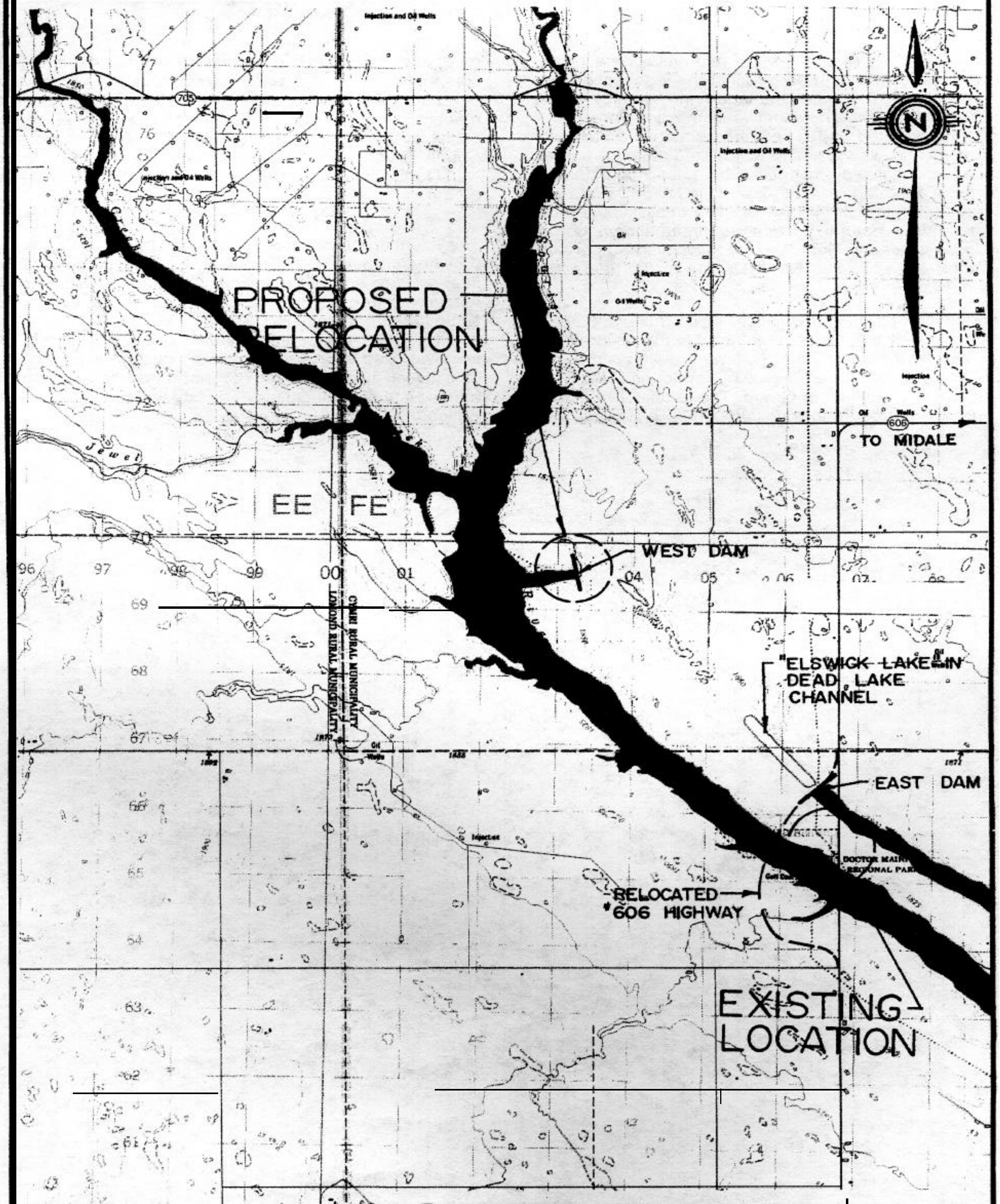
- Provide flood protection to urban and rural areas downstream of the Rafferty Dam and the Alameda Dam.

- Operate a flow regime in the Souris River and Moose Mountain Creek which will maintain acceptable water quality, and, when possible, enhance fish habitat and aquatic wildlife habitat. Instream flows should be supplied by water designated to meet Saskatchewan's apportionment obligations.

- Provide an adequate water supply for wildlife enhancement measures. This will include approximately 1,000 ha of wetlands development within and alongside the Rafferty and Alameda reservoirs.



Alameda Dam construction site with the low-level outlet structure in the centre, April 1991 (photo credit: RJ Riewe)



SOURCE:
"Water Management Plan for the Souris River Basin, Saskatchewan". April, 1990.

PROPOSED RELOCATION
DR. MAINPRIZE REGIONAL PARK
FIGURE 2.4

How these objectives are met when reservoir operating regimes are developed will, in part, reflect the legal obligations that are binding on the water management authority of the system. The 1989 Agreement between the governments of Canada and the United States sets out terms related to water apportionment and water quality at the international border. The U.S. water entitlement is defined by a set of rules based on the amount of storage in Lake Darling in North Dakota and the natural streamflow at the border. The rules stipulate the percentage of the natural flow at the international border which is to be passed to North Dakota, allocating 50 per cent of the natural streamflow to North Dakota in dry years and 40 per cent in other years.

In addition to the operating objectives listed above, and under the terms of the 1989 Agreement, the Souris River Basin International Water Quality Objectives were developed by the Water Quality Objectives Task Force of the Souris River Bilateral Water Quality Monitoring Group. These objectives cover 46 parameters grouped into four categories: biological (one parameter), inorganic compounds (22 parameters), organic compounds (17 parameters) and miscellaneous (six parameters). For each parameter, the objectives document identifies the most sensitive use being protected and the possible source of the contaminant. The objectives apply to Souris River waters as they cross both the Saskatchewan/North Dakota border and the North Dakota/ Manitoba border.

The intention of the water quality objectives is to protect and provide sufficient water quality in the Souris River so that in-stream uses, such as domestic consumption, fish and wildlife resources, irrigation, livestock watering and industrial consumption, are maintained. The numerical values for the water quality objectives for the Souris River at the two boundary sites were arrived at through a process that considered the objectives, guidelines and/ or standards of the participating agencies, the historical water quality and the monitoring capabilities of the various agencies.

3.0 PUBLIC AND AGENCY VIEWS

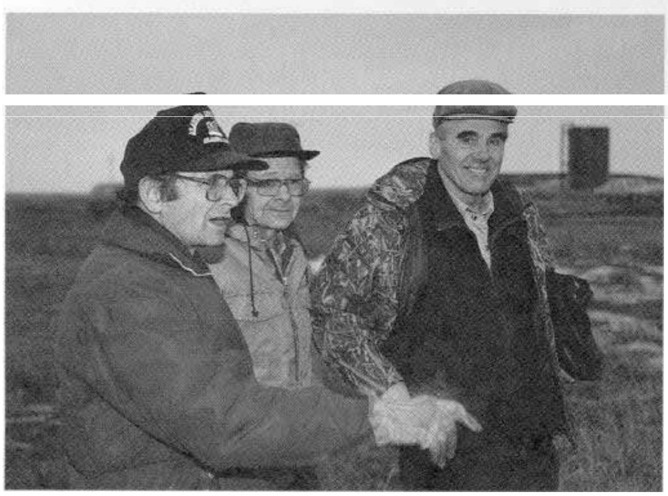
The Rafferty-Alameda Project has been the subject of widespread public discussion since it was announced in 1986. Numerous opportunities were provided to the public and agencies to comment on the Project as it moved through several formal reviews. During three sets of public hearings, the last of which was carried out by this Panel, a multitude of briefs, petitions and oral statements were presented. (A list of the hearings appears in Section 1.0 of Appendix VI.)

In early 1991, the Panel commissioned a consulting firm, Praxis of Calgary, Alberta, to survey public opinion in the Project area and downstream in the Province of Manitoba. The survey was intended to add to the Panel's understanding of public perception and concerns regarding the Project.

For the purposes of preparing this report, the Panel reviewed written submissions received from the public and government agencies, and the testimony at its public hearings. It also examined public and agency submissions to the first Environmental Assessment and Review Process (EARP) Panel, to Environment Canada's draft Initial Environmental Evaluation (IEE) review and to the Rafferty-Alameda Board of Inquiry.

An overview of the diversity of viewpoints expressed is presented in section 2.0 of Appendix VI. References to technical matters raised by review agencies appear in chapters 4, 5 and 6.

Many persons expressed themselves about water management issues primarily through petitions to the Rafferty-Alameda Board of Inquiry, indicating a strong support for the Project. Among the main benefits that are expected from the Project are flood control, water for cooling the Shand Power Station, irrigation and recreation. It is also expected to be a significant stimulant for the local and regional economies.



Harold and Edelbert Tetzlaff (local landowners), and Alan Scarth at the Alameda Dam site, April 1991 (photo credit: R. Riewe).

Though fewer in number, the expressions of concern about potentially adverse effects cover a significantly wider range of topics. The most frequently mentioned concerns relate to loss of fish and wildlife habitats, loss of agricultural land and farm operations, and poor water quality in the reservoirs. Concerns were expressed about the potential export of water to the United States. Another concern was the timing and effectiveness of the EARP. It was also suggested that the major share of the benefits would flow to the United States while many of the adverse effects would be borne by Canada.

The Praxis survey provided a general overview of current (1991) opinions of respondents in the study area about the Project. Strong support for the Project was indicated (79%) and the majority of respondents expected the Project would provide a number of benefits, such as recreation, irrigation and availability of water.

Respondents were asked how the Project would affect various aspects of the region, on a five-point scale from very positively to very negatively. The combined percentage of very positive and positive responses for these characteristics were: local recreation opportunities (74.6%), community life (61.3%), economy (60.3%), family life (59.7%), water quantity (59.5%), environment (57.5%), water quality (53.8%), tourism (49.0%), economic diversification (48.1%), and keep people in the region (45.8%).

Public optimism with respect to recreational benefits was especially high. When asked if they felt the Project would provide a number of recreational benefits, 88 per cent of respondents replied "yes" to boating, 87 per cent to fishing, 74 per cent to swimming, 55 per cent to cottage development, and 19 per cent to other forms of recreation. Forty per cent of respondents did not expect recreational benefits for more than five years, while 35 per cent expected them within three to five years.

Sixty-one per cent of respondents agreed or strongly agreed that irrigation would be a major benefit of the Project, while 19 per cent disagreed or strongly disagreed. Land owners were more likely to disagree with the statement that irrigation would be a major benefit of the Project: 41.6 per cent of land owners strongly disagreed or disagreed, compared to 13 per cent of non-land owners; and 36.7 per cent of land owners agreed or strongly agreed, compared to 67.9 per cent of non-land owners.

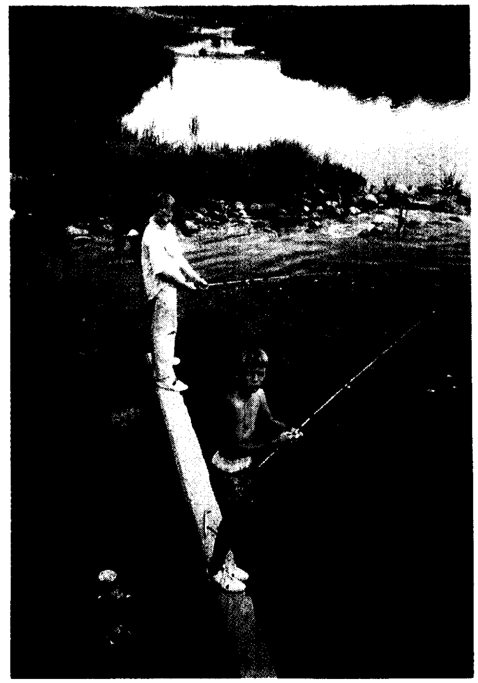
Eighty-two per cent of respondents felt the Project, on balance, would be beneficial to the region. Seven per cent felt the project would be harmful, and 11 per cent that the Project would have little effect on the region.

When asked about how the Project will affect various characteristics of the region, more land owners felt the effects on economic diversification would be positive (66.6% compared to 43.0% of non-land owners). However, more land owners felt the effects on water quality and community life would be negative: 20.0 per cent of land owners compared to 6.2 per cent of non-land owners felt the effect on water quality would be negative, and 18.3 per cent of land owners felt the effect on community life would be negative compared to 4.5 per cent of non-land owners.

The most frequently suggested uses for the water, other than irrigation, included recreation (36%), a power plant (1 9%), and urban water needs (9%).

Eight per cent of comments were negative: there would not be enough water or good enough quality water for irrigation, the U.S. would get the benefits, and locals would not be allowed to take water from the reservoir.

The complete results of the survey were made available to the public in June 1991.



Souris River recreational fishery (photo credit: The SBC

4.0 THE ACHIEVEMENT OF PROJECT OBJECTIVES

The benefits that are derived from project implementation will depend on the degree to which project objectives are achieved. As we have seen in Chapter 3, a significant proportion of the public seems to be quite optimistic in their anticipation of these benefits. It is, therefore, important to assess the degree to which objectives are likely to be fulfilled. In this chapter, the Panel explores this issue, drawing conclusions about the likely effectiveness of the Project and the uncertainty around the achievement of project objectives.

The SBDA proposes to operate the reservoirs to meet the following objectives:

- Releases to meet the U.S. apportionment of basin flows;
- Flood control in Saskatchewan and North Dakota;
- Achievement of water quality objectives at the international border;
- Provision of cooling water for the Shand and' Boundary power stations;
- Provision of water for existing and future irrigation;
- Enhancement of wildlife and recreation;
- Enhancement of summer water quality downstream from the reservoirs;
- Management of reservoir levels to enhance aquatic life within the reservoir;
- Maintenance of high and steady summer reservoir levels for recreation; and
- Maintenance of a minimum critical flow beneath the ice cover to allow better passage of late winter pre-flood releases.

Many of these objectives are potentially in conflict with each other (e.g., flood control argues for keeping the reservoir levels low whereas water supply argues for keeping the reservoir levels high). Of necessity, some objectives will have to be given a higher priority than others for effective reservoir operations.

Minot, North Dakota, a major flood damage centre on the Souris River (photo credit: R. Riewe).

4.1 Hydrologic Conditions and the Priority of Uses

The variability in flows in the Souris basin is much greater than in many other river basins. This natural variability of flows will complicate operations of the proposed reservoir system.

Sequential years of low and high flows are common in the Souris River and its tributaries. The extent of this long-term variability is illustrated by figures 4.1 and 4.2 which show annual flows measured below the dam sites. Assuming the future flows reflect the historical record, and given the expected consumption patterns, reservoir levels will follow an undulating pattern. It is important to realize that a succession of wet years will be required to fill the reservoirs if they are nearly empty. The wet years could then be followed by a progressive lowering of the reservoirs over a series of drier years in order to meet high priority demands. Examples of the expected fluctuations in levels are provided in figures 4.3 and 4.4.

Reservoir operations will be further affected by the usual scarcity of water in the area. The water to meet consumption requirements, evaporative losses and targets for apportionment are very close to the average expected annual flow. This means that there is limited leeway to meet other objectives. Table 4.1 reveals that up to 80 per cent of the natural flow at the North Dakota border will be allocated to U.S. apportionment requirements or consumed by evaporation in Saskatchewan in an average flow year, while, with a median flow (half of observed flows are below the median and half are higher), up to 105 per cent of the annual flow could be allocated to these uses (provided that reservoir storage can be drawn down to make up the 5 per cent deficit). There is a prospect that long-term climate change may further reduce the availability of water in the basin.

Table 4.1 Distribution of Natural Flows at the International Border after Project Implementation

	Average Year	Median Year
Reservoir Evaporation	18-30% *	29-49%
Cooling Water Evaporation	10%	16%
Apportionment Requirements	40%	40%
Sum	68-80%	85-105%

Notes: * Range exists because losses are a function of reservoir contents.

- Values are percentage of total annual natural flow. The apportionment requirement is a conservative estimate; it could be 50 per cent. Losses due to channel priming and seepage in the event of late summer releases were not included.

In light of the nature of flows in the basin, the Panel deduced a priority ranking for the Project objectives based on the 1989 agreement and on other factors that have motivated the development of the Rafferty-Alameda Project. The priorities were confirmed with the SBDA.

A summary of the Project objectives, as perceived by the Panel, separated into decreasing levels of priority is as follows:

Priority I
1. Provision of downstream flood control to the City of Minot
2. Releases for apportionment to North Dakota
3. Provision of water supply for the Shand Power Station

Priority II
4. Achievement of water quality objectives at the international border

Priority III
5. Provision of water for waterfowl habitat
6. Provision of water for irrigation

Priority IV
7. Management of reservoir levels to enhance fish populations in the reservoirs
8. Maintenance of reservoir levels to enhance reservoir recreation
9. Enhancement of water quality downstream from the reservoirs in Canada
10. Maintenance of summer river flow levels in Canada to enhance recreation
11. Maintenance of a minimum critical flow beneath the ice cover to allow better passage of late winter pre-flood releases

This ranking of objectives should not be taken as absolute. For example, if a decision is made to release water for international apportionment during the summer, other uses such as water-based recreation downstream will also benefit. More importantly, however, this setting of priorities means that some objectives will override others; for example, in a drought, the operation of the reservoirs will not be adjusted to enhance in-stream recreation because that would reduce the amount of water in storage and thus reduce the ability to respond to the needs of the Shand Power Station for water.

Boundary Power Station, April 1991 (photo credit: R. Riewe).

Figure 4.1 Souris River near Rafferty Naturalized Flows

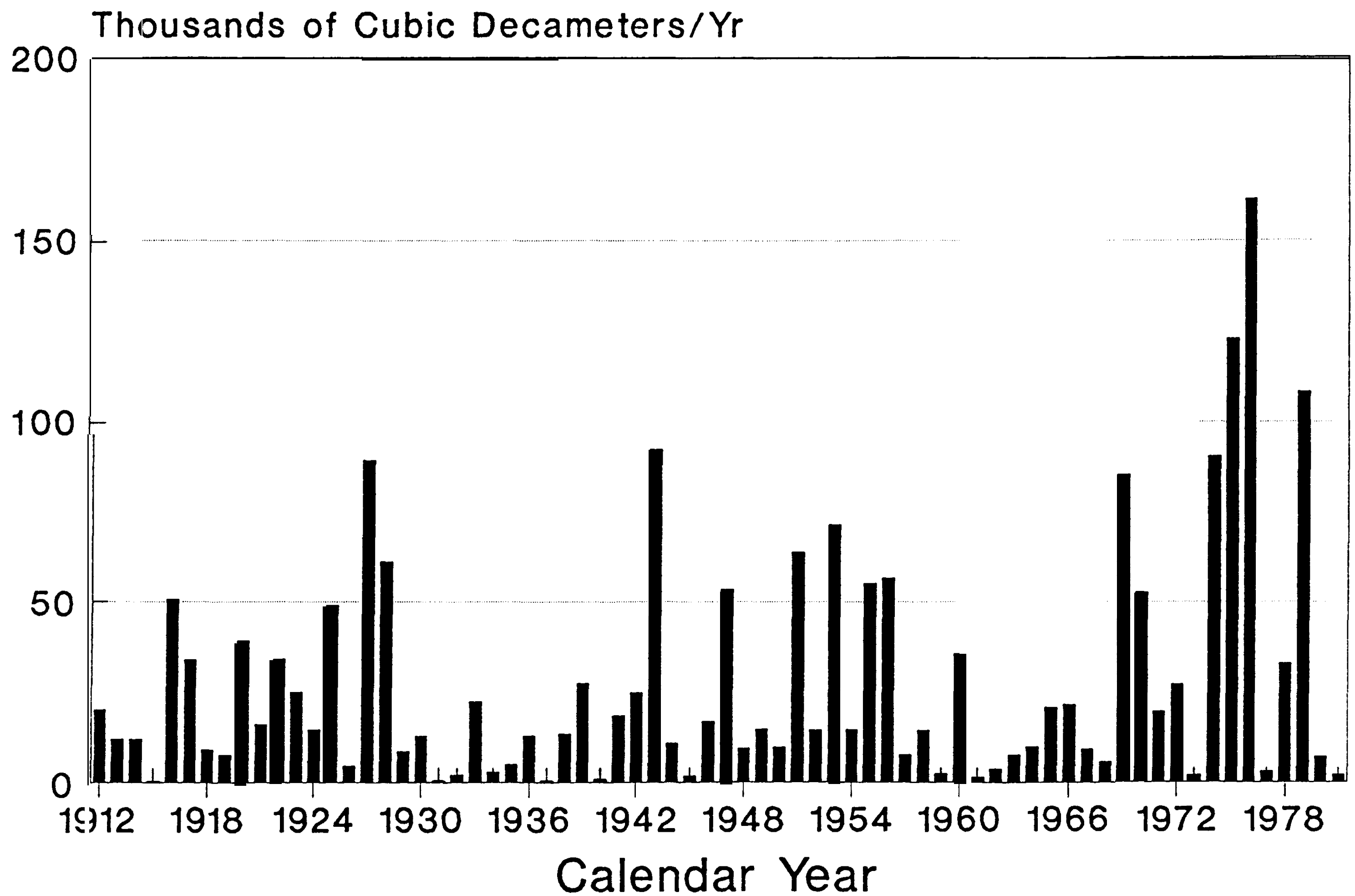


Figure 4.2 Moose Mnt. Creek near Alameda - Naturalized Flows

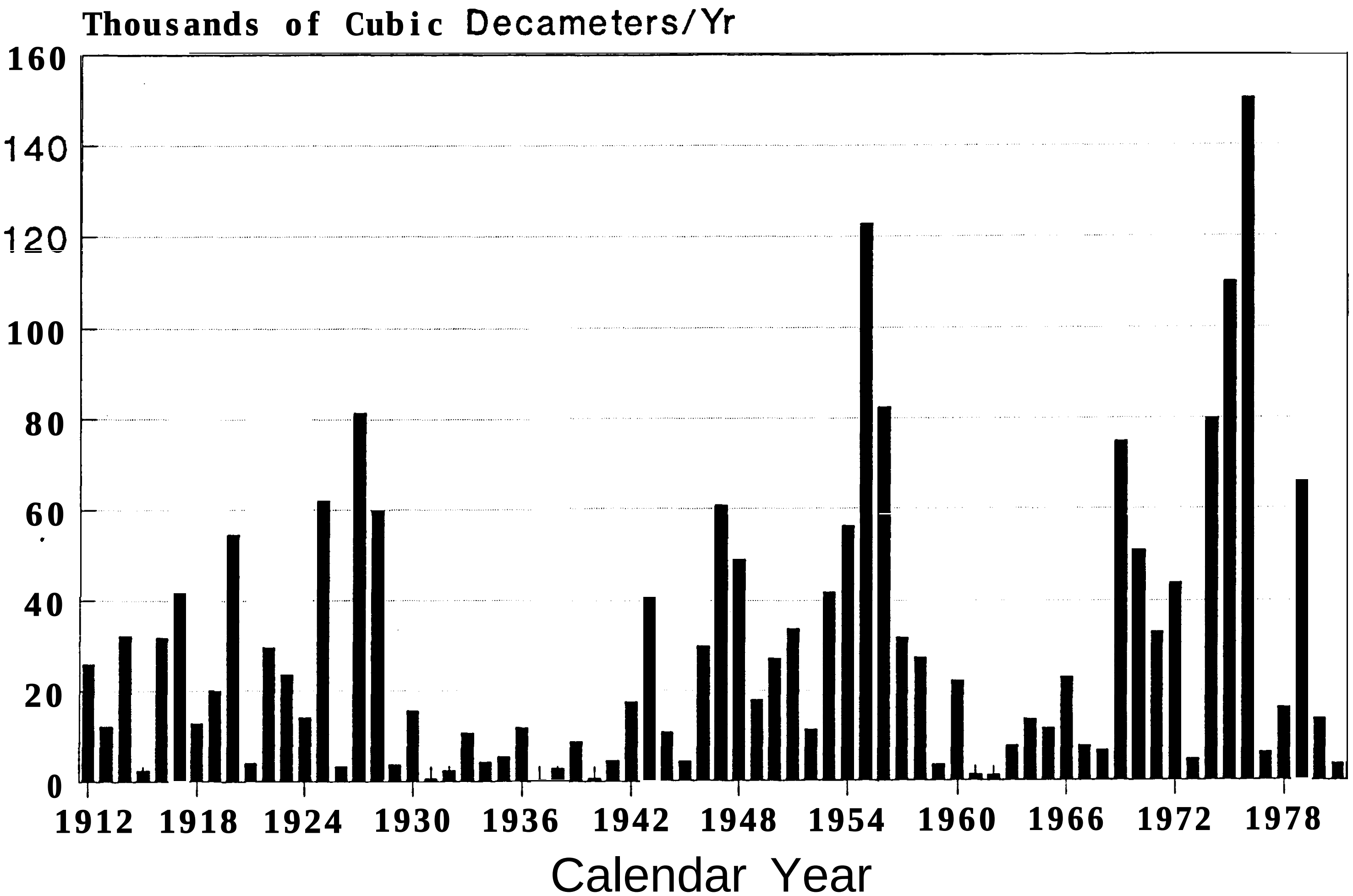


Figure 4.3 Average Annual Rafferty Reservoir Levels

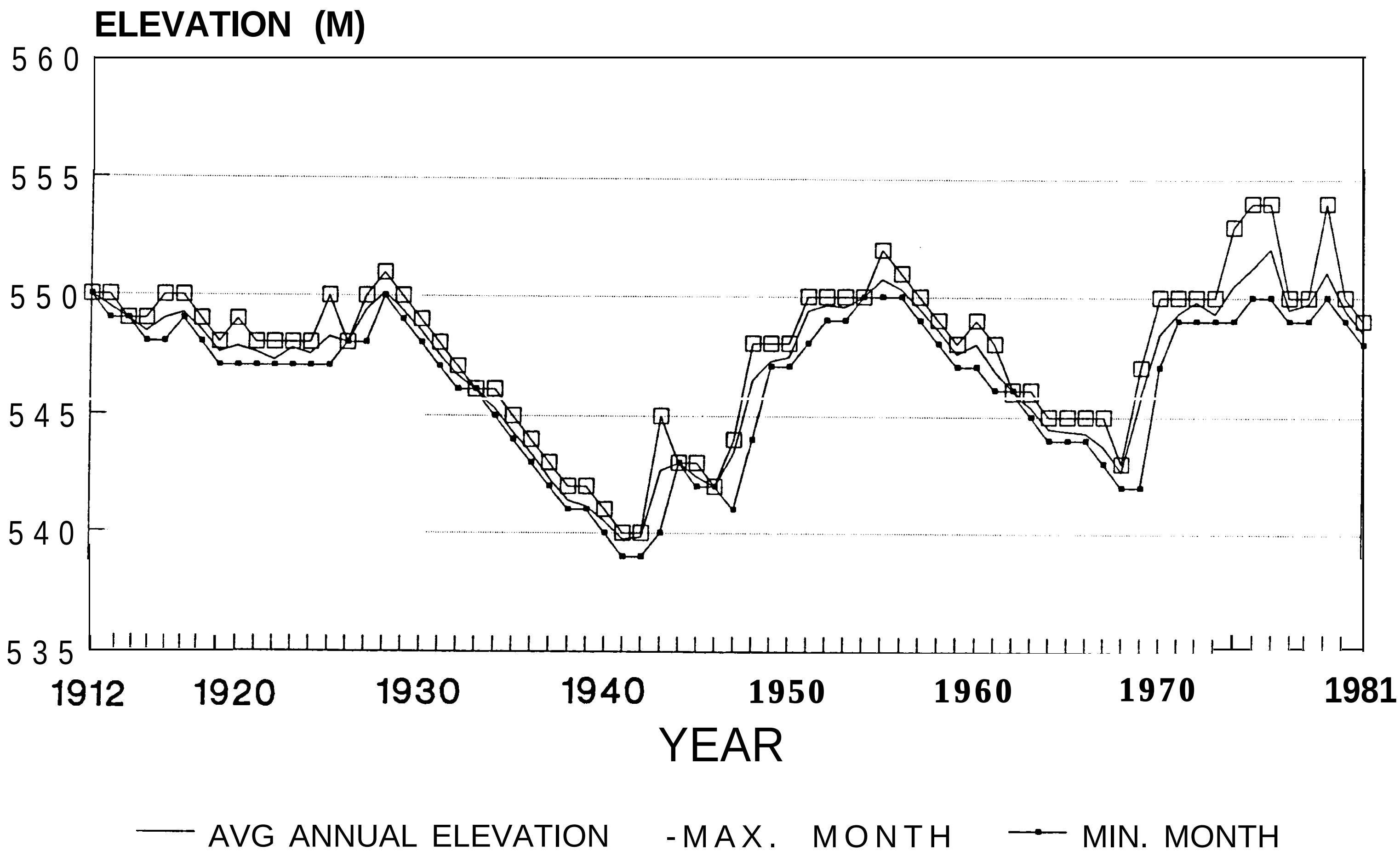
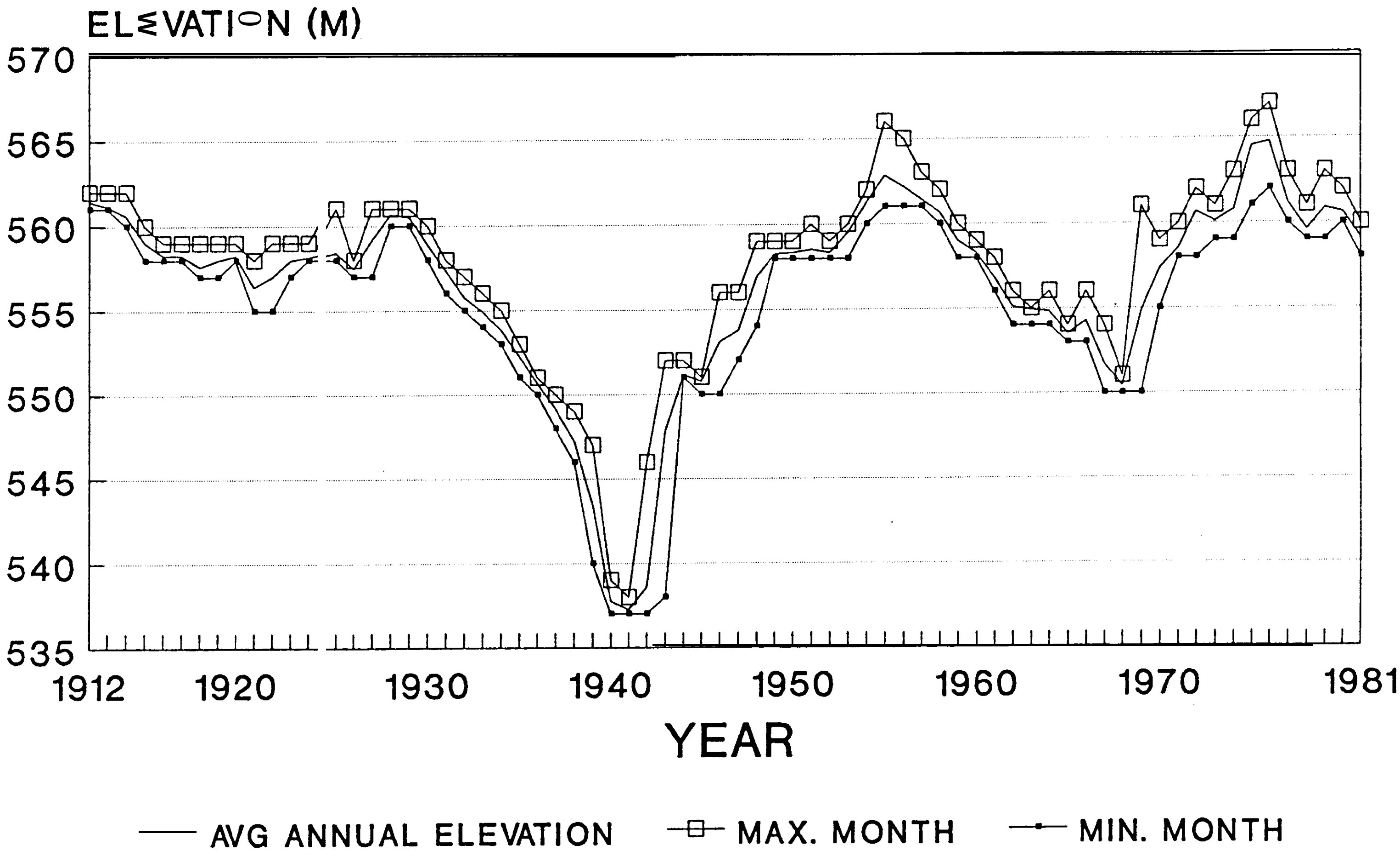


Figure 4.4 Average Annual Alameda Reservoir Levels



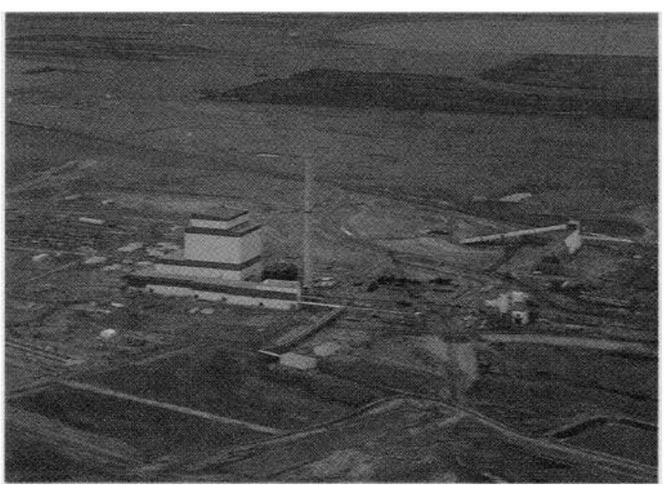
It is important to note that the highest priority objectives for the Rafferty-Alameda Project, namely meeting international requirements, flood control and cooling water supply for the Shand, will be consistently satisfied. Whether lesser objectives are met depends on whether the reservoirs are near empty, as in their'initial filling phase, or nearer to being full, as is intermittently expected to be the case in the operational phase.

During the initial filling period, no new irrigation withdrawals will be allowed until the reservoirs have reached a specific depth (542.0 m for Rafferty and 551.7 m for Alameda). The rate at which new irrigation allocations will be accepted cannot be specified until the filling sequence starts and the actual amount of water flowing in is known. It is expected that because of the size of the-reservoirs and the average flows into the Souris basin, the filling period will be relatively long, about 18 years for both the Rafferty and Alameda reservoirs. There is considerable uncertainty associated with the duration of this filling period. Potentially, filling the reservoirs could take only a few years, but there is an equal potential for it to take more than 30 years.

During this period of filling, it might not be possible to meet many-of the objectives. The reservoirs will thus be operated only-for apportionment, flood control and the supply of water for the Shand Power Station. Some additional uses will likely be considered as filling continues, but it could be a long time before any adjustments in operating strategy can be made.

Once filled, the reservoirs will be operated to meet the Project objectives in order of priority. During dry years, the reservoirs will be drawn down to meet apportionment and cooling water needs and to provide storage space for flood control. Natural mechanisms such as evaporation and groundwater infiltration will further decrease levels. The result could be a continuing multi-year drawdown.

As the reservoir levels continue to fall during a series of dry years, the reservoirs could lose their attraction as areas for recreation. Episodes of low reservoir levels could be very lengthy, possibly exceeding 10 years. The setting of priorities could thus have disadvantages in terms of recreation and aesthetics.



Shand Power Station, April 1991 (photo credit: R. Riewe).

4.2 Ability to Meet the Objectives

The Panel is of the opinion that some of the objectives, especially those listed under priorities III and IV, may be difficult — if not impossible — to achieve on a regular basis. This will be particularly true during drought. Authorities then will have to make some difficult choices.

The likelihood of meeting the various objectives will reflect the tradeoffs made between the various uses. Changing the priorities will change how frequently objectives are or are not met.

In terms of the Panel's understanding of the priorities, it estimates the ability of the SBDA to meet the various objectives as follows:

Priority I

1. **Provision of downstream flood control to the City of Minot** — Flood control objectives will be achieved and flood damage will be reduced in North Dakota. There could, however, be some localized flooding downstream of the dams because the level of the reservoir had been dropped quickly to free up storage for flood water. This could happen if there was difficulty in maintaining a winter/ spring flow path under the ice for the pre-release of water.

   Flood reduction cannot be expected further downstream in Manitoba. Most of the flooding there results from tributaries downstream of the Rafferty and Alameda dams. The duration of the flood depends on the nature of the flow. For example, if flood waters are flowing very quickly, the flood will pass very quickly.

2. **Releases for apportionment to North Dakota** — The required releases for international apportionment will have to be met with regularity. In the event of a deficit, the shortfall must be made up in subsequent years if requested by North Dakota. Saskatchewan intends to honour the apportionment requirements.

   The agreement between Canada and the United States specifies that releases "will be scheduled to coincide with periods of beneficial use in North Dakota." This phrase may not be specific, but the co-operation between the three jurisdictions has so far prevented major problems. The ability to meet Project objectives in future will depend on a more precise definition of the release schedules.

   The timing of the releases is very important because this will impact on many other objectives associated with the reservoir operations. For example, releases early in the spring will minimize losses due to evaporation and channel seepage.

Alternatively, if releases are made in the summer, the river flows will be increased substantially thereby improving water quality, aquatic life and recreation opportunities. On the negative side, summer releases will increase reservoir evaporative losses because the apportionment water is being held in storage during that time of year when the evaporative losses are high. There will also be increased evaporative and seepage losses from the increased flows in the rivers. Water quality in the river at the border may be reduced due to algae growth. No matter when apportionment waters are released, there will always be some advantages and some disadvantages associated with that timing.

3. **Provision of water supply for the Shand Power Station** -There will be occasions when water for cooling will not be available for the power station. Groundwater can, however, be pumped for this purpose.

Priority II

4. **Achievement of water quality objectives at the international border** - It is not clear how the agreed-upon water quality objectives can be met. Preference will be given to discharge from the Alameda rather than the Rafferty Reservoir when the opportunity permits because the water quality is expected to be better.

   Historically, there has been a wide variation of the quality of water in the Souris River. Most of the sources of the problems have been un-ionized ammonia, phosphorous and, periodically, dissolved salts. The occasional reduction in water quality has been tolerated in the past, in spite of the resulting imposed limitations on water use.

Priority III

5. **Provision of water for waterfowl habitat** — The enhancement of waterfowl production in the reservoir requires a steady water level between mid-April and mid-June. It is unlikely such steady water levels can be provided on a regular basis. Consequently, the waterfowl production in the reservoirs will be lower than before the Project was built.

6. **Provision of water for irrigation** — According to the SBDA, irrigation targets will not be met all of the time. Deficits of 50 per cent or more of demand will occur in 3 out of 10 years. In only 4 to 5 years out of 10 will the irrigation demand be fully met. These are average values. Individual farmers can expect higher or lower accessibilities to irrigation water depending on other factors, such as water levels in the reservoir, timing at the release of apportionment waters, etc.

Priority IV

7. **Management of reservoir levels to enhance fish populations in the reservoirs-The** most favourable environment for fish would be obtained by keeping the reservoir levels relatively stable. The operating procedures recognize that this should be attempted.

8. **Maintenance of reservoir levels to enhance reservoir recreation** — This objective will only be met as a result of meeting higher priority objectives, such as apportionment.

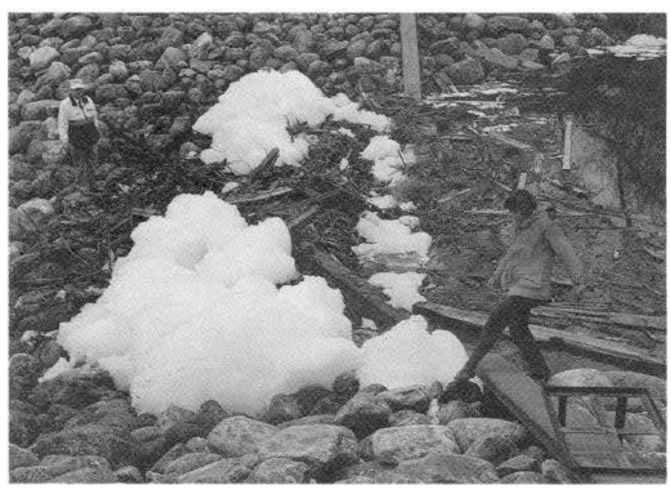
9. **Enhancement of water quality downstream from the reservoirs in Canada** -Stretches of the rivers immediately downstream from the reservoirs will be impacted negatively because of the inferior quality of the water being discharged from the reservoirs. (This point is discussed further in Section 5.2.) Water will not be released specifically to improve water quality further downstream, but downstream water quality could improve if the flows are increased during the summer for other reasons.

10. **Maintenance of summer river flow levels in Canada to enhance recreation -As** in the case of (9), this objective can only be met as a result of trying to meet higher priority objectives such as apportionment.

11. **Maintenance of a minimum critical flow beneath the ice cover to allow better passage of late winter pre-flood releases** — This action will occur when the reservoir levels are high and the winter snow-pack is thick. It is an experimental procedure and there may be difficulty in achieving the desired results.

In summary, it is apparent that meeting the primary objectives will limit operations. The secondary objectives can be met only when the. availability of water permits. There is considerable uncertainty as to the frequency of meeting the lower priorities.

Existing municipal, irrigation, wildlife and recreational demands could be rationed during a series of low-flow years. The residents in the basin should be made aware that such rationing could occur.



Woodlawn Park, Estevan, Saskatchewan: the impacts of releasing sewage effluent into the Souris River
(photo credit: R. Riewe).

5.0 NATURE AND AREA OF PROJECT IMPACTS

In this chapter, potentially significant impacts of the Project are reviewed and evaluated. Impact predictions and conclusions reached by the Souris Basin Development Authority (SBDA) and Environment Canada are summarized. The observations, conclusions and opinions of the Panel are then presented. The discussion is organized under the general headings of hydrology (i.e., water quantity), water quality, fisheries, upland wildlife, waterfowl, rare species, land use, mineral resources, recreation, and social and cumulative impacts.

The adverse impacts herein discussed are considered potentially significant and to warrant mitigation. The significance of the impacts is explained and, where possible, the discussion identifies whether impacts result from construction, reservoir filling, drawdown or downstream releases.

There is much uncertainty surrounding the prediction of impacts. The many sources of uncertainty include climatic variability, a scarcity of descriptive information or data on aspects of the study area, and a base of scientific knowledge that is both incomplete and unreliable.

5.1 Hydrologic Impacts

Most of the hydrologic impacts of the proposed reservoir system relate to project objectives, and accordingly were discussed in Chapter 4. Like those impacts, hydrologic impacts presented here are largely determined by the operating policies of the proposed reservoir system.

5.1.1 Impacts Identified by the SBDA

With the Project in place, maximum flows resulting from snow melt in the early spring will be reduced downstream of the dams. Flows will be increased in the late spring as the reservoir levels are lowered. There could also be elevated flows during the summer and the fall. It is difficult to predict the impacts on flow levels during the summer and fall when there is such uncertainty about the apportionment discharges.

The SBDA's Water Management Plan imposes further restrictions on the reservoir levels between June 1 and August 31, presumably to improve summer recreational opportunities. During this period, the water levels in Rafferty are not to be drawn down more than 1.5 m and the water levels in Alameda not more than 2.0 m. The June 1 reservoir levels will, however, exhibit considerable year-to-year variation over the long term.

In addition to the features of reservoir and flow fluctuations, other hydrologic impacts of Rafferty and Alameda reservoirs have been acknowledged by the SBDA. These include:

- During the periods when Rafferty reservoir levels are low, the cooling water requirements for the Shand Power Station will be met by the pumping of groundwater from the Tableland aquifer. There is uncertainty about the regional groundwater impacts that could result from large-scale pumping.

  There will also be impacts on groundwater levels due to seepage losses from Rafferty Reservoir. The nature of this interaction is not fully understood.

- Water levels at the new Dr. Mainprize Regional Park will fluctuate by as much as 5 m. Under these circumstances it will take considerable effort to establish and maintain attractive beaches.

5.1.2 Impacts Identified by Environment Canada and Manitoba Natural Resources

Operation of the reservoirs will significantly reduce spring flows (from April to June) in Manitoba during average or near-average flow years. Flows in summer months are expected to increase.

During low-flow years, summer flows into North Dakota and Manitoba will decrease. This is due in part to the natural evaporation from the reservoirs and rivers, in part to increased irrigation and in part to the evaporation of cooling water at the Shand Power Station.

5.1.3 Panel Observations and Conclusions

Other hydrologic impacts identified by the Panel, and others, include the following:

- Water will be diverted from Boundary Reservoir to Rafferty Reservoir to provide improved storage control at Rafferty for Long Creek flows. This diversion could adversely impact the freshening of Estevan's water supply. On the other hand, pumping from Rafferty to Boundary Reservoir could improve Estevan's water quality.
- Downstream of the reservoirs, there will be a substantial reduction in the spring flows. This will reduce the scouring effect of the river and may adversely impact water quality and the growth of aquatic plants.
- Shoreline erosion is not expected to be a problem in Rafferty Reservoir, but the potential for a problem of this sort resulting from rapid drawdown at Alameda does exist.

The Panel concludes that water quantity available to North Dakota will be reduced. It assumes that North Dakota has taken this loss into consideration in its reservoir operating procedures. In low-flow years, there may also be a significant reduction in summer flows reaching Manitoba.

It would have been preferable had the SBDA reproduced the statistical structure of the historical flow record when producing its predictive models, rather than merely repeating the historical flow record. The approach used by the SBDA does not take into account the streamflow sequences.

The efficiency levels at which the various objectives were met in the SBDA computer modelling analyses are considered to be optimistic. Lower efficiencies are more likely because human management is not as precise as "computer management".

The Panel is aware of the controversy surrounding the phenomenon of global warming and acknowledges that its impacts on the Project cannot be reliably predicted at this time. The Panel hopes that as more information becomes available the Project's operating policy will be adjusted accordingly.

5.2 Water Quality Impacts

The impoundment of water behind a dam results in a complex set of interactions. This fundamental change in the flow regime of the river impacts the water quality both within and downstream of the reservoir. Changes in water quality will affect all water uses including rural, industrial and municipal water supplies, livestock watering, irrigation, fishery, wildlife and recreation. The extent of water quality changes will determine whether a water use is impacted or stopped.

The following discussion identifies the more significant water quality impacts of the Project as they relate to reservoir filling, reservoir operation and downstream effects. The SBDA's conclusions are first evaluated and then those of Environment Canada and others. These are followed by the Panel's conclusions.

5.2.1 Impacts Identified by the SBDA

The SBDA carried out a series of analyses to predict the nature and extent of water quality changes in the river downstream and in the reservoirs. The SBDA applied water quality models to predict the impacts. Modelling, even in combination with professional judgement, has important limitations relating to:

- The assumptions made in characterizing of the flow regime;
- Defining the operating regime;
- Characterizing water quality data and processes from the historical data; and
- The capabilities of the model.

The SBDA expects water quality to be generally suitable for all intended uses. Filling during low-flow periods, however, will result in less satisfactory water quality conditions in both reservoirs than if the reservoirs were filled during periods of high flows.

Studies indicate that reservoir soils will release plant nutrients and salts during the filling period which, in turn. will cause relatively small increases in concentrations of such substances in the reservoirs.

After the initial filling period, concentrations of heavy metals, biocides and bacteria in the reservoirs are expected to be low, as they are in other Saskatchewan water bodies. A reduction in local or periodic water clarity is expected during run-off and during high winds, particularly for Rafferty. The SBDA has concluded that local run-off and contamination from mine spoil will be minor and can be effectively mitigated.

As in other reservoirs in the region the nutrients, phosphorus and nitrogen, released from inundated soils will cause an increase in the growth of aquatic plants. The higher densities of algae in Rafferty Reservoir than in Alameda Reservoir may periodically limit recreation potential and livestock watering.

There will be other impacts associated with nutrient-rich reservoirs. Algal blooms will develop to nuisance levels and could cause odour problems. Aquatic plants that die will sink and add to the organic material in bottom sediments. As this organic matter decays, it removes dissolved oxygen and releases nutrients into the water. In some years, the build-up of oxygen-poor waters that are high in un-ionized ammonia will kill fish.

The natural process of aeration caused by turbulent mixing from waves and currents can prevent the creation of oxygen-poor zones. Aeration does not occur under ice cover in winter or in summer when the water becomes stratified. The SBDA concluded that Alameda Reservoir would stratify almost every year when the reservoir is full or close to being full. This would result in a level of cold bottom water averaging 6 m thick. Rafferty Reservoir is expected to stratify in approximately 25 to 50 per cent of years. This will tend to occur when the reservoir is nearly full, when water quality is generally better. Summer stratification and the development of oxygen-poor bottom waters will not occur when reservoir levels are low enough to allow turbulent mixing to the bottom.

The SBDA did not expect low dissolved oxygen conditions to impact the fishery in summer. Winter oxygen conditions in Rafferty Reservoir will result in fish kills in 1 in 10 years. This frequency is similar to that of Lake Darling, North Dakota. The SBDA concluded that the oxygen conditions in the reservoirs will usually be adequate for fish.

Runoff and how the reservoirs are managed will affect the levels of dissolved salts. A series of low-flow years will result in low water levels and increased salinity; high-flow years will result in high water levels and decreasing salinity. Because of its larger surface area, Rafferty Reservoir will have a higher evaporation rate. Its salinity, therefore, is expected to be higher and more variable than that of Alameda Reservoir. The average salinity levels will be suitable for municipal/ domestic supply and non-restricted irrigation.

Mercury in inundated soils becomes biologically active (it is converted to a methylated form). It is concentrated through the food chain, eventually accumulating in fish tissues. Mercury was not detectable in Alameda Reservoir soils. Mercury levels in Rafferty Reservoir soils were within typical background levels. Consequently, mercury contamination in fish tissues in the Rafferty Reservoir and Alameda Reservoir is expected to be typical of the region (e.g., Cookson Reservoir). The effects are not expected to be extreme and will disappear as the reservoirs age.

The release of water with low oxygen and high un-ionized ammonia from the bottom of a reservoir could create a zone of impact below the dam. The impact would be mitigated if the water were to be aerated at the spillway through the addition of dissolved oxygen and nitrification of ammonia. How the reservoirs are managed and the timing of water release will also affect the degree of downstream impacts. The downstream reach of Rafferty Reservoir will be more affected than the downstream reach of Alameda Reservoir.

Releases in late winter and late summer will have lower oxygen and higher un-ionized ammonia levels than at other times; thus, releases during these periods will be avoided. Water will be released in late winter only to create storage in anticipation of flood flows. High-flow releases in late summer will only be required if widespread, extreme run-off conditions develop. Water quality downstream of Rafferty Reservoir will be most affected by late winter releases of poor quality water. Late winter releases from Alameda Reservoir would be of higher quality because the water outlet is located at a higher level. The SBDA concludes that the area of impact will be small and the impacts on fish minimal.

The SBDA concluded that reservoir processes and mixing will cause changes in water quality from inflow to outflow. Generally speaking, the variability in the outflow water quality parameters will be less than for the inflow waters. Some variability will be reintroduced by water sources downstream of the dams. The SBDA predicts generally improved conditions because of increased summer releases. Increased summer releases should also improve downstream aesthetics. Downstream concentrations of heavy metals, biocides and bacteria are expected to be low. Salinity downstream of the reservoirs will reflect the salinity in the reservoirs. Salinity will generally decrease during summer-fall periods and winter conditions will be essentially unaltered.

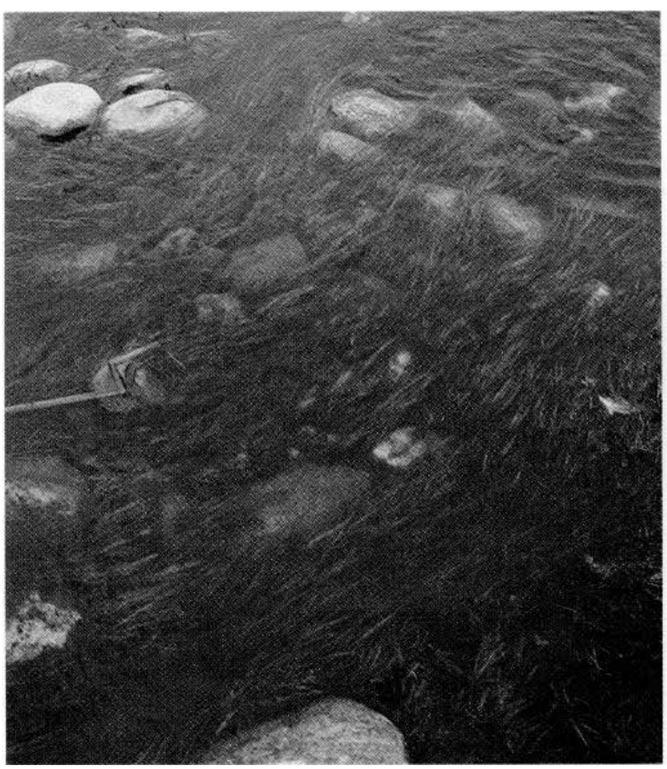
Water quality downstream of the junction of Moose Mountain Creek and the Souris River will reflect a combination of the water qualities of the two reservoir releases and of the additional run-off and in-stream biological processes. At the North Dakota border, total dissolved solids and boron will be higher in the spring, but lower in summer and fall. Nitrogen is expected to stay at levels similar to those of the past, but phosphorus could decrease. Nitrification will reduce concentrations of un-ionized ammonia below toxic levels before the water reaches the international border. The SBDA concludes that important water quality characteristics will not be adversely impacted at the Saskatchewan/ North Dakota border; there may even be some improvements.

The SBDA determined that water quality impacts from the Project are difficult to identify in North Dakota and Manitoba because of the effects of the system below the reservoirs, including the operation of Lake Darling, the J. Clark Salyer National Wildlife Refuge and sewage disposal at Minot.

5.2.2 Impacts Identified by Environment Canada

The Project review by Environment Canada attempted to define more thoroughly impacts within North Dakota and Manitoba. The review reached several different conclusions from those reached by the SBDA. One of the most important is that the downstream zone of impact from the release of anoxic water could extend to North Dakota under worst case conditions.

Also, in North Dakota, the operation of Lake Darling and the J. Clark Salyer National Wildlife Refuge would have to change in response to reduced flows. These changes may require that water levels be reduced in Lake Darling to maintain adequate levels in the refuges. Lower water levels, higher nutrient levels and gradual sedimentation in Lake Darling could lead to a major increase in the incidence of winter fish kills. Lower water levels and the accelerated growth of aquatic weeds may also increase the potential for botulism outbreaks in waterfowl.



Excessive plant growth in the Souris River near Dr. Mainprize Regional Park (photo credit: R. Riewe).

Lake Darling, North Dakota, April 1991 (photo credit: R. Riewe).

Environment Canada concluded that flow reductions during years of normal low flow would aggravate an already poor water quality situation in the Souris River. Recreational uses and the fishery would be adversely impacted by increased incidences of reduced dissolved oxygen, toxic concentrations of un-ionized ammonia and nuisance levels of plants.

In years when water levels in the Rafferty and Alameda reservoirs would be decreased during late winter or early spring in anticipation of flood flows, the level of Lake Darling will also have to be reduced. The water released from Lake Darling could be anoxic and kill fish wintering in Manitoba waters.

5.2.3 Panel Observations and Conclusions

In reaching its conclusions, the Panel was aware of the limitations of some of the impact prediction techniques. The uncertainty resulting from these limitations can only be clarified through appropriate monitoring during the life of the Project.

The Panel observed that the SBDA did not systematically address the problem of uncertainty associated with its impact prediction techniques. In general, its Environment Impact Statement (EIS) and related documents lacked any indication of the frequency and magnitude of possible extreme water quality conditions. An example of this is the SBDA's assessment of the reliability of water supplies for downstream irrigation.

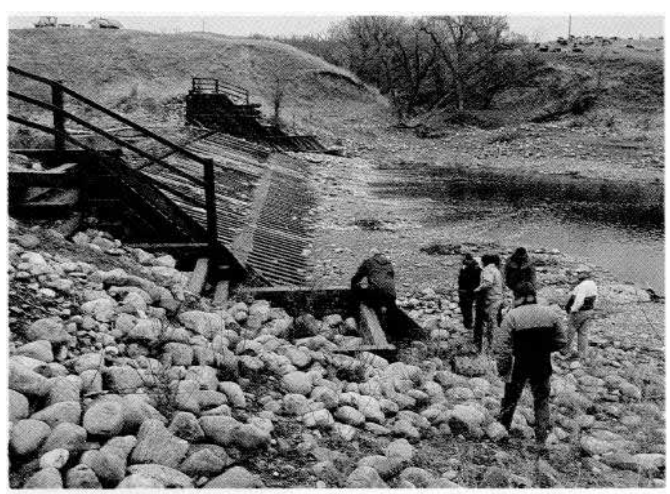
The basic component of the SBDA's water quality modelling is the characterization of flow. The historical natural flow records provide a basis for analysis. However, assumptions are required about hydrological effects, future uses and operating regimes. The uncertainties in the calculation of precipitation, evaporation and groundwater recharge/ discharge in defining the hydrological effects and uncertainties in the operating regimes have resulted in uncertainties in the water quality predictions.

The SBDA used an initial screening model to identify major issues for further study. It used a second model to study the extent of the impact. Additional models based on observation and experiment were used to predict the nutrient levels and oxygen deficit within the reservoirs. The use of professional judgement throughout the modelling was necessary and appropriate; the proponent combined its expertise with the opinions of others to strengthen its assessment.

Models using input data compiled over several years are very difficult to work with. This is particularly true of the Souris River which has extreme variability: it has had zero flow at various times during its history. In addition, many of the factors defining rate processes in the model were derived from river systems other than those within the Souris River basin. This increased the uncertainty of the results.

Despite these limitations, the water quality models provided a useful simplifying tool in the prediction of impacts on an extremely complex biological system. With the limitations associated with water quality modelling techniques in mind, the Panel reached the following conclusions:

- The inundation of soils is expected to increase levels of salinity, nutrients and mercury in the reservoir waters, as has occurred in other reservoirs in the region. The extended period required to fill the reservoirs could extend the duration of these impacts. Mercury contamination of fish tissues could impact human health if the fish are consumed. Mercury could also contaminate fish-eating birds. When reservoir levels are low, salinity extremes could limit some irrigation uses, although the use of water for irrigation at these low levels could already be limited by water quantity.
- The Panel expects that the high nutrient levels in the reservoirs will impact on aesthetics when algae decay causes odour. There may be additional aesthetic problems if algal blooms accumulate along shorelines by wind action. Both winter and summer fish kills could occur, but the frequency of kills is uncertain.
- Upstream weirs, including the weir at the new Dr. Mainprize Regional Park which limits water level fluctuation to 5 m, could promote algae and weed growth to densities greater than those predicted in the water quality modelling. The existence of the weir could also increase nutrient concentration and algae growth upstream of the weir.
- The water quality downstream of the reservoirs is expected to improve during the summer provided more water is released during that time. However, fisheries could be impacted by anoxic water releases immediately downstream of the dams at those times. The extent and duration of this impact cannot be accurately defined.
- The quality of pre-flood releases is expected to be poor.
- Uncertainties of predictions of water quality downstream in North Dakota and Manitoba make conclusions difficult. Operational adjustments required in North Dakota in response to the new flow regime will affect downstream users in Manitoba. The dissolved oxygen and un-ionized ammonia could impact the fishery. The extent of these impacts cannot be defined.
- Uncertainties of predictions and extremes of conditions dictate caution. Defining and implementing mitigation measures is crucial. The measures will also have to be monitored through a long-term program.



Panel tour of the weir at Oxbow, Saskatchewan, April 1991 (photo credit: R. Riewe).

5.3 Fisheries

Some fishery impacts have already been identified in association with water quality impacts (see Section 5.2). This section discusses the full range of habitat features that sustain fisheries.

53.1 Impacts Identified by the SBDA

The impacts which the SBDA predicted as a result of the operation and maintenance of the two dams and reservoirs are as follows:

- In Saskatchewan, the gains in habitat associated with the reservoirs are expected to offset the losses of river habitat. No net loss of fish habitat is expected.
- The seasonal movement of fish will be blocked.
- River habitat between Rafferty Dam and Dead Lake (primarily weedy pike-spawning habitat) will be lost.
- Summer stratification will cause the periodic occurrence of fish kills due to oxygen depletion and anoxia in reservoir waters. Algae die-off and decay and organic materials under the ice in winter will also cause fish kills.
- Mercury concentrations in the water and in fish are expected to increase for some time after the reservoirs are flooded.
- Habitat between the Rafferty Dam and Estevan will be lost as a result of channelization and stabilization of the river.

5.3.2 Impacts Identified by Environment Canada and Fisheries and Oceans Canada

Environment Canada concluded that fish kills within the Rafferty Reservoir could also occur in the late summer and early fall when water levels are low, particularly during periods of hot, calm weather.

Fisheries and Oceans Canada identified some residual impacts following implementation of mitigation measures proposed by the SBDA. A decline in the quality of fish habitat and in fish populations is expected in Lake Darling and in the Souris River downstream of Lake Darling. In Manitoba, northern pike and yellow perch spawning success is expected to decrease if the quality and quantity of Souris River water declines as a result of the operation of the Rafferty and Alameda reservoirs, and if no mitigation is implemented. This appears to be particularly true if average and near-average flows are reduced as much as the SBDA's data indicate.

5.3.3 Panel Observations and Conclusions

Major impacts on fisheries will likely be the blockage of fish movements, the inundation of river habitat, the creation of reservoir habitat and the alteration of flows downstream of the two reservoirs.

Moose Mountain Creek — Biologist investigating fish movement during spring run-off (photo credit: The SBDA).

The principal impact on the Souris River fishery involves the replacement of 57 km of important river habitat with lake habitat. Spawning sites for northern pike and yellow perch will be inundated above the Rafferty Dam. Channelization below the dam will eliminate additional spawning habitat for these species. Once the Rafferty Dam is in operation, it will disrupt upstream fish migrations that occur during years of high flow.

The lake created behind the reservoir could conceivably more than offset river habitat losses. This will depend in large part on water quality and the water level fluctuations of impounded waters. The onset of any habitat benefits will depend on the length of time required to fill the reservoir. There is considerable uncertainty regarding the quantity and quality of reservoir waters (see Section 5.2).

High nutrient levels could cause periodic fish kills. The need to reduce reservoir levels during stretches of dry years could seriously limit available habitat for reservoir fish. Much of the fisheries management activity, therefore, could centre on recurring efforts to renew depleted fish populations.

There is also concern that changes in water quality and flow volumes will affect fish habitat in Lake Darling, and the Souris River in Manitoba. Reductions in water supply, changes in water quality and alteration of flood peaks could reduce pike-spawning habitat in Manitoba. The frequency of summer and winter fish kills could increase.

The Panel feels that insufficient attention has been given to the harmful impacts that long-term water level fluctuations and the potentially long filling period could have on fisheries development. An additional and possible major negative impact is that the loss of the Lake Darling fishery implies loss throughout the system. There is considerable evidence that fish stocks throughout the basin are replenished from Lake Darling.

5.4 Wildlife and Vegetation

5.4.1 Impacts Identified by the SBDA

The EIS prepared by the SBDA identified the following impacts relating to waterfowl, upland wildlife, and rare bird and plant species.

Waterfowl

- The proposed reservoirs will result in the loss of some breeding waterfowl habitat.
- Because of fluctuating water levels, any residual waterfowl production could be less than optimal.
- The reservoirs will provide secure rearing habitat for duck broods produced in the uplands.
- The channelization of a 16-km stretch of the Souris River downstream of the Rafferty Dam will result in minimal losses of waterfowl.

Upland Wildlife

The SBDA indicates that the inundation of reservoir lands could result in the following impacts on upland wildlife:

- In the Rafferty Reservoir area, 1,676 ha of critical white-tailed deer habitat will be lost. Both reservoir areas were used intermittently by white-tailed deer. For example, in the winter of 1989, only 17 per cent of the Rafferty deer population used the flood plain and only 9 per cent of the Alameda population used the Moose Mountain Creek basin. It appears that during years of heavy snow-pack, deer used the valleys but, in more open winters, they foraged on the uplands.
- Critical sharp-tailed grouse habitat (5,015 ha) will be lost in the area. This is a mobile species that can adapt to both lowland and upland environments, particularly, if the lowland areas provide additional food from cereal crops. An important habitat feature for the sharp-tailed grouse are leks (dancing grounds) where essential spring courtship displays take place. It is known that the same sites are used year after year. Whether the loss of specific sites has a lasting negative impact on productivity is not known. Leks located in the reservoir areas will eventually be destroyed by inundation.
- Critical ring-necked pheasant habitat (1 ,195 ha) will be lost in the Rafferty Reservoir area. The ring-necked pheasant is not a native species. It was introduced to enhance hunting opportunity for local residents. Pheasant is common on farm lands where cereal crops provide food and where shrubbery, hedges, marsh edges and irrigated fields provide cover. Thus, pheasants are not exclusively a valley species but are equally adapted to farms or haylands situated on the uplands. Flooding of the reservoirs will cause some loss of pheasant habitat but the impact is considered minor.
- The inundation of the flood plain will negatively affect species such as the threatened ferruginous hawk and the Baird's sparrow. The Project area is located at the eastern limit of the range of the threatened ferruginous hawk. Only one active nest of the species was found in the Souris basin; none was found in the Moose Mountain Creek valley. In total, 20 raptor nests were found in the Rafferty Reservoir area. Some foraging areas associated with 12 nests could be lost to flooding. The Baird's sparrow is a relatively uncommon species in the area. It inhabits dry slough bottoms and tall grassy pastures, haylands and north-facing slopes. Filling the reservoirs will eliminate some habitat used by the birds. The fenced, grassy buffer strips surrounding the reservoirs and the wildlife mitigation lands will probably be suitable replacements.

Rare Plants

According to the SBDA, 36 provincially rare plant species are found in the general area of the Souris River and Moose Mountain Creek. Of these, 14 species are also considered rare throughout Canada. Ten rare species, of which six are also found in the inundation area of the Rafferty Reservoir, grow in the area to be flooded by the Alameda Reservoir. The rare plants growing within the reservoir areas will be lost as filling of the reservoirs proceeds. Local population of all these plants, however, are also found in the general area outside the inundation area.

5.4.2 Impacts Identified by Environment Canada

Environment Canada in its Initial Environment Evaluation (IEE) and subsequent review documents concluded that:

- The river habitat along the Souris River and Moose Mountain Creek will be inundated by the reservoirs behind the Rafferty and Alameda dams, and its waterfowl production lost.

  The new reservoirs are not expected to provide substantial areas of shoreline breeding habitat. The shorelines along much of the reservoirs will be subject to wave, wind and ice action. They could be actively eroding for many years, limiting the development of the aquatic vegetation necessary for brood rearing. Some areas of valuable habitat could, however, develop at the upstream ends of flooded coulees and tributaries.

  Lower water levels in the two wildlife refuges on the Souris River in North Dakota will significantly affect their management. In the most severe low water years, migratory bird habitat could be reduced by 65 to 95 per cent. Waterfowl productivity could be reduced by up to 80 per cent. Lower water levels will also accelerate the growth of noxious weeds. Incidences of avian botulism are expected to double. Worst case reductions in productivity in the absence of mitigation are estimated to be almost 22,000 ducks annually. Additional losses could result from more frequent botulism outbreaks.

  Some birds produced in the United States move into Canada before fall migration or return to Canada to breed in subsequent years. It is estimated that the indirect worst-case losses to Canada from reduced waterfowl production in North Dakota could total 4,400 ducks annually. Reduced opportunities for waterfowl hunting in North Dakota are expected as a result of attracting migrating waterfowl to the Rafferty and Alameda reservoirs, and away from their usual migratory patterns.

- Waterfowl populations may suffer increasing hunting mortality during fall staging as waterfowl which would normally stage over a large area will concentrate in and around the Rafferty and Alameda reservoirs. This will result in increased hunter success and, consequently, in fewer breeding pairs returning. Fewer birds will remain for North Dakota.

- In an international context, the total losses are substantial and significant and, if not fully mitigated, would seriously jeopardize the success and credibility of the North American Waterfowl Management Plan (NAWMP) in the prairie pothole region of the continent.

- Project-related losses are not expected to be significant in the Manitoba reaches of the Souris River because this area is not considered to be an important waterfowl breeding habitat. However, further information is required to substantiate this prediction.

Waterfowl staging area in North Dakota (photo credit: U.S. Fish and Wildlife Service).

Environment Canada has also identified the following impacts on rare, threatened and endangered species.

The Souris River drainage basin provides habitat for 19 species of plants that have been identified as rare in Saskatchewan and in Canada. Most of these plants are located at the extremity of their range. Most are widely distributed in the eastern hardwood forests and the former tall-grass prairies of the American Midwest. The Project could affect these rare plant species through four mechanisms: flooding and drowning out, suppression of the occasional spring flood of all or much of the valley bottom, irrigation of terraces and valley bottom flats, and construction activities.

Any adverse impacts that would result in a reduction of plant species within Canada should be viewed with concern. A reduction in numbers of a given species, below some minimum value, lessens genetic diversity. With decreasing genetic diversity, a species becomes less and less able to adapt to environmental changes and could eventually become extinct. In a more direct sense, in a small population, flowers have less chance of being pollinated and hence of setting seed. Elimination of the species in local areas could result.

In general, vegetation impacts will result from the inundation and the loss of habitat, and from the reduction of spring flooding of downstream valley bottoms affecting riverside woodlands. A reduction in spring flooding could adversely affect vegetation downstream of the Rafferty Dam. Impacts would be caused directly by a reduced water supply for flood plain species or, indirectly, by reduced water for local aquifers which feed back soil moisture to the flood plain during the summer. If irrigation projects are developed on the flood plain, then the natural vegetation will be cleared, and rare species and their necessary habitat will be lost.

5.4.3 Panel Observations and Conclusions

Waterfowl

The Rafferty Reservoir will flood 57 km of river waterfowl habitat on the Souris River, and the Alameda Reservoir will flood 24 km of river habitat along Moose Mountain Creek. Additional works impacting waterfowl include channel modifications below Rafferty in which the first 8 km will be bermed, and the river channel straightened for an additional 8 km.

Waterfowl production from both basins will be lost, particularly while the reservoirs are being filled. The channelizing of the river below Rafferty will adversely affect waterfowl production. Macdonald Lake and adjacent wetlands will also be lost for waterfowl production due to flooding. The new lake environment of the reservoirs will attract migrating and staging waterfowl. This may present new management problems such as depradation of crops, new migratory patterns and harvesting pressures.

Increased concentrations of methyl mercury, derived from the decomposition of organic vegetation and soils, will increase the risk of contamination to certain types of waterfowl (e.g., diving ducks, fish-eating birds) through mercury accumulation in fish and other food sources. This effect has been demonstrated in other newly created reservoirs in which a great deal of organic detritus has been left in the basins before the reservoirs were filled.

White-tailed Deer

Residents have stated that there were not many white-tailed deer present in the area in the past. No doubt this was because the mule deer -the typical prairie and foothills species -was then dominant, frequenting steep broken terrain, brush lands and river valleys. In contrast, the white-tailed deer is found in open areas, aspen parklands and cultivated areas. The species uses the Souris River and Moose Mountain Creek basins only intermittently as winter habitat. The Panel is of the opinion that, contrary to the SBDA's beliefs, neither the Rafferty nor Alameda Reservoir areas are critical white-tailed deer habitat. It is probable that the filling of the reservoirs will have a minimal effect on the regional population.

Sharp-tailed Grouse

This species is common in the area and favours grasslands and cultivated lands near brush or open woodland. Their use of the flood plain cereal crop lands would be lost as would a number of traditional leks used in spring courtship rituals. Serious impacts on the species, however, are not expected.

Ferruginous Hawk

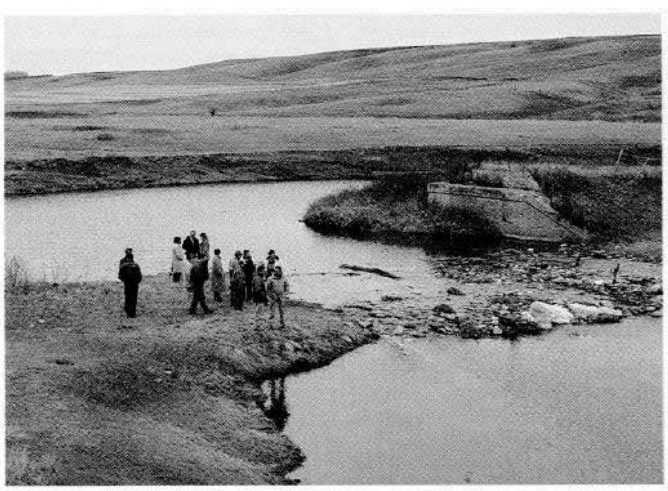
The ferruginous hawk is considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be an endangered species. The Project area is at the eastern limit of its range. In the vicinity of the Souris River basin, 20 raptor nests were found but only 4 of these were ferruginous hawk nests and only 1 was at risk from flooding. No impacts could be determined except for some loss of foraging habitat within the basin.

Baird's Sparrow

Baird's sparrow, listed as threatened by COSEWIC in 1989, is found only in the grassland and parkland areas of the prairie provinces. It prefers areas of long grass for nesting and low shrubs for perching. Flooding will not impact on the bird until the reservoirs are nearly full.

Rare Plants

Filling of the reservoirs will eliminate small, localized populations of 10 plant species which are rare in Saskatchewan. Local populations of all these plants are also found in the general area outside the inundation areas.



Panel tour of Moose Mountain Creek, south of Alameda, April 1991 (photo credit: R. Riewe).

5.5 Land Use

5.5.1 Impacts Identified by the SBDA

The main land uses in the Project area are agriculture and associated activities. The existing transportation system has evolved to support the prevailing land-use pattern.

The natural landscape characteristics have exerted a strong influence on land-use patterns. The undulating to rolling uplands are largely used for crop production and livestock grazing. Many valley slopes, too steep and rocky for cultivation, remain covered by native grassland and shrub. They are typically used for extensive cattle grazing and provide wildlife habitat. The wide flood plain of the Souris River and the valley of Moose Mountain Creek are also used for agriculture. Flood plain soils are irrigated in a few scattered locations. Cereal grains are produced in the upper reaches and hay in the lower, more poorly drained sections.

Cultivation practices will be curtailed over a large area. The Rafferty Reservoir, when full, will inundate 4,900 ha of flood plain lands and the Alameda Reservoir will flood an additional 1,240 ha. The SBDA has purchased 31 quarter sections (2,008 ha) of arable uplands next to the Rafferty Reservoir and 30 quarter sections (1,943 ha) near Alameda Reservoir to provide white-tailed deer and other wildlife habitat. These lands will be permanently removed from cultivation, and permanently covered with vegetation. The loss of about 1,700 ha of community pasture lands caused by filling the reservoirs will be replaced through acquiring an equal amount of arable or pasture lands.

Local hay production (photo credit: The SBDA).

5.5.2 Panel Observations and Conclusions

The permanent loss of about 6,140 ha of flood plain lands through reservoir filling eliminates cultivated acreage, haylands, pastures and productive wildlife habitat, and displaces family farms that have used these lands for many decades. While replacement of particular uses in the flooded area can be attempted, fundamental changes to the landscape cannot be mitigated.

The replacement of wildlife habitat by means of the purchase of 3,950 ha (61 quarter sections) of cultivated uplands near the reservoirs and the replacement of 1,700 ha of community pasture lands will have a further impact on land-use patterns and the socio-economic structure of the farming communities of the area.

Fencing the reservoir lands will bring an end to the current practice of livestock watering from the Souris River and the Moose Mountain Creek. Farmers will need alternative water supplies of equal reliability and without an added cost burden. Filling of the reservoir will also impede access to some fields and facilities for those farm operations with property located on both sides of either reservoir.

5.6 Mineral Resources

The Panel notes that the SBDA has proposed to initially keep the reservoirs filled at a level such that the oil resource within the inundation areas can be fully utilized in both reservoirs.

A number of oil facilities will eventually be inundated by the reservoir, including oil wells, gathering systems and storage facilities.

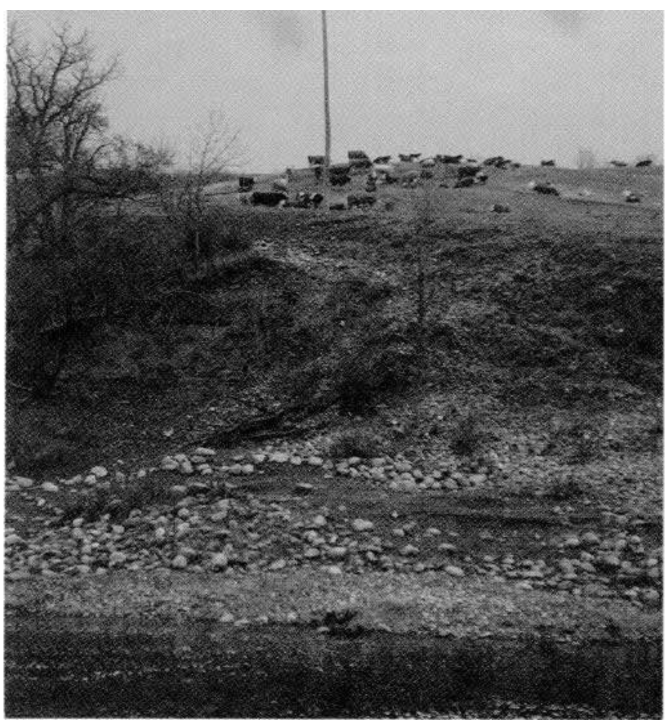
In the Rafferty reservoir eight oil wells which are below 549.5 m will have to be abandoned. If warranted, replacement wells may be drilled from a location above the flood control level.

Twelve oil wells which are above the elevation of 549.5 m but below the flood control level will be raised. The well heads will have to be elevated and the elevated sites will. have to be riprapped and dyked.

Twenty-eight oil wells which are above the flood control level will require containment dykes to contain any potential oil spills.

Two “satellites”, which are oil-gathering systems, will be moved to higher ground.

A number of “flow lines”, which are pipelines that transmit the raw well fluids (called emulsions) from the oil wells to the satellites and then to the treating facilities, will have to be moved.



Site for cattle access to the Souris River
(photo credit: Ecologistics Ltd).

In the Alameda reservoir area, there are three oil wells that will have to be abandoned with the possibility that two additional wells that may have to be abandoned.

There are no capped (abandoned) oil wells affected in the Rafferty reservoir area, but there are three abandoned oil wells in the Alameda reservoir that will have to be re-abandoned in order to conform with the Saskatchewan Department of Energy and Mines standards.

Six pipelines will be affected as well as the Cochin Pipeline Pump Station. In addition, some flowlines might have to be re-routed.

5.7 Recreation

The SBDA identified opportunities for outdoor recreation as a positive impact of the Project. Plans for recreation facilities include the integration of existing parks with new parks on the reservoirs, the relocation and upgrading of Dr. Mainprize Regional Park, public access to the reservoirs for cottaging and other recreation, and the creation of private investment opportunities in cottage subdivisions, tourism and other recreation developments.

Whether recreation benefits are realized is critically dependent on the levels to which the reservoirs are filled and, to a lesser extent, on the achievement of an acceptable water quality within the reservoirs. These restrictions have not been especially evident in the SBDA's studies. Rather, it assumes that the very existence of water will guarantee recreational use of the water body and the shoreline.

The Panel recognizes that there are few water-based recreation areas in southeastern Saskatchewan and that the public is accustomed to less than optimal water levels and water quality for such recreation. The Panel also notes from the Praxis survey that the public has highly optimistic expectations for recreational opportunities on the reservoirs and downstream. These expectations may be difficult to meet due to the likely scarcity of water.

Historically, the Souris basin has been subject to long-term cycles of wet and dry years. These cycles will be reflected in the reservoir levels, (i.e., there will be a series of years during which the reservoir levels are decreasing followed by a series of years in which they are increasing). When low reservoir levels occur, fishery, recreation and aesthetic attributes will be degraded. These adverse impacts can be expected to occur during prolonged dry periods throughout the life of the Project, as well as during the initial filling period of the reservoirs.

At the new Dr. Mainprize Regional Park, changes in the water levels are expected to affect the beach width and aesthetic qualities. The Panel was unable to fully assess the consequences of these impacts on the recreational use of water. In addition, the expectations of recreational users may have been raised to unrealistic levels.

5.8 Social Issues

Chapter 4 identified project benefits related to flood control and water supply. Adverse social impacts include the displacement of households in the reservoir acquisition areas and disruption to normal travel patterns as roads are closed. In its EIS, the SBDA did not acknowledge the personal distress that may be associated with such forced displacement.

Other possible social impacts, both positive and negative, include changes in the lifestyle of the affected communities, changes in emigration rates from the local area, negative or positive interactions between local residents and visitors to the recreation facilities that will be developed, and both long- and short-term economic gains in the region as a result of construction contracts and other economic developments associated with the reservoirs.

The community in general anticipates beneficial social impacts from the Project, as is evident from the social issues survey conducted for the Panel and testimony presented to the Panel.

5.9 Cumulative Impacts

Water and air are the two strongest and most recognizable of the chains which link the global ecosystems. Impacts on any watershed or a part of it are seldom localized; they eventually influence other components of the ecosystem. The Souris River is a tributary of the Nelson River. It is reasonable to expect that some of the biophysical impacts associated with the Project could be transferred to the Nelson-Churchill system and eventually to Hudson Bay.

The Panel appreciates that the notion of cumulative impacts has only recently been recognized and that reliable methodologies have not yet been fully developed and tested. The Panel could not help noticing that neither the proponent nor the intervenors, particularly Environment Canada, dealt with any aspect relating to the cumulative impacts of the Project. The unique circumstances surrounding this review and the resulting constraints left little room for the Panel to undertake a detailed assessment of cumulative impacts connected with the Project. The Panel is, however, convinced that all major development proposals and, especially, major watershed management projects, need to be reviewed with respect to their cumulative impacts. A comprehensive, well-designed and properly implemented monitoring program will be essential for measuring cumulative impacts, judging the adequacy and effectiveness of mitigative measures, and taking appropriate remedial measures.

5.10 Summary of Potentially Significant Impacts Requiring Mitigation

The Panel concluded that the following impacts are significant and require mitigation:

- During low-flow years, summer flows into North Dakota and Manitoba will decrease.

- The extended period required to fill the reservoirs could increase the duration of the water quality impacts resulting from soil inundation. Mercury contamination of fish tissue will impact human and bird consumption of fish.

- The Panel expects that the high nutrient levels in the reservoirs will affect aesthetics if algae decay causes odour problems or if algal blooms accumulate along shorelines.

- Upstream weirs, including the weir at the new Dr. Mainprize Regional Park site, could promote algal and weed growth to densities greater than predicted by the water quality modelling.

- Fisheries could be impacted by anoxic water releases immediately downstream of the dams. The extent and duration of this impact cannot be accurately predicted.

- The quality of water released in late winter or early spring to provide storage space for flood is expected to be poor.

- The way North Dakota responds to the new flow regime will affect downstream users in Manitoba. The extent of resulting impacts in Manitoba cannot be defined at this time.

- The principal impact on the Souris River fishery involves the replacement of 57 km of important river habitat with lake habitat. Spawning sites for northern pike and yellow perch will be inundated above the Rafferty Dam, and channelization below the dam will also eliminate spawning habitat for these species.

- When the Rafferty and Alameda dams are in operation, upstream fish migrations will be prevented.

- High nutrient levels could cause periodic fish kills. The need to draw reservoir levels down considerably in consecutive dry years could also seriously limit available habitat for reservoir fish. Much of the fisheries management activity may, therefore, centre on recurring efforts to renew depleted fish populations.

- Changes in water quality and flow volumes will affect fish habitat in Lake Darling, North Dakota, and in the Souris River in Manitoba. The major impact on fish in these jurisdictions would be caused by (1) reductions in water supply, (2) changes in water quality, and (3) alteration of flood peaks with a resultant loss of pike-spawning habitat in Manitoba. The frequency of summer and winter fish kills could increase in Lake Darling.

- The Panel feels insufficient attention has been given to the harmful impact that long-term water level fluctuations and the potentially long filling period could have on fisheries development.

- Waterfowl production from both basins will suffer losses, particularly while the reservoirs are being filled. The new lake environment will attract migrating and staging waterfowl. This will present new management problems for the area. The channelization of the river reach below Rafferty Dam will adversely affect waterfowl production from pre-Project levels. Macdonald Lake and adjacent wetlands will be lost for waterfowl production.

- Increased concentrations of methyl mercury resulting from the decomposition of organic vegetation and soils will increase the risk of contamination of diving ducks and fish-eating birds through mercury accumulation in fish and other food sources.

- The permanent loss of about 6,140 ha of flood plain lands through reservoir filling eliminates cultivated acreages, haylands, pastures and productive wildlife habitat, and displaces family farms that have used these lands for many decades. While replacement of particular uses in the flooded area can be attempted, fundamental changes to the landscape cannot be mitigated.

- The inundation of oil wells and related facilities in the reservoirs presents a risk of hydrocarbon release from either dyked wells and/or buried pipelines.

- The replacement of wildlife habitat by means of the purchase of 3,950 ha (61 quarter sections) of cultivated uplands near the reservoirs and the replacement of 1,700 ha of community pasture lands will have a further impact on land-use patterns and the socio-economic structure of the farming communities of the area.

- Fencing of the reservoir lands will bring an end to the current practice of livestock watering from the Souris River and the Moose Mountain Creek. Filling of the reservoir will also impede access to some fields and facilities for those farm operations with property located on both sides of either reservoir.

6.0 EVALUATION OF THE PROPOSED MITIGATION AND MONITORING MEASURES

This chapter addresses the Souris Basin Development Authority's (SBDA) and Environment Canada's proposals for the mitigation and monitoring of the potentially significant impacts identified by the Panel. Mitigation and monitoring measures are dealt with separately. Measures are assessed based on their relevance to the impacts, their likely effectiveness and the probability of their implementation in light of known constraints such as agency mandates and resources.

The Panel wishes to state from the outset that the effectiveness of many of the proposed measures cannot easily be assessed. This reflects uncertainties related to the operating regime, the limitations of predictive modelling and the SBDA's reluctance to commit to specific measures. The purpose of the monitoring program is to provide the data so that these uncertainties can be better understood and dealt with in future. The Bilateral Water Quality Monitoring Group and the various jurisdictions will require a high degree of co-ordination, communication and co-operation to fulfil this responsibility.

6.1 Hydrology

The Rafferty and Alameda reservoirs will impact on the hydrology of the Souris River, that is, its rate of flow and how it flows. That is the intended purpose of the reservoir development: flood control, meeting apportionment requirements and the supply of cooling water for Shand Power Station. There are few options for mitigating these impacts beyond adjusting the management of the reservoirs to reflect tradeoffs among the objectives. The position of the SBDA in this respect is to accept the assumption that shortfalls in water quantity will be met by cutbacks in demands, such as in domestic consumption, irrigation withdrawals and recreational opportunities.

To be most effective, this strategy probably requires the development of a comprehensive basin-wide water conservation strategy addressing municipal, industrial and agricultural uses. Elements could include user pay, public education, eliminating the subsidies that promote the uneconomic use and waste of water and conservation.

A general plan entitled "A Water Management Plan for the Souris River Basin" was prepared by the SBDA in 1990 in response to Condition #2 of the Ministerial Approval under Saskatchewan's *Environmental Assessment Act.*

Monitoring water and weather conditions can have a direct bearing on achieving the identified purposes of the dams because such information can be used to refine operations and improve the efficiency of water use. For example, soil moisture levels in agricultural areas can be monitored to provide the basis for an irrigation advisory service for farmers.

6.1.1 Monitoring by the SBDA

The SBDA has proposed monitoring water quantity and quality in the reservoirs and downstream demands to provide guidance in determining when apportionment should be released from year to year. The actual criteria for deciding apportionment releases are poorly defined, however, and the SBDA has not fully specified the priorities that are being given to the various uses.

6.1.2 Panel Observations and Conclusions

The Panel observed that the SBDA has prepared a water management plan for the Souris River basin in Saskatchewan to meet a condition of approval for the project from the Government of Saskatchewan. The Panel notes, however, that this plan is limited to that portion of the basin (one-third) which lies in Saskatchewan. The plan, therefore, does not provide an adequate basis for resolving many of the basin-wide water management problems.

The SBDA's computer modelling of operations calculated a waste of 18 per cent of available water due to uncontrolled spillage during high-flow periods. Since simulated operations are more efficient than real operations, waste could be even higher.

Modelling analyses played a central role in the SBDA's planning and management of the proposed Project. The Panel's comments, therefore, focus largely on modelling requirements. There are a number of opportunities for research that would improve the modelling information that is needed for effective planning:

- Because water is in short supply and the current apportionment requirements reduce flexibility, improvements in flow forecasting are essential to reduce waste that could occur when apportionment requirements are exceeded. Better flow forecasting can also help to reduce pre-flood drawdowns to achieve adequate reservoir and storage capacity.
- Intensive efforts to develop accurate flow forecasts seem warranted. Annual flows appear to have a strong cyclical character; possible causative factors should be examined to help develop long-term forecasts. These would contribute greatly toward improving long-term operational policies.
- Long-term climate change could also have a major impact on hydrologic conditions and water uses in the basin. The water management strategy for the basin should incorporate a long-term view that includes the possibility of climate change. The policy should be adapted to new conditions as they become apparent.
- The method whereby the SBDA reached conclusions about reservoir filling times, and other reservoir and river flow attributes violates important statistical principles. It would be

worth investigating whether a rigorous statistical simulation of streamflows would produce better forecasts about these factors.

- Channel capacity may be inadequate for winter pre-flood releases. Although these releases would be relatively infrequent, experimental procedures for prevention of associated flooding should be explored.
- Interactions between groundwater pumping, sustainable aquifer yield and aquifer recharge from the reservoir are very poorly defined. Additional studies and monitoring of aquifer characteristics should be undertaken.
- Losses due to evaporation and/or seepage are very poorly understood. Further studies in this area should be undertaken.
- Field studies are needed to determine the rate of flow during low-flow periods. The resulting information is critical for water quality and fishery assessments, and for future flow-modelling analyses.

0.2 Water Quality

The mitigation measures proposed by the SBDA are discussed in terms of the reservoir filling period, water quality in the reservoir and downstream effects. This is followed by a discussion of the SBDA's proposed monitoring program. Further mitigation and monitoring measures proposed by Environment Canada are then presented. Finally, the Panel will evaluate the effectiveness of these measures.

6.2.1 Mitigation by the SBDA

The SBDA proposed the following mitigation measures for the impacts associated with filling the reservoirs. Measures to reduce high nutrient levels and methyl mercury contamination caused by the filling of the reservoir include selected removal of organic material, such as trees and brush. The SBDA has already removed some topsoil for use at the new Dr. Mainprize Regional Park golf course. The SBDA will monitor fish for mercury contamination and will issue public advisories when necessary. The SBDA did not propose any measures for mitigating the release of salts caused by filling the reservoirs.

Mitigative measures proposed by the SBDA for impacts associated with the reservoir are discussed in terms of high nutrient levels, erosion, mine spoil and hydrocarbons (i.e., oil wells).

The expected nutrient levels of the reservoirs reflects the naturally high concentrations of nitrogen and phosphorus in the rivers, lakes and reservoirs of the prairie region. Nevertheless, the SBDA proposes to reduce the impact of additional sources of nutrients by means of pollution control measures to be applied throughout the basin. These include:

- Fencing to deny livestock direct access to the reservoirs;
- Wetland development at the mouth of Roughbark Creek;
- Waste management at recreation sites;
- Recycling of Estevan effluent for use as cooling water for the Shand Power Station;
- Urban waste disposal/treatment; and
- Promotion of water conservation in irrigation practices.

Several of these measures will also mitigate bacterial contamination from wastes.

The contribution of soil erosion to poor water clarity and suspended sediments is to be mitigated through the use of construction measures under hydrological conditions that minimize impacts. Land-use controls and maintenance of vegetation above the high water level of the reservoirs will also ease erosion.

The Boundary-Rafferty Diversion Channel was designed to limit contamination from exposed coal seams and mine spoil. The design was reviewed and accepted by the Saskatchewan Department of Environment and Public Safety before construction.

The detailed plan by the Saskatchewan Department of Energy and Mines for abandonment or protection of oil wells, lines, stations and pipelines, and access roads is to prevent contamination of the reservoir by hydrocarbons. The department is a regulatory body. No additional mitigation strategy, other than the department's mitigation standards, has been proposed. In the event of a spill, the nearest oil spill co-operative unit (operated by the oil industry), and the department are to be notified immediately. Oil spill units are located in Estevan and Weyburn.

The operating regime and timing of water releases from the reservoirs will govern the water quality downstream of the reservoirs. Downstream water quality impacts from releasing low level water from Rafferty Reservoir, with its high concentrations of un-ionized ammonia and low concentrations of dissolved oxygen, have been addressed by introducing mechanisms for releasing some surface waters with their higher concentrations of dissolved oxygen and lower concentrations of un-ionized ammonia. This would be done by releasing water over the spillway or pumping it through pipes installed over the spillway. Design features to improve aeration at the outlet structure of both dams and downstream will increase dissolved oxygen concentrations and increase the rate of conversion of un-ionized ammonia to nitrate, a less toxic compound. A high-level outlet with a working capacity of two cubic metres per second will be installed in the Alameda Dam to assure that the best quality water in the reservoir is released downstream. To meet the International Water Quality objectives, releases from Alameda Reservoir will offset some of the potential impacts of releasing poorer quality Rafferty Reservoir water.

New irrigation development, made possible by the Project, may affect water quality by increasing levels of salinity, biocides or nutrients. State-of-the-art irrigation management practices will mitigate these impacts.

6.2.2 Monitoring by the SBDA

The SBDA states that its monitoring program will address limitations encountered during the analysis of impacts. The SBDA has proposed a program which is geared to the construction phase of the Project (nominally to 1993).

In Saskatchewan, water quality is currently monitored at several important locations and covers essential parameters. Within the reservoirs, additional monitoring will include depth profiles for dissolved oxygen, temperature, nutrients and ammonia in the bottom waters.

Future monitoring in North Dakota and Manitoba is undefined, beyond existing measures.

Before construction began, the soils within the area to be flooded by the reservoirs were sampled for their nutrient, salinity, mercury and boron content. During construction, locations downstream of the construction will be monitored.

The monitoring program during filling and reservoir operations is designed to focus on the periods of greatest significance: the inflows during spring snow melt or major rainfall, the diversion channel when in use, and the lower Souris River on a routine basis and augmented during major releases. Reservoir sampling will commence when filling begins.

Existing monitoring programs also include long-term monitoring and municipal effluent sampling. They are being conducted by Environment Canada and the Saskatchewan Department of Environment and Public Safety. Saskatchewan Power Corporation is monitoring the Boundary Reservoir. It is expected that the SBDA will co-ordinate its programs with these other agencies.

6.2.3 Environment Canada Mitigation and Monitoring

Environment Canada identified the need for several additional mitigation and monitoring measures which would have a basin-wide perspective, including North Dakota and Manitoba. First, a basin-wide water management plan with input from all affected jurisdictions was suggested as a basis for co-operation throughout the Souris basin. Environment Canada also recommended that advance notice of changes in flow quantity and quality should be given to downstream users so that appropriate actions could be taken in their jurisdictions. This step was considered particularly important with regard to releases from Rafferty, the wildlife refuges and sewage discharges.

Second, the development of transborder water quality objectives was proposed as an important mitigative measure. These objectives have been defined (see Chapter 4) and the Bilateral Water Quality Monitoring Group has the mandate to address the issue of water quality at the borders.

The Department proposed pollution control for North Dakota and Manitoba to reduce the input of additional nutrients. The pollution control methods would include upgrading the wastewater treatment facility in Minot, and increasing the lagoon capacity and timing of lagoon releases by Manitoba communities.

Environment Canada suggested that the operations of Lake Darling and J. Clark Salyer National Wildlife Refuge be adjusted to reduce high concentrations of un-ionized ammonia and low concentrations of dissolved oxygen downstream. The use of artificial shallow areas and irrigation weirs to enhance aeration of water in locations throughout the river basin was proposed. Additional monitoring in Manitoba was also suggested.

J. Clark Salyer National Wildlife Refuge — Souris River flowing to Manitoba, April 1991 (photo credit: R. Riewe).

6.2.4 Panel Observations and Conclusions

While many of the measures proposed by the SBDA to mitigate the water quality impacts associated with the Project will not be fully effective, the water would be acceptable for various uses. Acceptability is most often determined by comparison of actual water quality to established water quality objectives. These objectives exist in Saskatchewan, Manitoba and North Dakota, and transborder water quality objectives have been established by the Bilateral Water Quality Monitoring Group. The acceptability to users is also affected by their expectations, particularly for recreational uses.

During the filling of the reservoirs, the measures proposed by the SBDA for reducing high nutrient levels, mercury contamination and the release of salts from the soils will only be partially effective. However, no additional mitigation measures are feasible.

Similarly, pollution control measures to reduce the impacts of additional nutrients on the existing nutrient levels in the reservoirs will only be partially effective. Increased nutrient levels can cause algae growth and fish kills. These two factors, in turn, affect fisheries, downstream water quality and the recreational user in three ways. Algae can cause odour problems and accumulate on shorelines and beaches, affecting aesthetics; poor water clarity and weeds could affect swimming and boating; and fish kills affect fishing.

Mitigative measures to contain contamination by hydrocarbons and bacteria are expected to be effective.

References to appropriate and sound practices are made by the SBDA throughout its description of mitigation measures. Some of these measures cannot be assessed because the information provided is not specific in respect to:

- Construction practices to mitigate erosion;
- Irrigation practices to mitigate salinity, nutrient enrichment and biocides;
- Design features of the Boundary-Rafferty Diversion Channel to mitigate impact from mine spoil;
- Design of recreational beaches to mitigate poor water clarity and aquatic weeds; and
- Reservoir operations in North Dakota to mitigate impacts in Manitoba. How these measures are applied by authorities will determine their effectiveness.

The proposed structural measures to reduce the area of water quality deterioration downstream of the dams will not be fully effective. Higher priority water management objectives could frequently require release of lower quality water, particularly during pre-flood releases and in late summer.

The water quality monitoring program outlined by the SBDA is extensive. However, the program should be designed so that it can record basin-wide changes both in the short and the long term. For example, as the number of irrigated acres increases, the monitoring of factors (i.e., salinity) specific to that use will also have to increase. The Bilateral Water Quality Monitoring Group is set up to deal with the interjurisdictional aspects. It has a long term mandate, but its focus is monitoring at the borders. Responsibility for the co-ordination of the monitoring programs in the long term needs to be defined.

The relationship among the agencies responsible for water quality monitoring, interpretation of data and implementation of mitigation measures is unclear. At present, the Souris River Water Quality Objectives and the Bilateral Water Quality Monitoring Group provide framework for monitoring and mitigation. For this framework to be effective, the roles and responsibilities of the different agencies represented by this Group will have to be defined.

When and how the results of the monitoring stations are reported will affect the identification of mitigation needs. For example, the proposed monitoring program is based on data collected from December to November; the last data collection for the report on 1991 monitoring would be in November 1991. The Water Quality Monitoring Task Force reports to the Bilateral Water Quality Monitoring Group on May 1, 1992. The results of the spring 1991 water quality analysis would not be available until after May 1, 1992. Should analysis indicate a need for altering summer flows, there likely would not be enough time to take action in the summer of 1992; action would have to be postponed until 1993, two years after the problem became evident.

The water quality objectives defined for the basin have occasionally not been met in the past. It can be expected that they will not always be met in the future. This failure cannot automatically trigger mitigation measures. There is clearly a need for an objective procedure for defining when non-compliance with the water quality objectives exceeds historically defined limits, thus requiring mitigation measures. The statistical analysis of the frequency, magnitude and seasonal distribution of observed non-compliances is an important tool that can help interpret violations. Annual reviews based on such analyses require sufficient water quality monitoring information to allow for meaningful comparisons. This is especially true in light of the kind of variations that can be created by reservoir and other water management activities.

Better predictive modelling can help to reduce uncertainty in the assessment of impacts. Efforts in this area could focus on:

- Developing a reservoir model capable of predicting the effects of horizontal and vertical mixing;
- Developing a network of issues-related models rather than one all-encompassing model; and
- Collecting data to meet the needs of the model.

Measures may be required in North Dakota to mitigate transboundary water quality impacts:

- Reduced flows into North Dakota will make it more difficult for North Dakota to maintain water quality in Manitoba;
- Pre-flood release of poor quality water from Saskatchewan will impact water quality in North Dakota, but only infrequently; and
- Pre-flood releases of poor quality water from North Dakota will impact water quality in Manitoba, but only infrequently.

Professional judgement must come into play in drawing final conclusions about the impact of the Project on water quality. The best arbiter will be open, unbiased discussion between well-informed participants. The good working relationship between the Water Quality Task Force and the Souris River Bilateral Water Quality Monitoring Group will certainly ensure that all possible efforts will be made to achieve acceptable water quality standards.

The Panel trusts that water management agencies will take project impacts into consideration in setting reservoir operating procedures and will make every reasonable effort to reduce impacts to a minimum.

6.3 Fisheries

6.3.1 Mitigation by the SBDA

The federal *Fisheries Act* requires that projects not cause a net loss of fish habitat. The SBDA has concluded that the Rafferty-Alameda Project will create reservoir habitat of a quality and extent which more than compensates for any loss of river channel and flood plain fish habitat in the inundated areas and any habitat modified by channelization downstream of the dams.

The SBDA's fisheries mitigation proposals focus on improving the quality of habitat available to fish populations in the backwater zones upstream of the dams, the reservoirs and areas downstream of the two dams. The SBDA intends to manage Rafferty as a walleye and smallmouth bass fishery and Alameda possibly for rainbow trout.

The SBDA identified Roughbark Creek below Roughbark Reservoir as a potential spawning habitat for northern pike, provided that water releases are made to the creek during the spring spawning and incubation period.

The SBDA has suggested that channelization downstream of Rafferty Dam will create permanent fish habitat. Dredging and wetland creation will facilitate northern pike and perch spawning activity. Further downstream, proposed permanent low-level irrigation weirs will be designed to specifications that safeguard habitat and assure fish passage during the spring.

The SBDA also proposed other measures:

- Additions to available cover for walleye and smallmouth bass of between 10 and 40 per cent by creating reefs of used tires.
- The viability of walleye eggs from Nickle Lake is to be assessed. The SBDA recommended that either a permanent or mobile hatchery be established at Rafferty Reservoir. One option involves the terracing of borrow pits in Rafferty Reservoir to provide suitable spawning materials when the reservoir is filled to different levels. This proposal assumes that water movement will create clean substrate shoals viable for spawning activities. (During the site visit, the Panel observed finer sediment than is typical of walleye spawning habitat.) The SBDA also suggested the development of rearing ponds along the margin of Rafferty Reservoir for use by both walleye and smallmouth bass for stocking the reservoirs. The weir at Highway 606 could be used for this purpose after the reservoir has been filled to evaluate the performance of these target species before large-scale stocking of the main reservoir. The Highway 606 weir could also possibly provide brood stock for future fishery initiatives. Rock placed on the dam face will be of value for spawning.
- Development of a brown trout fishery downstream of the Alameda Dam if water quality and physical habitat are adequate. Reservoir releases would have to be managed to provide a wetted stream year-round and water temperatures would have to be maintained at or near optimum for brown trout through use of multi-level release structures.
- Removal of existing northern pike and bullhead populations from the Alameda Reservoir area to allow development of a rainbow trout fishery.
- If water quality (temperature, dissolved oxygen) in the inflow to the Alameda Reservoir (Moose Mountain Creek) are suitable for rainbow trout spawning and incubation, a spawning facility for this species could be designed in the creek above the reservoir.
- The population of black bullhead will be controlled by stocking the reservoirs with predators.
- Release of water to the United States in a manner that will improve fish habitat in the Souris River.

6.3.2 Monitoring by the SBDA

The SBDA proposed a number of monitoring activities to be implemented once the Project is in operation. Monitoring is to include:

- Analysis of reservoir water quality to determine whether the target sport fish species of the fisheries management plan are well suited to the water quality conditions that develop in the reservoirs;
- Fish sampling to evaluate productivity and to determine the effectiveness of mitigation measures; and
- Determination of mercury concentrations in fish flesh in the first, third, fifth and seventh years after impoundment.

The SBDA has proposed that monitoring results be used to determine if fisheries management methods or the reservoir operating regimes need to be changed in order to realize the full potential of the reservoir fisheries.

6.3.3 Panel Observations and Conclusions

The feasibility and effectiveness of these measures cannot generally be assessed at this time either because the SBDA has not provided sufficient design detail or because there is not enough known about future water quality and quantity conditions to make an assessment. The appropriate selection of fish species and their management will have to be determined once the reservoirs are filled.

The suitability of water quality and quantity for the fishery in the Souris River cannot be assessed because reservoir operation to benefit downstream fish habitat does not appear to have been considered in the modelling analysis. It seems unlikely that release targets for fish habitat could be met with any reliability given the higher priority uses for reservoir water.

The SBDA's proposed weirs upstream of the dams will require considerable personnel. Perhaps local sports enthusiasts could assist with these fish-rearing efforts. Local residents would thus be provided with an opportunity to help improve fishery resources in the Souris basin.

The loss of river fish habitat is a significant impact of the Project. The reservoirs will provide alternative habitat that could offset the loss but the suitability of the reservoirs as fish habitat is not known at this time. The SBDA proposed used tires as fish shelters to increase the reservoir suitability. Other options should also be considered to enhance cover for fish in the reservoirs, for example, boulder piles would be more aesthetically appealing than tire reefs that were exposed during drawdown. Tire reefs should be placed initially only in the deepest portions of the reservoir so that they are not visible during drawdown periods.

6.4 Wildlife and Vegetation

6.4.1 Waterfowl

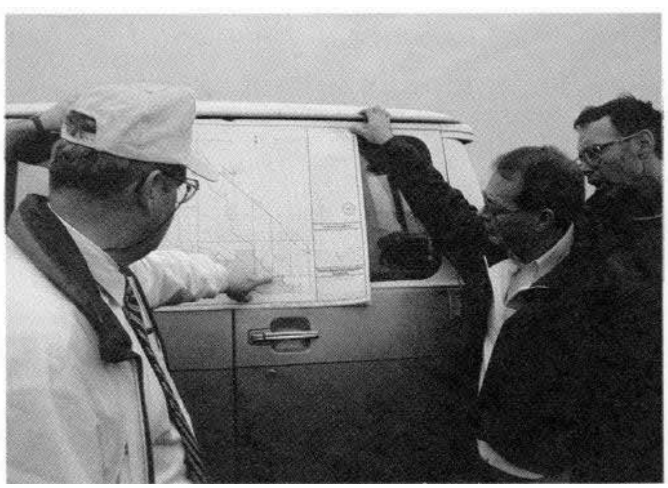
6.4.1.1 Waterfowl Mitigation by the SBDA

At Rafferty, the SBDA proposes to construct artificial wetlands totalling 53 km of shoreline, including impoundments in coulees of the Macoun Complex south of Hitchcock, 10 km of wetland shoreline development at Primary Grid Road #705, 2 km in the Dead Lake Channel and an additional 11 km at the new Dr. Mainprize Regional Park and in the Roughbark Creek Complex (see Figure 6.1). The SBDA is proposing four wetland developments totalling 38 km of shoreline at Alameda. These end-of-coulee developments are expected to support more breeding ducks than Moose Mountain Creek did before the Project was built (see Figure 6.2).

The expected increase in staging at the reservoirs by migrating waterfowl will produce problems in managing the likely increased harvest. The SBDA, together with the regulatory agencies, has agreed to limit hunter access to both reservoirs and to pay compensation to farmers for any increased crop depredation.

The only mitigation for the first 8 km of the channelized area downstream from the Rafferty Dam, which is in the form of a bermed channel, will be the establishing of an ecological reserve downstream of the Rafferty Dam. In the second 8-km stretch, in which the river course has been straightened, the meander loops of the river which have been cut off apparently will be preserved. The water levels will be maintained so that in effect they will be functioning wetlands.

No mitigation has been considered for the loss of Macdonald Lake and its adjacent wetlands. However, the artificial wetlands should more than make up for that loss.



Hilding Franson, of the SBDA, indicating the location of wildlife mitigation lands during the Panel tour of the Project, April 1991 (photo credit: R. Riewe).

The Midale Dam and Dead Lake looking upstream to the northwest. The sliver of land between Dead Lake Channel and the main Souris River is designated as wildlife mitigation land (photo credit: The SBDA).

The mitigation measures dealing with the impact of the Project on waterfowl populations are substantive and extensive. The SBDA has no real option but to develop alternative wetlands mainly by the use of control structures outside of, or on the periphery, of the reservoirs.

Mercury concentrations in Rafferty Reservoir are to be mitigated by the removal, before inundation, of trees, shrubs, dense plant growth and, as much as possible, of the organic detritus of the flood plain. The alluvial flood plain soils contain very little organic matter. No major problems are, therefore, expected.

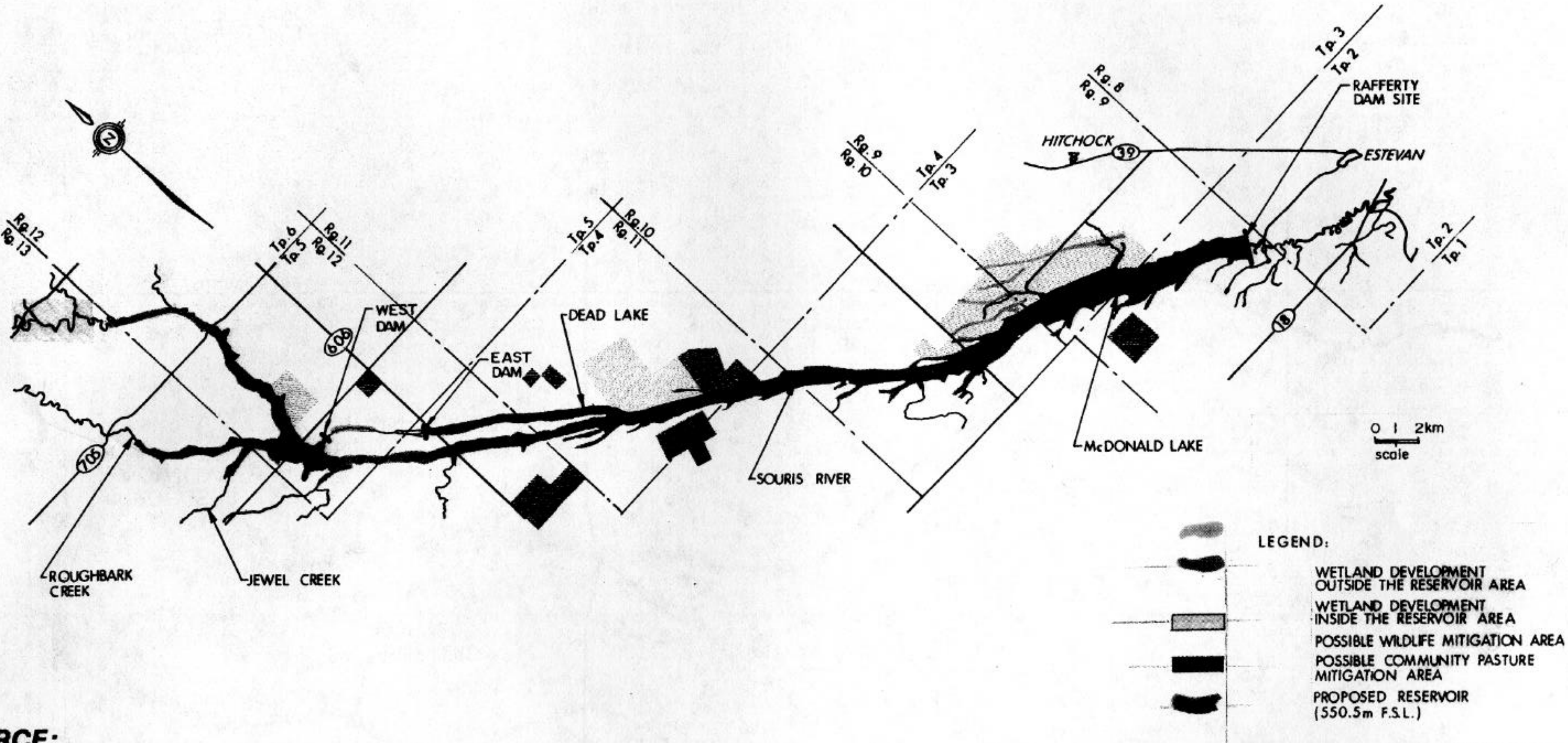
6.4.1.2 Waterfowl Monitoring by the SBDA

Waterfowl production on the artificial wetlands and on the two reservoirs will be monitored in accordance with the Saskatchewan Ministerial Approval for the Project and the *International River Improvements Act* Licence. Waterfowl productivity in the channelized area will be compared to production in the river habitat before the Project was begun.

6.4.1.3 Panel Observations and Conclusions

While most of the SBDA's proposed mitigation and monitoring measures have merit, they are often not described or analyzed in sufficient detail to enable the Panel to feel confident that impacts will be adequately mitigated. For example, there are no annual waterfowl harvest estimates and no description of the restrictions that would be placed on waterfowl harvest for areas next to the reservoirs. It is difficult, therefore, to predict the precise number of waterfowl available for hunting purposes.

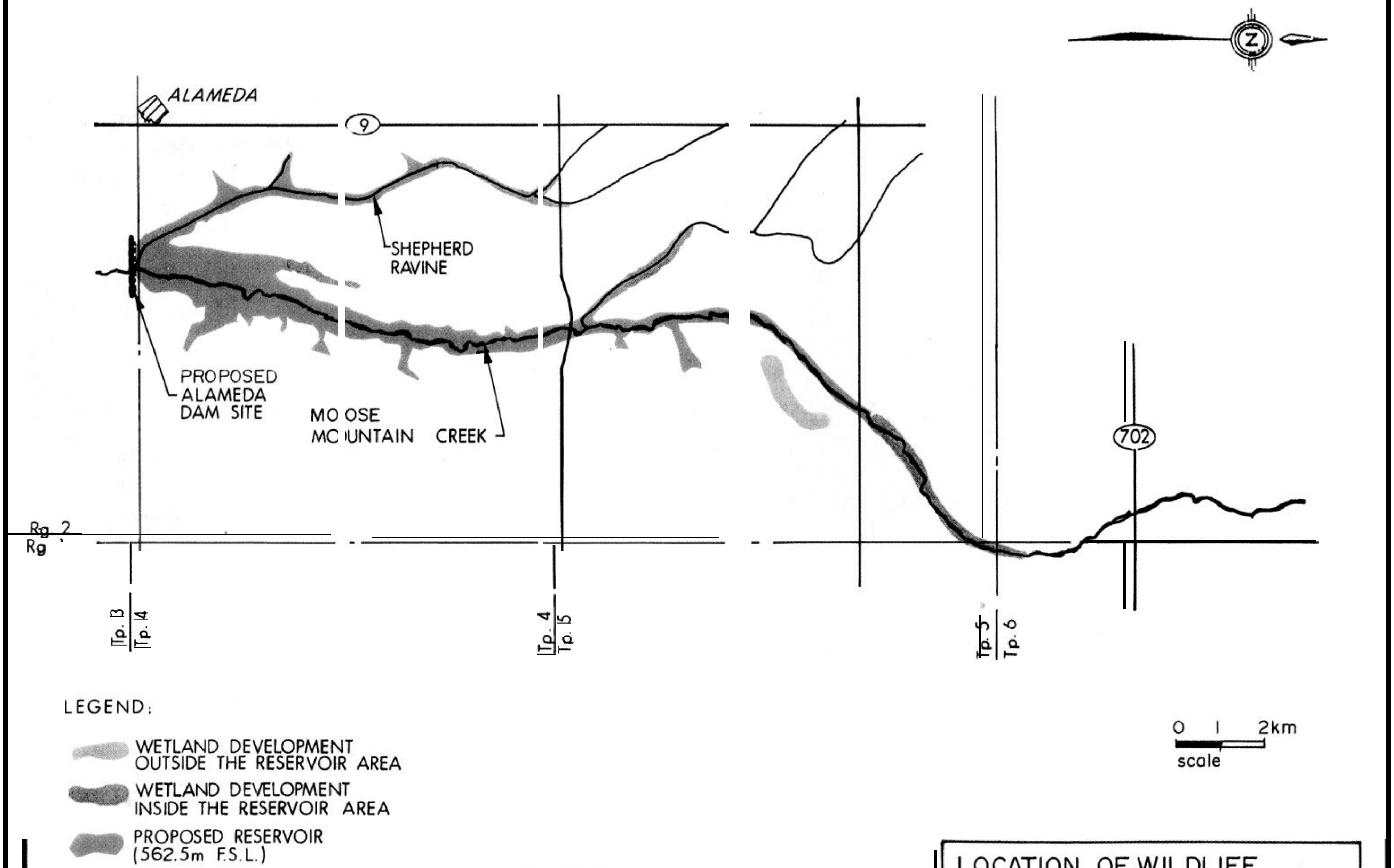
All artificial wetland projects are in the form of small-scale civil engineering works. Biological requirements have not been adequately considered in their design. The wetland projects,



LOCATION OF WILDLIFE MITIGATION AREAS AT THE RAFFERTY RESERVOIR
FIGURE **6.1**

SOURCE:

"Water Management Plan for the Souris River Basin, Saskatchewan". April 1990.



LOCATION OF WILDLIFE MITIGATION AREAS AT THE ALAMEDA RESERVOIR
FIGURE **6.2**

SOURCE:

"Water Management Plan for the Souris River Basin, Saskatchewan". April 1990.

particularly the coulee impoundments, will require a reliable water source for duck production. This source will mainly be spring runoff which is extremely variable in the region.

The Panel finds that the proposed habitat-based mitigation measures rely too much on trapping runoff water which is seasonally or annually variable or unavailable. The kilometre-for-kilometre replacement of shoreline loss has been exceeded but this does not assure that there has been no net loss of waterfowl production. The SBDA has not made a commitment to a reservoir operating regime to maintain the static water levels for May and June that are needed for successful breeding and nesting.

The plan for mitigating projected waterfowl losses in the channelized area lacks specificity and does not take into account the irrigation requirements.

The monitoring of waterfowl production is a long-term requirement; the SBDA does not currently have a mechanism in place for ongoing monitoring or to correct mitigation shortcomings and production short-falls.

As the channelization is already in place and pre-project waterfowl production levels are known, monitoring must continue to record losses in productivity that are to be made up elsewhere. The alternative is to modify the channelized area to enhance waterfowl productivity.

Another proposal suggests monitoring the hunting of waterfowl and the magnitude of any crop depredation. Any new hunting regulations will have to be enforced.

6.4.2 White-tailed Deer

6.4.2.1 White-tailed Deer Mitigation by the SBDA

The purchase of 61 quarter sections (3,951 ha) of previously cultivated upland and its planned conversion to habitat for white-tailed deer, waterfowl and game birds is the principal means of mitigation proposed by the SBDA for offsetting the loss of river and flood plain habitats. Other mitigation lands were purchased to replace community pasture lands lost to inundation.

The 31 quarter sections (2,008 ha) of mitigation lands in the Rafferty area have been assembled into three parcels, consisting of a block of 20 quarter sections (1,295 ha) south of Macoun and two smaller parcels on the east side of the basin south of Halbrite and on the northeast side of the basin south of Midale. The SBDA has also purchased 30 quarter sections (1,943 ha) of arable uplands, consisting of four parcels, in the Alameda area.

The SBDA intends to plant 25 per cent of each quarter section with mixed trees and shrubs to serve as browse and cover. The remaining 75 per cent will be planted to forage grasses (rye grass and wheat grass) and legumes (alfalfa and sweet clover). The SBDA reported there has been row-planting of trees and shrubs since 1988.

6.4.2.2 White-tailed Deer Monitoring by the SBDA

The SBDA has published no monitoring plan for the mitigation lands as they develop into habitats for various species or for white-tailed deer.

Upland tree planting on the north side of the Souris River Valley (photo credit: The SBDA).

6.4.2.3 Panel Observations and Conclusions

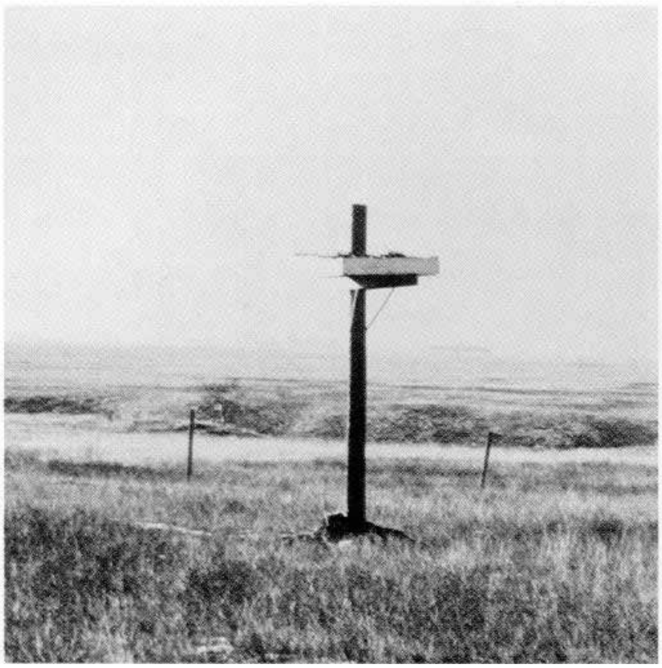
The Panel notes that about 50 per cent of the seedlings planted by the SBDA on the mitigation lands are not native to the area or the province. Those that are indigenous are characteristic of the valley complex rather than the uplands. No data are available on the palatability of any of the exotic plant species to white-tailed deer nor on their growth characteristics that would ensure their long-term availability as winter browse.

Effective development of deer habitat from previously cultivated land requires long-term research in order to determine what constitutes good deer habitat. A more thorough analysis of deer behaviour, feeding patterns, and food and habitat preferences might have indicated that the lands purchased were unsuitable or unnecessary as replacement deer habitat. Thus, instead of concentrating on white-tailed deer, for which better habitat exists in other, nearby areas of southeast Saskatchewan, the emphasis should be on re-creating natural ecosystems with greater biological diversity through the process of old field succession and plantings of indigenous trees and shrubs.

6.4.3 Rare Birds

6.4.3.1 Rare Bird Mitigation and Monitoring by the SBDA

Nest platforms have been erected on poles in selected upland locations to mitigate against the loss of ferruginous hawk nesting sites in the inundated area. The use of these new nest sites will be monitored on a continuing basis. Replacement habitat for Baird's sparrows is provided on the grassland areas protected from cattle grazing, such as the mitigation lands and the fenced perimeter of the basin, particularly the north-facing slopes. Ground surveys will be conducted to determine the presence of Baird's sparrows by identifying sound patterns.



Artificial ferruginous hawk nest (photo credit: The SBDA).

6.4.3.2 Panel Observations and Conclusions

The Panel is aware that experimental artificial nest sites have been successful elsewhere. However, the success of such a measure depends on the quality and quantity of foraging habitat. In an area that is heavily cultivated, the mitigation lands, once they revert to natural vegetation, will become useful foraging habitat for the ferruginous hawks. They should also provide adequate habitat for the Baird's sparrows.

6.4.4 Upland Game Birds

6.4.4.1 Upland Game Bird Mitigation and Monitoring by the SBDA

Sharp-tailed grouse and ring-necked pheasant are primarily upland species that were drawn to the valley by cereal crops and cover and have adapted to the ecosystem. The sharp-tailed grouse have established certain areas as their traditional dancing grounds (leks). Leks also exist on the uplands. The SBDA believes that both species will establish themselves on the upland mitigation lands where cover and access to farmland will be available.

The SBDA has studied the affinity of the sharp-tailed grouse to specific leks by tracking individual birds by radio.

6.4.4.2 Panel Observations and Conclusions

The Panel believes that, over time, the sharp-tailed grouse and ring-necked pheasant currently using the valleys will re-establish on the uplands and possibly on the mitigation lands. If the affinity for certain leks is found to be weak in the sharp-tailed grouse then the overall impact of inundation will be minor for both species.

6.4.5 Rare Plants

6.4.5.1 Rare Plant Mitigation and Monitoring by the SBDA

The SBDA concluded that isolated populations of provincially rare plants found within the reservoir areas cannot be salvaged by transplanting them to other sites. It may be possible to ensure long-term protection of other locations within the region where these rare species are present.

In this context, the SBDA has promoted the establishment of several provincial ecological reserves under the Ecological Reserves ***Act.*** To date, one such site, referred to as the Rafferty-Buffalo Grass Ecological Reserve, has been formally proposed for designation and action by the Province of Saskatchewan. Six to eight additional sites have been selected within the Souris basin as potential ecological reserves for existing rare plant populations within their habitat. One of these potential areas is the Hirsch-Pinto Site which, more than 20 years ago, was first recommended for protection by the Saskatchewan Committee of the International Biological Programme (IBP).

6.4.5.2 Panel Observations and Conclusions

The creation of a network of ecological reserves in the general project area offers an alternative opportunity to mitigate project-related ecological impacts through the permanent protection of examples of typical native plant communities of the flood plains, valley slopes and upland. The sites could serve as valuable benchmarks against which the vegetation on the wildlife mitigation lands could be compared. The reserves could also serve as benchmark sites for monitoring the effects of global climatic change.

The Panel recognizes that the SBDA is not authorized to designate and manage ecological reserves under the Ecological Reserves ***Act*** of the Province of Saskatchewan. However, one of the conditions of the licence under the *International* River Improvements ***Act,*** dated August 31, 1989, requires the licencee to propose "methods, such as ecological reserves," for mitigating project impacts on rare plants.

The active participation of provincial agencies is required for the successful creation of ecological reserves both for their legal establishment and for their ongoing protection from any form of encroachment and avoidable environmental damage. There is no assurance that these measures will, in fact, be implemented and no responsible agency has been identified.

6.5 Land Use

Much of the mitigation for the loss of pasture lands involves the purchase of arable upland areas. The same approach was followed for the mitigation of wildlife habitat. The SBDA intends to fence these lands and to seed or plant them to permanent herbaceous or woody cover so that they can serve as replacement wildlife habitat or community pasture lands. This approach, however, is disrupting agriculture in the study area.

Reservoir filling will also disrupt local transportation. The road realignments implemented by the Saskatchewan government, however, appear to have successfully mitigated harmful impacts.

The SBDA will be providing dugouts to farmers whose livestock will be denied access to the reservoirs. The approach assumes either that rainfall will be adequate to keep the dugouts filled or that the SBDA will provide an alternative means of filling them.

6.6 Mineral Resources

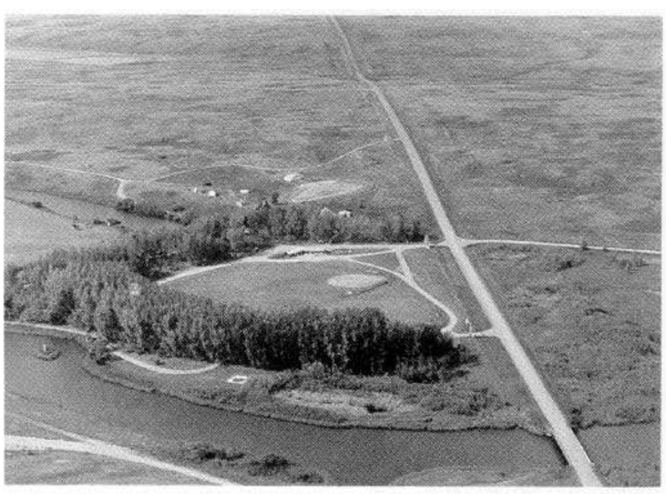
The Panel was informed that the SBDA would be applying state-of-the-art technology to cap and secure oil wells which are likely to be submerged by the reservoir. (see 6.2.1).

6.7 Recreation

The relocation of Dr. Mainprize Regional Park is a mitigation measure which includes a significant enhancement of the facilities to be inundated. Sites that feature interesting geologic formations, landforms, and historic or archaeologic resources, for example, the “Valley of the Rocks”, will be protected. The Panel is satisfied that these mitigation measures adopted by the SBDA will be effective.

It is important to clarify the dependence of recreational opportunities on water level fluctuations and water quality. This is essential for planning such activities and setting up suitable facilities.

The SBDA proposes to enhance recreational use of the reservoir by providing contoured and sanded beaches. This could have a minor negative impact on duck habitat.



Dr. Mainprize Regional Park (photo credit: The SBDA).

6.8 Social Issues

In its submissions to the Panel, the SBDA cited many positive aspects and social benefits of the Project. The Panel was repeatedly reminded that the remedial measures taken by the SBDA, including generous compensation for land acquisition, have effectively mitigated all major social impacts.

The Panel has noted and appreciates the SBDA’s efforts to provide adequate compensation and minimize social disruption. Most seem to be satisfied with the compensation. At the same time, the Panel is cognizant that some were not willing to make such arrangements. The Project is located in an area established by pioneer settlers. The people have strong historical, cultural and emotional ties to the land and the prairie environment. It is possible that a few were anticipating a larger or more attractive compensation package. Many others, however, were simply reluctant to uproot themselves and cut their ties with ancestral homes and memories of past generations. The Panel acknowledges and appreciates that, for some, such a loss cannot be mitigated.

6.9 Summary of the Panel’s Conclusions Regarding Mitigation and Monitoring

- The refinement of reservoir operating policies and procedures over time will be important for water quality, waterfowl and fisheries impacts. Modelling tools are the primary means of analyzing and understanding the interaction between basin hydrology and reservoir operations. A number of weaknesses were apparent in the modelling analyses undertaken for the Rafferty-Alameda Project. Field studies to better understand basin characteristics could redress some of the weaknesses. Others will require more sophisticated analytical approaches to the modelling.

- The examination of opportunities to understand and forecast long-term hydrologic cycles and trends would help the reservoir management authority plan for cyclical weather patterns and climate change.

- There is considerable concerning the ability of the Project to reliably meet the objectives for water quality, waterfowl, fisheries and recreation. A failure to meet demands could be minimized if a comprehensive water conservation plan is developed and implemented for the entire Souris River watershed.

- The Panel generally endorses the SBDA’s proposed mitigation plans for water quality impacts both in and downstream of the reservoirs. At the same time, however, it realizes that these measures are likely to meet with only limited success in easing the anticipated adverse impacts. The main weakness of existing plans lies in the failure to assign roles and responsibilities in a manner that will clearly establish the accountability, the authority and the material means to implement mitigation plans.

- There is a need to co-ordinate mitigation and monitoring plans for water quality. Long delays in reporting monitoring results will make it impossible to achieve timely mitigation responses to water quality problems. In addition, present monitoring commitments extend only to 1993. The reservoir might not be completely filled until 2010 or later.

- Existing fisheries will be adversely impacted, but too little is known at present to say with assurance that these impacts can be fully mitigated by the proposed plans for fish habitat and fishery management. The Panel endorses the proposed mitigation plans with the condition that the approach remain flexible. The Panel has noted some possibilities for enhancing the proposed measures, and recommends that potential opportunities for fisheries below the Rafferty Dam in the cut-off oxbows and the irrigation weirs be examined.

- To be effective, the recommended flexible approach to fisheries management must be supported by a sound program of fisheries monitoring involving creel surveys, netting studies and habitat assessments.

- Accumulation of mercury in fish and waterfowl flesh during the filling period cannot be mitigated. Such accumulation is expected but will abate over the long term. The Panel concurs with the SBDA that a public advisory program is needed to protect human health.

- Primary mitigation measures for waterfowl rely on the supply of runoff water to smaller impoundments behind weirs in the upper reaches of the main reservoirs. The Panel concludes that success of these measures is as uncertain as the supply of water to the weirs.

- The Panel endorses the acquisition of land to establish habitat for white-tailed deer in upland areas. It is concerned that the proposed plantings on these lands rely on exotic plants that are not proven suitable for white-tailed deer.

- All reasonable measures should be employed to ensure minimal risk of an oil spill in the reservoir. The Panel endorses the measures taken to achieve this including consultation with oil well owners and the application of the highest possible mitigation standards.

7.0 PANEL RECOMMENDATIONS FOR MITIGATION AND MONITORING

In this chapter, the Panel provides its recommendations regarding operations, mitigation and monitoring measures. The Panel summarizes its observations and conclusions regarding project impacts and the proposed mitigation and monitoring measures in order to provide some background to each of its recommendations.

The Panel found that, in certain areas, there has been considerable difficulty in predicting the nature and scope of impacts associated with the Project. Limitations in terms of available data and prediction techniques have contributed to the many uncertainties in impact prediction. This in turn has made it difficult for the Panel to assess impact mitigation and monitoring needs or the measures proposed by the Souris Basin Development Authority (SBDA).

The Panel observes that, notwithstanding these difficulties, the SBDA has proposed mitigation measures which should effectively address many of the potentially significant impacts. Some measures have already been fully implemented.

In a few cases, the Panel has concerns about the effectiveness of the mitigation and monitoring measures proposed by the SBDA. There are also a few instances in which the Panel has identified mitigation and monitoring measures which were not suggested by the SBDA. These are also listed below.

In considering options for mitigation measures, the Panel looked at a broad range of measures, including those that could apply both to the design/construction and the operating phases. It found that none of the potentially significant impacts can be mitigated through structural modification, beyond those already committed to by the SBDA, for example, a high level outlet for Alameda and baffles for aeration.

The Panel considers its recommendations for monitoring measures to be not only important for detecting any subsequent impacts, but also for developing an information base that can be used to improve impact management techniques, such as changes in the operating regime, and to improve impact prediction capabilities for future projects.

Recommendations made in this chapter are related to specific impacts and involve particular measures, actions or programs. More general observations and recommendations arising from the Panel's experience in this particular review and related to the environmental assessment process are presented in Chapter 8.

7.1 Mitigation

Responsibility for Implementation of Mitigation

The Panel encountered considerable uncertainty in attempting to assess the effectiveness of various mitigation measures because details of specific practices and design features were not available and responsibilities for implementing mitigation were not clearly identified.

Recommendation 1

That responsibilities for ongoing implementation and refinement of mitigation practices should be assigned to relevant agencies to ensure proper mitigation.

Inflexibility Caused by the Many Operating Constraints

Given the high priority of flood protection, water supply and apportionment requirements, there is limited opportunity to pursue other objectives such as environmental quality.

Recommendation 2

That alternative approaches to reservoir operation, such as release timing, water use priorities, etc., should be fully evaluated so that higher priority can be given to environmental benefits.

Recommendation 3

That flow monitoring and analysis should be carried out and used as a basis for refining the rules for reservoir water releases.

Recommendation 4

That licensing of Rafferty-Alameda water for additional irrigation should be delayed until reservoir losses to evaporation and groundwater are better understood.

Timing of Apportionment Releases

The relative merits of a spring/ early summer release versus a later release are not obvious.

Recommendation 5

The scheduling of releases should be flexible, with more priority given to waterfowl production. Other impacts should also be considered.

Release of Anoxic Water from the Reservoirs

The stratification of reservoir waters and the decay of dead phytoplankton following an algae bloom may cause dissolved oxygen levels in the reservoirs to become too low to support fish life in the river below the dams. Experience in Manitoba has shown that low concentrations of dissolved oxygen can be effectively mitigated through aeration.

Recommendation 6

That water management authorities should co-operate with each other to explore aeration techniques on reaches of the Souris River.

Water Quality Concerns in Manitoba

The reduced availability of water to North Dakota will make it difficult for North Dakota to maintain water quality in the Souris River.

Recommendation 7

That the Government of Canada should take appropriate steps to ensure that Manitoba's interests are protected.

Fisheries Management Plan

Until the fish habitat, water level, water quality and flow volume characteristics associated with the operation of the reservoirs have been observed for a number of years, it is difficult to know precisely what the most cost-effective fisheries management scheme will be.

Recommendation 8

That, under the current circumstances, it is premature to develop a comprehensive, detailed series of fisheries mitigation and monitoring commitments. Therefore, an experimental fisheries management plan should be implemented in both reservoirs.

Loss of Fish Habitat Below Rafferty Dam

Oxbows below Rafferty Dam will be cut off from streamflows as a result of channelization. The proposed preservation of these oxbows as wetlands creates an opportunity to develop additional fish habitat.

Recommendation 9

That consideration should be given to the development of fish habitat in the cut-off oxbows by designing a mechanism for their seasonal flooding. This would replace the natural flooding found in the unregulated river system.

Waterfowl Mitigation

The Panel is not confident from the information supplied by the SBDA that a "no net loss" of waterfowl production can be achieved (see Section 6.4.1).

Recommendation 10

Further development of the Waterfowl Management Plan should include additional mitigation measures below Rafferty such as a pond, pool and weir system similar to that downstream from Lake Darling, North Dakota.

Management of Wildlife Mitigation Lands

Current planting schemes for new wildlife habitat rely on exotic and native trees and shrubs planted in rows.

Recommendation 11

That the acquired cultivated lands should eventually be allowed to revert, through old field succession, to prairie grasslands.

7.2 Monitoring

Responsibility for Monitoring

The SBDA has not clearly identified responsibilities for long-term monitoring of impacts and mitigation effectiveness.

Recommendation 12

That the roles and responsibilities of different agencies in long-term monitoring and reporting mechanisms should be clearly defined.

Linkage of Mitigation to Monitoring

Long delays have occurred in reporting the results of water quality monitoring. There are no mechanisms in place that can facilitate prompt mitigation action in response to problems identified by the monitoring.

Recommendation 13

That the relationships between water quality monitoring efforts, the interpretation of data and the implementation of mitigation measures should be clearly established.

Mercury Contamination of Fish Flesh

The SBDA proposed the monitoring of fish flesh in the reservoirs for seven years because it is expected that mercury will be released from inundated soils into reservoir waters.

Recommendation 14

That monitoring of mercury levels in fish flesh should be conducted both in and downstream of the reservoirs. This monitoring should be repeated in alternate years for at least 12 years following the filling of the reservoirs. When conditions warrant, fish consumption advisories should be issued.

Uncertain Fisheries Development in the Future

Recognizing that the fish population structure in the reservoirs is likely to be dynamic, the SBDA has committed to fisheries management in the reservoirs and acknowledges the need for monitoring.

Recommendation 15

That management efforts to assure recreational opportunities should be based on fish monitoring, including creel census programs.

Waterfowl Monitoring

The proposed survey techniques to determine waterfowl breeding pairs, nesting success and brood survival are basically sound (see Section 6.4.1) but there is concern about how long the surveys will continue to be taken.

Recommendation 16

Surveys should be continued annually until waterfowl production levels are stabilized to regional levels.

Wildlife Mitigation Lands

The SBDA is converting 61 quarter sections into wildlife mitigation lands.

Recommendation 17

That plant succession toward mixed grass prairie should be monitored on the wildlife mitigation lands.

Recommendation 18

That a monitoring system should be established and maintained whereby the degree of use of the mitigation lands by wildlife can be documented.

Rare Plant Protection

Ecological reserves established under the Ecological Reserves *Act* can provide protection for rare or threatened species (see Section 6.4.5).

Recommendation 19

That the potential ecological reserves identified by the SBDA should be considered for protective status and that, for those selected, adequate management measures should be instituted by appropriate levels of government.

Panel member, Dr. William Stolte, viewing the confluence of the Souris with the Assiniboine River, April 1991 (photo credit: RJ Riewe).

8.0 GENERAL OBSERVATIONS AND RECOMMENDATIONS OF THE PANEL

Since early days, there has been a persistent vision in prairie Saskatchewan that has motivated those who would make their living from the land. This dream or vision has to do with the availability of water for people, for irrigation, for power, for recreation. It was this vision that led George Spence, an early Minister of Public Works in Saskatchewan, to recommend diverting water from the South Saskatchewan River into the Qu'appelle River system in order to provide water for Regina and other centres. It was this same vision that prompted people to demand the building of a dam on the South Saskatchewan River. Today, this vision finds a focus in the Souris River basin and is expressed in a call for managing the water of this prairie river.

The narrower focus of the vision today brings planners face to face with the realities of the prairie environment and the harsh limitations imposed on those who would seek to turn the vagaries of a prairie river to the purposes of a 20th century people. Today, the vision has much to do with the quality of life and with a concern for the environment in which people must live.

The Panel has taken the view that the desires and wishes of the people most closely connected with the Project, that is, the residents of the basin, must be taken very seriously. This it has done. However, these wishes cannot be considered determinative. All Canadians have an interest in the stewardship of their land. Therefore, the Panel has also incorporated a broader national view into its deliberations.

8.1 Cumulative Impacts

It should be pointed out that the impacts of a project do not occur in isolation. The impacts of a new project interact with the impacts of existing projects. Sometimes this synergistic interaction can generate a negative impact which is much greater than it would have been if the interaction did not exist. Thus, the environmental impacts of a project have to be considered within the context of the entire ecosystem in which the project is placed.

The Rafferty-Aiameda Project has direct impacts on the regime of the entire Souris River basin. It may also cause some cumulative impacts which are less direct. The Souris River is part of the Nelson drainage system which flows into Hudson Bay. The impact of the Rafferty-Alameda Project on the Nelson River system and the Hudson Bay ecosystem may or may not be pronounced but such a possibility cannot be discarded. The Panel did not have adequate information at its disposal to ascertain the scope and magnitude of those impacts but they are bound to be exceeded by the impacts of water management projects of far greater scale on other river basins draining into Hudson Bay.

Recommendation 20

That environmental reviews of such proposals should be conducted thoroughly because the associated impacts could have implications of national and global significance.

8.2 The Federal Environmental Assessment and Review Process (EARP)

The Panel is aware of the growing public concern about the state of the Canadian environment and of government's frequently declared resolve to put environmental protection at the top of the political agenda. The rapid transition in the public's attitude toward increased environmental protection created some unusual conditions during the assessment and construction of the Project. Most obvious is the fact that this Panel review is being undertaken and completed long after the Project was begun. This put severe limits on the relevance, effectiveness and usefulness of the Panel's deliberations.

The Panel understands that another important purpose of environmental impact assessment is to explore different ways to complete a proposed project and also to identify other possible and feasible alternatives. The stages of development of the Rafferty-Alameda Project at which both the previous and the current EARP Panel got involved made it impossible to contemplate such approaches.

Recommendation 21

That for the environmental impact assessment (EIA) process to serve as an effective planning tool, it is imperative that the provincial process and the federal process should be more closely co-ordinated, and that an EIA be completed before irrevocable decisions are made about a project.

8.3 Economics

The economics of the Project were not considered because this matter was not included in the Panel's mandate. However, it is worth noting that some estimates of the cost of mitigating negative environmental impacts have ranged as high as 30 per cent of the total project cost. It is conceivable that this proportion could be greatly exceeded in other similar projects.

What is obvious to the Panel is that, for this project and probably for many others, the cost of mitigating the negative impacts of water management projects can be a significant portion of the total cost. In future, it should be incumbent on water managers to take this factor into account in their decision making about the merits of such projects. The Panel wishes to highlight the importance of factoring the costs of mitigation into the overall benefit cost analysis of the project. Furthermore, analysis of project economics should include, as much as possible, the environmental costs or benefits of project impacts which cannot be mitigated.

8.4 Basin-wide Water Management

It was brought to the attention of the Panel that a more global approach to transboundary water management issues should be taken. It was suggested that a basin-wide integrated management perspective be adopted. The Panel concludes that proper water management in the Souris River basin can only be accomplished within the framework of a comprehensive basin-wide water management plan.

Recommendation 22

That the SBDA's Souris River basin water management plan should be expanded to apply to the entire Souris River basin including North Dakota and Manitoba. Further, it recommends that, for effective implementation of this plan, institutional arrangements and delegation of authority to other levels of government should be considered.

8.5 Water Diversion

The prospect of water diversions to the United States is emerging as a political issue in this country. This issue was raised with respect to this Project and relative to various interpretations of the wording of the *International* River *Improvements* Act (IRIA) licence allowing diversion into the basin of an amount of water equal to one-half of the annual flow in the Saskatchewan portion of the Souris basin.

While this is not a substantial amount of water, this possible diversion can be seen as creating a precedent. Apparently the drafters of the licence did not intend this interpretation of the clause. Also, it seems at variance with the position of the Government of Canada which has previously stated that the water of Canada is not for sale.

The Panel observes that the present state of knowledge would not allow for the identification, let alone mitigation, of the continental environmental impacts that could result from large-scale diversion of water.

Recommendation 23

That the IRIA licence should be revised to reflect clearly the intent of not allowing the diversion of Canadian water to the United States.

8.6 Global Warming

Another issue raised in the course of the Panel's deliberations was global warming and its possible impacts on the viability of the Project. Public sensitivity to this issue has come into play, mainly in the last few years, after the Project was initially designed. Thus, the planning and design documents for the Project make no reference to this phenomenon.

The Panel recognizes that the possible climatic changes caused by global warming and its effects on the Souris River basin are uncertain. It is understandable that it would be virtually impossible to incorporate this factor in the design of the project. This would not be the case for future projects.

Recommendation 24

That designers of future water management projects take into consideration the global warming phenomenon and its possible impact on the hydrology of the impacted region.

8.7 Water Availability for Irrigation

The Panel examined the issue of water supply for irrigation and came to the conclusion that water for additional irrigation may not be available with the reliability that some potential users seem to expect.

Recommendation 25

The Panel feels that potential users should be made more aware of this possibility.

8.8 Flood Plain Zoning

It is a given that present development exists along the Souris flood plain and that the flood protection only covers the 100-year flood. It should be recognized that there will be floods in the future which will outstrip the flood storage capacity of the reservoirs and again inundate the downstream flood plain.

Recommendation 26

That flood plain zoning should continue to be implemented to prevent further development in the flood plain which could suffer damage under major flood conditions. This should be done throughout the basin.

8.9 Agricultural and Land-Use Practices

Another factor which can contribute to the need for flood control is land-use practices which enhance runoff. In particular, these practices include fall tillage, summer fallow, stubble burning and overgrazing. Under these conditions, the capacity for snow entrapment is reduced. The snow that would otherwise be retained on the uplands, where it could infiltrate and increase soil moisture in the spring, is accumulated in drainage ditches and river bottoms, where it can contribute to flooding problems. Had land-based conservation been practised in the past, the Rafferty and Alameda dams might not have been necessary.

Recommendation 27

That the various levels of government should consider instituting policies and programs to encourage farmers to adopt farming practices which reduce the potential for flooding.

8.10 Wetlands

It is a condition of the IRIA licence that no wetlands be drained to secure water for filling the Project reservoirs. At present there is a moratorium on wetland drainage in the study watershed. The Panel recognizes that agricultural policies may provide incentives to increase the amount or quality of arable land by means of drainage.

Recommendation 28

That the preservation of wetlands should be given priority at the national, provincial and regional levels and that a reliable mechanism be found to permanently safeguard wetlands in the study area.

8.11 Conservation-based Management

Sections 8.8, 8.9 and 8.10 relate to the impact of human developmental activity on the ecological and hydrological conditions of the Souris basin. It would appear that efforts to mitigate some of the resultant problems have focussed narrowly on structural solutions.

Recommendation 29

Canadian society in general should adopt a more conservation oriented approach to water resource planning, and indeed all developmental activity, in order to achieve a more harmonious, balanced and integrated stewardship of the physical environment.

8.12 Future Research Needs

The Panel urges that further research into specific areas relating to knowledge deficiencies in the Souris basin be undertaken. Areas requiring attention include the following:

Hydrology

- Climatic cyclicity and its relation to prediction of water availability;
- Statistical structure of Souris basin flows and their use in predicting reliability of water supplies;
- Hydraulics of the system including flow travel times, channel seepage and channel capacity under pre-flood conditions; and
- Interactions between groundwater pumping, sustainable aquifer yield and aquifer recharge from the reservoir.

Water Quality

- Spatial and temporal variations in the major water quality parameters, including dissolved oxygen and un-ionized ammonia, particularly on an hourly basis, and how they are affected by travel times, aeration schemes, photosynthesis, ice cover, snow cover, etc.

Research of a more general nature is also required. In particular, it is essential that baseline data be collected on all important streams in Canada, especially those which have the potential of being developed for hydroelectric production and other purposes.

Another important area of research would be the development of methodologies for evaluating cumulative impacts.

Recommendation 30

That the relevant levels of government should make research in the area cumulative impacts a priority, and strengthen institutional structures and allocate funding that will allow rapid knowledge generation in this area.

8.13 Summary

In summary, the issues that have confronted the Panel in the course of its review have been varied, complex and of great importance. The Panel found little evidence that any of the agencies involved in the Project have acted in a manner contrary to the public interest. Nevertheless, rapid transitions in public attitudes have led to situations which were less than ideal and on occasion, caused strained relationships among the agencies. The Panel hopes that its review of the Project has helped to alleviate these problems, and that in the future water management in Canada might be a more amicable process of co-operation among the various levels of government and the public.

RAFFERTY-ALAMEDA PROJECT

ENVIRONMENTAL ASSESSMENT PANEL

John H. Archer O.C. (Chairman)

Roderick R. Riewe

William J. Stolte

APPENDIX I

KEY DOCUMENTS USED BY THE PANEL DURING THE REVIEW

Agreement Between the Government of Canada and the Government of the United States of America for Water Supply and Flood Control in the Souris River basin. 1989.

Environment Canada. 1987. Comments of the Regional Screening Coordinating Committee on the Rafferty-Alameda Environmental Impact Statement.

________. 1989. Rafferty-Alameda Project Initial Environmental Evaluation.

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Rawson Academy of Aquatic Science. 1991. The Rafferty-Alameda: Who Benefits, Who Pays and Who Controls? Discussion Draft.

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APPENDIX II

TERMS OF REFERENCE FOR THE RAFFERTY-ALAMEDA DAM ENVIRONMENTAL ASSESSMENT PANEL

Issued by the Minister of the Environment

Mandate

The Environmental Assessment Panel is to undertake a review of the environmental and directly related social impacts (resulting from changes to the biophysical environment) of the Rafferty-Alameda Dam Project. In addition, the Panel has the mandate to:

- Review plans to mitigate the effects of both the construction and operation of the Project;
- Make recommendations concerning the mitigation of these impacts;
- Provide advice to the Minister on the adequacy of the mitigation plans prepared by the proponent pursuant to the International River *Improvements* Act licence; and
- Make recommendations concerning the operation of the dams, including possible structural modifications if necessary.

In formulating its recommendations, the Panel will take account of Canada's international obligations, including agreements with the United States, related to this project.

Scope of the Review

The Panel will review all existing studies prepared in association with the environmental reviews conducted in accordance with the Saskatchewan Environmental Assessment Act, the United States *National Environmental Policy Act* and the Canadian federal Environmental Assessment and Review Process (EARP) Guidelines Order.

Review Process

The main components of the process will be:

1) Appointment of an Environmental Assessment Panel and issuance of the Panel's Terms of Reference by the Minister of the Environment;

2) Development and issuance, by the Panel, of operational procedures for the review;

3) Review by the Panel and the public of information submitted in response to original Panel's Information Request of August 1, 1990;

4) Convening of hearings by the Panel to receive public comment; and

5) Preparation of a report to the Minister.

APPENDIX III

PANEL MEMBERS' BIOGRAPHIES

John Archer (Chairman)

Dr. Archer is a native of Saskatchewan and a highly regarded historian. He has a Ph.D. in History from Queen's University and was President of the University of Regina before serving as Professor of Western Canadian History at that university. Among his many awards and honours, Dr. Archer is an Officer of the Order of Canada and holds the Saskatchewan Order of Merit. He currently writes and hosts his own television program detailing the history of Saskatchewan communities. He is also the author of "Saskatchewan: A History", a comprehensive account of the province's past. Throughout his career, he has been an active member of many voluntary associations, boards and commissions at the local, provincial and national levels including the Canadian Centenary Council and the Saskatchewan Heritage Property Review Board.

Roderick R. Riewe

Dr. Riewe is a Professor of Zoology at the University of Manitoba where he has taught since 1973. His current research interests include wildlife ecology and management, native land use and northern land claims. He is currently on research leave at the Canadian Circumpolar Institute, University of Alberta.

William J. Stolte

Dr. Stolte is currently Associate Professor of Civil Engineering at the University of Saskatchewan. He holds a Ph.D in Civil Engineering (Hydrology) from the University of Washington and has been teaching since 1970. His current research centres on hydrological issues relative to the prairies.

APPENDIX IV

SCIENTIFIC — TECHNICAL TEAM IN SUPPORT OF THE PANEL REVIEW OF THE RAFFERTY-ALAMEDA DAM PROJECT

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APPENDIX V

DATES, LOCATIONS AND LIST OF PRESENTERS AT THE HEARINGS

Alameda, Saskatchewan	June 24, 1991	2:00 pm	Community Session

Glen Gibson
Joe Harvey
Alan Scarth (for Ed and Harold Tetzlaff)

Estevan, Saskatchewan	June 24, 1991	7:00 pm	Community Session

Alfred Garneau
Glenn Peterson

Estevan, Saskatchewan	June 25, 1991	9:00 am	General Session

Dennis Moore
Patrice Kreuger (for Jack Fingler)
John Empey — Mayor,' City of Estevan
Robert Halliday — Environment Canada

Souris, Manitoba	June 25, 1991	7:00 pm	Community Session

Clare Somersall — Mayor, Town of Souris
Doug Denning — Reeve, Rural Municipality of Glenwood
Wayne Williams — Councillor, Rural Municipality of Glenwood

Brandon, Manitoba	June 26, 1991	9:00 am	General Session

Howard Nixon
James Clark — Councillor, Ward 6, Rural Municipality of South Cypress
Orlin Hanson — Senator, North Dakota
Ron Renwick — Chairman, Souris River Water Commission
David DesLauriers — Renville County Board of Commissioners

Melita, Manitoba	June 26, 1991	7:00 pm	Community Session

Wayne Drummond
Ken Carels — Mayor, Town of Melita
Duncan Stewart — Sierra Club

Oxbow, Saskatchewan	June 27, 1991	9:00 am	Community Session

Jim Reed — Mayor, Town of Oxbow
Betty Pegg
Alan Shay
Mike Bartolf

Regina, Saskatchewan	June 28, 1991	9:00 am	General Session

Jack Muirhead
Richard Backes — Department of Transportation, North Dakota
George Christenson — Mayor, City of Minot, North Dakota
George Ledingham — Professor, University of Saskatchewan
David Orchard — Citizens Concerned About Free Trade
Mike Bishop

APPENDIX VI

PUBLIC PARTICIPATION IN THE RAFFERTY-ALAMEDA REVIEW

1.0 OPPORTUNITIES FOR PUBLIC COMMENT

Opportunities for public participation have been provided at different stages during reviews of environmental studies on the Rafferty-Alameda Project. These included public hearings, open houses and informal meetings. Written comments and petitions have been submitted by the public and various agencies have submitted technical reviews.

Three major public forums have been conducted in reference to the Project:

1 Public hearings were held in 1987 by the Saskatchewan Board of Inquiry to review the Environmental Impact Statement prepared by the Souris Basin Development Authority.

Carlyle	September 9, 1987
Oxbow	September 10, 1987
Weyburn	September 11 /12, 1987
Estevan	September 17/18/19, 1987
Regina	September 21, 1987
Alameda	November 13, 1987
Estevan	December 3/4, 1987

2. In 1989 public meetings were held by Environment Canada to review the Initial Environmental Evaluation.

Saskatchewan:

Regina	June 22, 1989
Oxbow	June 23, 1989
Estevan	June 24, 1989

Manitoba:

Melita	June 26, 1989
Souris	June 28, 1989
Brandon	June 29, 1989

North Dakota:

Minot	June 27, 1989

3. In June 1991 public hearings were held by the Rafferty-Alameda Environmental Assessment Panel.

Saskatchewan:

Alameda	June 24, 1991
Estevan	June 24, 1991
Oxbow	June 27, 1991
Regina	June 28, 1991

Manitoba:

Souris	June 25, 1991
Brandon	June 26, 1991
Melita	June 26, 1991

4. In addition to the opportunities for the public to express themselves at the Panel's formal hearings, the public had the opportunity to meet the Panel on two previous occasions:

a) On March 11, 1991, the Panel held an open house in Estevan to meet with members of the community and listen to their concerns. The Panel also toured the Project accompanied by the media and the public.

b) On April 17 and 18, 1991, the Panel again toured the Project, as well as the Souris basin through North Dakota and Manitoba. The public was invited to tour the Project with the Panel.

2.0 Overview of Public and Agency Comments on the Rafferty-Alameda Project 1987 to 1991

	SUPPORTING VIEWS	OPPOSING VIEWS
AGRICULTURAL RESOURCES		• loss of good cropland to flooding and new wildlife habitat • loss of existing farms • land acquisition at low prices
ARCHEOLOGICAL RESOURCES		• loss of significant sites
ASSESSMENT PROCESS		• dissatisfaction with process
COMMUNITY EFFECTS	• project will stimulate growth • economic diversification • increased tax revenues	• added infrastructure costs • increased taxes due to lost land base
ENERGY REQUIREMENTS	• need for Shand project	• alternatives not considered
FLOOD CONTROL	• flood protection	• more small dams • better location of dams • benefits mainly to United States
FLOODING OF RESERVOIR LANDS		• effects on ecological system • compensation may be inadequate • loss of existing recreational potential • impacts on agricultural community
IRRIGATION	• more water available for irrigation	• financially not feasible • water quality and quantity unreliable • irrigation land unsuitable
OTHER JURISDICTIONS		• benefits to United States • impacts in Manitoba • potential for inter-basin diversions to U.S.
RARE AND ENDANGERED SPECIES		• loss of habitats
RECREATION	• new fishing and boating opportunities	• water quality will be poor • fishing opportunities will decline • hunting opportunities will decline
WATER MANAGEMENT	• long-term benefits exceed costs • water control stabilizes economics	• project not viable • competing water demands • alternatives not considered • groundwater impacts • inadequate flows to fill reservoirs
WATER QUALITY		• pollution will increase • livestock use will be impaired • recreation use will be impaired • fish will decline • salinity will increase
WILDLIFE AND FISHERIES	• improved wildlife habitat • new hunting opportunities • improved fish habitat	• crop damage from waterfowl and deer • habitat losses in reservoirs and oxbows • waterfowl production will decline • wetlands will be lost • migrating songbirds will be affecte • loss of turtle habitat • non-game species affected

APPENDIX VII

GLOSSARY OF TERMS AND DEFINITIONS

Aeration of water	A process by which oxygen becomes dissolved in water.
Algal bloom	Population explosion of algae common in nutrient-rich waters.
Anoxic water	Water which has no dissolved oxygen.
Apportionment	The allocation of proportions of the total flow to various users or jurisdictions according to an agreed formula.
Aquifer	Layer of rock or soil able to hold or transmit much water.
Avian botulism	A bacterial infection, deadly to birds, often found in anoxic waters.
Bankful capacity	The maximum flow that a given watercourse can convey in a specified reach without the water level rising above the level of either bank.
Benthos	Flora and fauna inhabiting aquatic sediments.
Berm	Earthen embankment.
Biocides	A substance or agent that destroys biological organisms.
Borrow pits	Pits created by the removal of earth for use in the construction of dams, roads and other works.
Consumptive loss	Removal of natural flows for such uses as irrigation, livestock watering or municipal and industrial uses.
Control point	A streamflow gauging station or dam which is used to develop operating decisions for a water management system.
Controlled volume	The volume of runoff that can be controlled by using available flood control storage.
Coulees	A steep ravine.
Creel census	Survey of anglers' fishing effort, success and harvest.
cubic decametre (dam^3)	1,000 cubic metres or 0.811 acre-feet.
cubic foot per second (cfs)	0.0283 cubic metre per second (m^3/s)
Detritus	Dead and decaying parts of vegetation.
Dissolved solids (dissolved salts)	Mineral compounds dissolved in water.
Drawdown	The physical act of lowering the pool level of a reservoir through controlled releases.
Ephemeral stream	A stream which flows intermittently.
Estimate	A value based on the best judgement of qualified personnel using all available data.
Eutrophic	Rich in nutrients.
Exotic species	Animals or plants which do not naturally occur in a given geographic area.
Flood control storage	The volume set aside below the maximum allowable water level in a reservoir to store flood event runoff.
Forced evaporation	Evaporation of water as a means of cooling steam generators or other industrial equipment.

Full Supply Level (FSL)	The maximum elevation that the reservoir pool is allowed to attain in the course of normal operations.
hectare (ha)	10,000 m^2 or 2.468 acres.
Hydrograph	A graph showing a river's flow rate over time.
Hypolimnion	The colder bottom zone of a stratified lake.
Seepage loss	Loss of water from the reservoir through seepage into groundwater.
Lacustrine	Relating to, or growing in lakes.
Lek	An area (dancing ground) where grouse assemble for courtship displays.
Local flow	The runoff that occurs between two given locations.
Macrophyte	An aquatic plant visible to the naked eye.
Maximum allowable flood level	The highest level a reservoir is allowed to reach while storing water for flood control purposes. When a reservoir reaches this level, any additional flows into the reservoir must be spilled.
Maximum level prior to spring runoff	The reservoir level which must not be exceeded prior to the spring runoff, regardless of the predicted volume of runoff.
Methylated mercury	An organic mercury compound, often formed by inundation of organic matter, which may accumulate in the tissue of aquatic organisms.
Mine spoil	The overburden removed in the process of strip mining.
Minimum supply level	The lowest pool level at which water can be released from a reservoir.
Mitigation	An action intended to alleviate an adverse impact.
Natural flow	The volume of runoff naturally occurring in a river system.
Nitrification	Chemical process by which un-ionized ammonia is transferred into nitrates.
Nitrogen and phosphorus loading	The addition of dissolved nitrogen and phosphorus to an aquatic system.
Non-compliance	The act of exceeding allowable standards
1 per cent flood (100-year flood)	The flow level that would be equalled or exceeded, on average, once in 100 years.
Old field succession	The natural succession of abandoned field to forest.
Oxygen deficit	A dissolved oxygen level that is less than that required by aquatic organisms.
Periphyton	Organisms that live attached to underwater surfaces.
Pool level	The static water surface elevation of a reservoir.
Pore water pressure	Pressure of water within the soil.
Raptor	Bird of prey such as eagles, hawks and owls.
Recharge	The replacement of groundwater by infiltration of surface waters.
Releases	The controlled discharge of water from a reservoir other than spills.
Reservoir Regulation Manual	A document which is to be used as a guide by the responsible agency in the day-to-day operation of a reservoir. The manual includes discussion of the following topics: description of the Project, history of the Project, watershed characteristics, data collection and communication networks, hydrologic forecasts, the water control plan and water control management.
Riparian	Relating to the banks of a natural water course.
Riverine	Relating to a river.
Runoff	The flow of water in a watercourse in response to rainfall and/or snow melt.

Runoff volume, 30-day (= 30-day volume)	Maximum 30-consecutive-day runoff volume that occurs in any given year.
Runoff volume, 90-day (= 90-day volume)	Maximum 90-consecutive-day runoff volume that occurs in any given year.
Runoff volume 90 per cent, 90-day	The estimated 90-day volume of unregulated runoff with a 90 per cent probability of being equalled or exceeded by the actual runoff.
Sedimentation	The process of forming aquatic substrates through erosion.
Seepage	The act or an instance of a fluid passing through porous material, (e.g., water through soil).
Sensitivity testing	A method of determining which parameters have the most impact on a given result.
Sherwood	The international gauging station, number 05114000, latitude 48:59:24, longitude 101:57:28, on the Souris River, 0.8 miles downstream of the international boundary.
Short-stopping of waterfowl	Stopping migratory waterfowl by attracting them away from their normal migration.
Slumping	Mass downward movement of unstable, earthen slopes.
Spill	The uncontrolled discharge of water from a reservoir.
Stratification	The process by which waterbodies develop layers of different temperatures and chemical properties.
Submergent vegetation	Vegetation growing underwater.
Substrate	The base or material on which an organism lives.
Target drawdown level	A pool level to which a reservoir should be lowered in response to estimated spring runoff so that the desired level of flood protection will be provided.
Target flow	The instantaneous flow at a given location that should not be exceeded during a given flood event as a result of releases from a reservoir or reservoirs.
Trophic	Relating to nutrient levels.
Trophic upsurge	A pronounced increase in nutrients in a waterbody as a result of an event such as spring runoff, inundation, etc.
Uncontrolled volume	The volume of runoff that cannot be controlled by the available flood control storage.
Un-ionized ammonia	Refers to dissolved ammonium gas in neutral form which is toxic to aquatic organisms.
Unregulated flow	That flow which would occur in the absence of a water control structure.
Waterfowl staging	Waterbodies where waterfowl rest and feed while on their spring and fall migrations.

APPENDIX VIII

LIST OF ACRONYMS USED

COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWF	Canadian Wildlife Federation
EARP	Environmental Assessment and Review Process
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
FEAR0	Federal Environmental Assessment and Review Office
IBP	International Biological Programme
IEE	Initial Environmental Evaluation
IRIA	International River Improvements Act
NAWMP	North American Waterfowl Management Plan
SBDA	Souris Basin Development Authority

APPENDIX IX

CONVERSION FACTORS

The following table may be used to convert measurements in the English (United States) system of units to the SI or metric (Canadian) system of units.

Multiply English Units by conversion factor to obtain SI Units

	Conversion Factor	
	Length	
inch (in)	25.4	millimetre (mm)
foot (ft)	0.3048	metre (m)
mile (mi)	1.609344	kilometre (km)
	Area	
square mile (mi2)	2.590	square kilometre (km2)
acre (ac)	4051.09	square metre (m3)
	Flow	
cubic foot per second (cfs)	0.02831685	cubic metre per second (m3/s)
	Volume	
acre-foot (ac-ft)	1.233482	cubic decametre (dam)
	Velocity	
foot per second (ft/s)	0.3048	metre per second (m/s)
	Slope	
foot per mile (ft/mi)	0.1894	metre per kilometre (m/km)

1 ha = 10 000 m^2 ==> ha x 2.46848 = acres

1 dam3 = 1 000 m^3 ==> dam3 x 0.811 = ac-ft

APPENDIX X

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